Exhibit F

POWER OF ATTORNEY TO PROSECUTE APPLICATIONS BEFORE THE UNITED STATES PATENT AND TRADEMARK OFFICE

This Power of Attorney is submitted by

Submitter Name: **Crusoe Energy Systems Inc.**

Address: **1641 California St.**
Suite 400
Denver CO, 80202

The Submitter hereby appoints the practitioners at **Davidson, Davidson & Kappel, LLC** associated with the Customer Number:

187732

as its attorney(s) or agent(s) to represent the Submitter before the United States Patent and Trademark Office (USPTO) and to transact all business before the USPTO in connection with any and all applications of which the Submitter is the/an applicant and the/an assignee or entity to whom the inventor(s) is/are obligated to assign.

Please direct all correspondence for any and all applications in which this Power of Attorney is submitted to the address associated with the Customer Number:

187732

The individual(s) whose name(s) and title(s) is/are supplied below is/are authorized to act on behalf of the Submitter.

Date: **2022-05-16**

By **/ Kyle Zeller /**
Name: Kyle Zeller
Title: Assistant General Counsel

Electronic Acknowledgement Receipt

EFS ID:	46302466
Application Number:	16529152
International Application Number:	
Confirmation Number:	9940
Title of Invention:	Systems and Methods for Generating and Consuming Power from Natural Gas
First Named Inventor/Applicant Name:	Charles Cavness
Customer Number:	186952
Filer:	Clint R. Mehall
Filer Authorized By:	
Attorney Docket Number:	CRUSOE-105002US1
Receipt Date:	29-JUL-2022
Filing Date:	01-AUG-2019
Time Stamp:	12:26:14
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	no

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Assignee showing of ownership per 37 CFR 3.73	9656001002_StatementOwnership29jul22.PDF	120060 c767927f435d922d4ad7fbb74ab89ab78b8b6197	no	3

Warnings:

Information:					
2	Power of Attorney	CrusoePOA.PDF	81490 05d1dcedb5c4887c46b3b88c400f8afc6162 6d98	no	1
Warnings:					
Information:					
		Total Files Size (in bytes):	201550		

This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.

New Applications Under 35 U.S.C. 111

If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

National Stage of an International Application under 35 U.S.C. 371

If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office

If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

PTO/AIA/96 (08-12)
Approved for use through 11/30/2020. OMB 0651-0031
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it displays a valid OMB control number.

STATEMENT UNDER 37 CFR 3.73(c)

Applicant/Patent Owner: CRUSOE ENERGY SYSTEMS INC.

Application No./Patent No.: 16/529,152 Filed/Issue Date: 08/01/2019

Titled: Systems and Methods for Generating and Consuming Power from Natural Gas

CRUSOE ENERGY SYSTEMS LLC, a LLC

(Name of Assignee) (Type of Assignee, e.g., corporation, partnership, university, government agency, etc.)

states that, for the patent application/patent identified above, it is (choose **one** of options 1, 2, 3 or 4 below):

1. ☑ The assignee of the entire right, title, and interest.

2. ☐ An assignee of less than the entire right, title, and interest (check applicable box):

   ☐ The extent (by percentage) of its ownership interest is _____%. Additional Statement(s) by the owners holding the balance of the interest must be submitted to account for 100% of the ownership interest.

   ☐ There are unspecified percentages of ownership. The other parties, including inventors, who together own the entire right, title and interest are:

   Additional Statement(s) by the owner(s) holding the balance of the interest must be submitted to account for the entire right, title, and interest.

3. ☐ The assignee of an undivided interest in the entirety (a complete assignment from one of the joint inventors was made). The other parties, including inventors, who together own the entire right, title, and interest are:

   Additional Statement(s) by the owner(s) holding the balance of the interest must be submitted to account for the entire right, title, and interest.

4. ☐ The recipient, via a court proceeding or the like (*e.g.*, bankruptcy, probate), of an undivided interest in the entirety (a complete transfer of ownership interest was made). The certified document(s) showing the transfer is attached.

The interest identified in option 1, 2 or 3 above (not option 4) is evidenced by either (choose **one** of options A or B below):

A. ☐ An assignment from the inventor(s) of the patent application/patent identified above. The assignment was recorded in the United States Patent and Trademark Office at Reel _____, Frame _____, or for which a copy thereof is attached.

B. ☑ A chain of title from the inventor(s), of the patent application/patent identified above, to the current assignee as follows:

1. From: The inventors To: CRUSOE ENERGY SYSTEMS INC.

   The document was recorded in the United States Patent and Trademark Office at
   Reel 049932, Frame 0952, or for which a copy thereof is attached.

2. From: CRUSOE ENERGY SYSTEMS INC. To: CRUSOE ENERGY SYSTEMS LLC

   The document was recorded in the United States Patent and Trademark Office at
   Reel 060356, Frame 0571, or for which a copy thereof is attached.

This collection of information is required by 37 CFR 3.73(b). The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.11 and 1.14. This collection is estimated to take 12 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

If you need assistance in completing the form, call 1-800-PTO-9199 and select option 2.

PTO/AIA/96 (08-12)
Approved for use through 11/30/2020. OMB 0651-0031
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it displays a valid OMB control number.

STATEMENT UNDER 37 CFR 3.73(c)

3. From: _____ To: _____

The document was recorded in the United States Patent and Trademark Office at

Reel _____, Frame _____, or for which a copy thereof is attached.

4. From: _____ To: _____

The document was recorded in the United States Patent and Trademark Office at

Reel _____, Frame _____, or for which a copy thereof is attached.

5. From: _____ To: _____

The document was recorded in the United States Patent and Trademark Office at

Reel _____, Frame _____, or for which a copy thereof is attached.

6. From: _____ To: _____

The document was recorded in the United States Patent and Trademark Office at

Reel _____, Frame _____, or for which a copy thereof is attached.

☐ Additional documents in the chain of title are listed on a supplemental sheet(s).

☑ As required by 37 CFR 3.73(c)(1)(i), the documentary evidence of the chain of title from the original owner to the assignee was, or concurrently is being, submitted for recordation pursuant to 37 CFR 3.11.

[NOTE: A separate copy (i.e., a true copy of the original assignment document(s)) must be submitted to Assignment Division in accordance with 37 CFR Part 3, to record the assignment in the records of the USPTO. See MPEP 302.08]

The undersigned (whose title is supplied below) is authorized to act on behalf of the assignee.

/Clint R. Mehall/	07/29/2022
Signature	Date
Clint R. Mehall	62,380
Printed or Typed Name	Title or Registration Number

Privacy Act Statement

The **Privacy Act of 1974 (P.L. 93-579)** requires that you be given certain information in connection with your submission of the attached form related to a patent application or patent. Accordingly, pursuant to the requirements of the Act, please be advised that: (1) the general authority for the collection of this information is 35 U.S.C. 2(b)(2); (2) furnishing of the information solicited is voluntary; and (3) the principal purpose for which the information is used by the U.S. Patent and Trademark Office is to process and/or examine your submission related to a patent application or patent. If you do not furnish the requested information, the U.S. Patent and Trademark Office may not be able to process and/or examine your submission, which may result in termination of proceedings or abandonment of the application or expiration of the patent.

The information provided by you in this form will be subject to the following routine uses:

1. The information on this form will be treated confidentially to the extent allowed under the Freedom of Information Act (5 U.S.C. 552) and the Privacy Act (5 U.S.C 552a). Records from this system of records may be disclosed to the Department of Justice to determine whether disclosure of these records is required by the Freedom of Information Act.
2. A record from this system of records may be disclosed, as a routine use, in the course of presenting evidence to a court, magistrate, or administrative tribunal, including disclosures to opposing counsel in the course of settlement negotiations.
3. A record in this system of records may be disclosed, as a routine use, to a Member of Congress submitting a request involving an individual, to whom the record pertains, when the individual has requested assistance from the Member with respect to the subject matter of the record.
4. A record in this system of records may be disclosed, as a routine use, to a contractor of the Agency having need for the information in order to perform a contract. Recipients of information shall be required to comply with the requirements of the Privacy Act of 1974, as amended, pursuant to 5 U.S.C. 552a(m).
5. A record related to an International Application filed under the Patent Cooperation Treaty in this system of records may be disclosed, as a routine use, to the International Bureau of the World Intellectual Property Organization, pursuant to the Patent Cooperation Treaty.
6. A record in this system of records may be disclosed, as a routine use, to another federal agency for purposes of National Security review (35 U.S.C. 181) and for review pursuant to the Atomic Energy Act (42 U.S.C. 218(c)).
7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (*i.e.*, GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.
8. A record from this system of records may be disclosed, as a routine use, to the public after either publication of the application pursuant to 35 U.S.C. 122(b) or issuance of a patent pursuant to 35 U.S.C. 151. Further, a record may be disclosed, subject to the limitations of 37 CFR 1.14, as a routine use, to the public if the record was filed in an application which became abandoned or in which the proceedings were terminated and which application is referenced by either a published application, an application open to public inspection or an issued patent.
9. A record from this system of records may be disclosed, as a routine use, to a Federal, State, or local law enforcement agency, if the USPTO becomes aware of a violation or potential violation of law or regulation.

UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NUMBER	PATENT NUMBER	GROUP ART UNIT	REQUEST ID
16/529,152	10862307	2836	162921

PAIR Correspondence Address/Fee Address Change

The following fields have been changed to Customer Number 186952 on 04/06/2022 via Private PAIR in view of the certification copied below that authorized the change.

- Maintenance Fee Address

The address for Customer Number 186952 is:
186952
Crusoe Energy Systems Inc.
Attn: Kyle Zeller
247 W 87th ST, 10K
New York, NY 10024

I certify, in accordance with 37 CFR 1.4(d)(4) that I am:

An attorney or Agent of Record registered to practice before the Patent and Trademark Office who has been given power of attorney in this application

Signature:	/Kyle Zeller/
Name:	Kyle Zeller
Registration Number:	64748

UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
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16/529,152	10862307	2836	162921

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186952
Crusoe Energy Systems Inc.
Attn: Kyle Zeller
247 W 87th ST, 10K
New York, NY 10024

I certify, in accordance with 37 CFR 1.4(d)(4) that I am:

An attorney or Agent of Record registered to practice before the Patent and Trademark Office who has been given power of attorney in this application

Signature:	/Kyle Zeller/
Name:	Kyle Zeller
Registration Number:	64748

UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NO.	ISSUE DATE	PATENT NO.	ATTORNEY DOCKET NO.	CONFIRMATION NO.
16/529,152	12/08/2020	10862307	CRUSOE-105002US1	9940

114903 7590 11/18/2020

Zeller IP Group PLLC
155 Water St.
Suite 6-6
Brooklyn, NY 11201

ISSUE NOTIFICATION

The projected patent number and issue date are specified above.

Determination of Patent Term Adjustment under 35 U.S.C. 154 (b)
(application filed on or after May 29, 2000)

The Patent Term Adjustment is 0 day(s). Any patent to issue from the above-identified application will include an indication of the adjustment on the front page.

If a Continued Prosecution Application (CPA) was filed in the above-identified application, the filing date that determines Patent Term Adjustment is the filing date of the most recent CPA.

Applicant will be able to obtain more detailed information by accessing the Patent Application Information Retrieval (PAIR) WEB site (http://pair.uspto.gov).

Any questions regarding the Patent Term Extension or Adjustment determination should be directed to the Office of Patent Legal Administration at (571)-272-7702. Questions relating to issue and publication fee payments should be directed to the Application Assistance Unit (AAU) of the Office of Data Management (ODM) at (571)-272-4200.

APPLICANT(s) (Please see PAIR WEB site http://pair.uspto.gov for additional applicants):

Crusoe Energy Systems Inc., Denver, CO;
Charles Cavness, Denver, CO;
Chase Lochmiller, Castle Rock, CO;
Kenneth Parker, Denver, CO;

The United States represents the largest, most dynamic marketplace in the world and is an unparalleled location for business investment, innovation, and commercialization of new technologies. The USA offers tremendous resources and advantages for those who invest and manufacture goods here. Through SelectUSA, our nation works to encourage and facilitate business investment. To learn more about why the USA is the best country in the world to develop technology, manufacture products, and grow your business, visit SelectUSA.gov.

UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

NOTICE OF ALLOWANCE AND FEE(S) DUE

114903 7590 11/03/2020

Zeller IP Group PLLC
155 Water St.
Suite 6-6
Brooklyn, NY 11201

EXAMINER
AMAYA, CARLOS DAVID

ART UNIT	PAPER NUMBER
2836	

DATE MAILED: 11/03/2020

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
16/529,152	08/01/2019	Charles Cavness	CRUSOE-105002US1	9940

TITLE OF INVENTION: Systems and Methods for Generating and Consuming Power from Natural Gas

APPLN. TYPE	ENTITY STATUS	ISSUE FEE DUE	PUBLICATION FEE DUE	PREV. PAID ISSUE FEE	TOTAL FEE(S) DUE	DATE DUE
nonprovisional	SMALL	$600	$0.00	$0.00	$600	02/03/2021

THE APPLICATION IDENTIFIED ABOVE HAS BEEN EXAMINED AND IS ALLOWED FOR ISSUANCE AS A PATENT. PROSECUTION ON THE MERITS IS CLOSED. THIS NOTICE OF ALLOWANCE IS NOT A GRANT OF PATENT RIGHTS. THIS APPLICATION IS SUBJECT TO WITHDRAWAL FROM ISSUE AT THE INITIATIVE OF THE OFFICE OR UPON PETITION BY THE APPLICANT. SEE 37 CFR 1.313 AND MPEP 1308.

THE ISSUE FEE AND PUBLICATION FEE (IF REQUIRED) MUST BE PAID WITHIN THREE MONTHS FROM THE MAILING DATE OF THIS NOTICE OR THIS APPLICATION SHALL BE REGARDED AS ABANDONED. THIS STATUTORY PERIOD CANNOT BE EXTENDED. SEE 35 U.S.C. 151. THE ISSUE FEE DUE INDICATED ABOVE DOES NOT REFLECT A CREDIT FOR ANY PREVIOUSLY PAID ISSUE FEE IN THIS APPLICATION. IF AN ISSUE FEE HAS PREVIOUSLY BEEN PAID IN THIS APPLICATION (AS SHOWN ABOVE), THE RETURN OF PART B OF THIS FORM WILL BE CONSIDERED A REQUEST TO REAPPLY THE PREVIOUSLY PAID ISSUE FEE TOWARD THE ISSUE FEE NOW DUE.

HOW TO REPLY TO THIS NOTICE:

I. Review the ENTITY STATUS shown above. If the ENTITY STATUS is shown as SMALL or MICRO, verify whether entitlement to that entity status still applies.

If the ENTITY STATUS is the same as shown above, pay the TOTAL FEE(S) DUE shown above.

If the ENTITY STATUS is changed from that shown above, on PART B - FEE(S) TRANSMITTAL, complete section number 5 titled "Change in Entity Status (from status indicated above)".

For purposes of this notice, small entity fees are 1/2 the amount of undiscounted fees, and micro entity fees are 1/2 the amount of small entity fees.

II. PART B - FEE(S) TRANSMITTAL, or its equivalent, must be completed and returned to the United States Patent and Trademark Office (USPTO) with your ISSUE FEE and PUBLICATION FEE (if required). If you are charging the fee(s) to your deposit account, section "4b" of Part B - Fee(s) Transmittal should be completed and an extra copy of the form should be submitted. If an equivalent of Part B is filed, a request to reapply a previously paid issue fee must be clearly made, and delays in processing may occur due to the difficulty in recognizing the paper as an equivalent of Part B.

III. All communications regarding this application must give the application number. Please direct all communications prior to issuance to Mail Stop ISSUE FEE unless advised to the contrary.

IMPORTANT REMINDER: Maintenance fees are due in utility patents issuing on applications filed on or after Dec. 12, 1980. It is patentee's responsibility to ensure timely payment of maintenance fees when due. More information is available at www.uspto.gov/PatentMaintenanceFees.

PART B - FEE(S) TRANSMITTAL

Complete and send this form, together with applicable fee(s), by mail or fax, or via EFS-Web.

By mail, send to: Mail Stop ISSUE FEE
Commissioner for Patents
P.O. Box 1450
Alexandria, Virginia 22313-1450

By fax, send to: (571)-273-2885

INSTRUCTIONS: This form should be used for transmitting the ISSUE FEE and PUBLICATION FEE (if required). Blocks 1 through 5 should be completed where appropriate. All further correspondence including the Patent, advance orders and notification of maintenance fees will be mailed to the current correspondence address as indicated unless corrected below or directed otherwise in Block 1, by (a) specifying a new correspondence address; and/or (b) indicating a separate "FEE ADDRESS" for maintenance fee notifications.

CURRENT CORRESPONDENCE ADDRESS (Note: Use Block 1 for any change of address)

114903 7590 11/03/2020

Zeller IP Group PLLC
155 Water St.
Suite 6-6
Brooklyn, NY 11201

Note: A certificate of mailing can only be used for domestic mailings of the Fee(s) Transmittal. This certificate cannot be used for any other accompanying papers. Each additional paper, such as an assignment or formal drawing, must have its own certificate of mailing or transmission.

Certificate of Mailing or Transmission

I hereby certify that this Fee(s) Transmittal is being deposited with the United States Postal Service with sufficient postage for first class mail in an envelope addressed to the Mail Stop ISSUE FEE address above, or being transmitted to the USPTO via EFS-Web or by facsimile to (571) 273-2885, on the date below.

(Typed or printed name)
(Signature)
(Date)

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
16/529,152	08/01/2019	Charles Cavness	CRUSOE-105002US1	9940

TITLE OF INVENTION: Systems and Methods for Generating and Consuming Power from Natural Gas

APPLN. TYPE	ENTITY STATUS	ISSUE FEE DUE	PUBLICATION FEE DUE	PREV. PAID ISSUE FEE	TOTAL FEE(S) DUE	DATE DUE
nonprovisional	SMALL	$600	$0.00	$0.00	$600	02/03/2021

EXAMINER	ART UNIT	CLASS-SUBCLASS
AMAYA, CARLOS DAVID	2836	307-154000

1. Change of correspondence address or indication of "Fee Address" (37 CFR 1.363).

❑ Change of correspondence address (or Change of Correspondence Address form PTO/SB/122) attached.

❑ "Fee Address" indication (or "Fee Address" Indication form PTO/SB/47; Rev 03-09 or more recent) attached. **Use of a Customer Number is required.**

2. For printing on the patent front page, list

(1) The names of up to 3 registered patent attorneys or agents OR, alternatively,

(2) The name of a single firm (having as a member a registered attorney or agent) and the names of up to 2 registered patent attorneys or agents. If no name is listed, no name will be printed.

1 _____

2 _____

3 _____

3. ASSIGNEE NAME AND RESIDENCE DATA TO BE PRINTED ON THE PATENT (print or type)

PLEASE NOTE: Unless an assignee is identified below, no assignee data will appear on the patent. If an assignee is identified below, the document must have been previously recorded, or filed for recordation, as set forth in 37 CFR 3.11 and 37 CFR 3.81(a). Completion of this form is NOT a substitute for filing an assignment.

(A) NAME OF ASSIGNEE (B) RESIDENCE: (CITY and STATE OR COUNTRY)

Please check the appropriate assignee category or categories (will not be printed on the patent) : ❑ Individual ❑ Corporation or other private group entity ❑ Government

4a. Fees submitted: ❑ Issue Fee ❑ Publication Fee (if required) ❑ Advance Order - # of Copies _____

4b. Method of Payment: *(Please first reapply any previously paid fee shown above)*

❑ Electronic Payment via EFS-Web ❑ Enclosed check ❑ Non-electronic payment by credit card (Attach form PTO-2038)

❑ The Director is hereby authorized to charge the required fee(s), any deficiency, or credit any overpayment to Deposit Account No. _____

5. **Change in Entity Status** (from status indicated above)

❑ Applicant certifying micro entity status. See 37 CFR 1.29

❑ Applicant asserting small entity status. See 37 CFR 1.27

❑ Applicant changing to regular undiscounted fee status.

NOTE: Absent a valid certification of Micro Entity Status (see forms PTO/SB/15A and 15B), issue fee payment in the micro entity amount will not be accepted at the risk of application abandonment.
NOTE: If the application was previously under micro entity status, checking this box will be taken to be a notification of loss of entitlement to micro entity status.
NOTE: Checking this box will be taken to be a notification of loss of entitlement to small or micro entity status, as applicable.

NOTE: This form must be signed in accordance with 37 CFR 1.31 and 1.33. See 37 CFR 1.4 for signature requirements and certifications.

Authorized Signature _____ Date _____

Typed or printed name _____ Registration No. _____

UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
16/529,152	08/01/2019	Charles Cavness	CRUSOE-105002US1	9940

114903 7590 11/03/2020

Zeller IP Group PLLC
155 Water St.
Suite 6-6
Brooklyn, NY 11201

EXAMINER	
AMAYA, CARLOS DAVID	
ART UNIT	PAPER NUMBER
2836	

DATE MAILED: 11/03/2020

Determination of Patent Term Adjustment under 35 U.S.C. 154 (b)
(Applications filed on or after May 29, 2000)

The Office has discontinued providing a Patent Term Adjustment (PTA) calculation with the Notice of Allowance.

Section 1(h)(2) of the AIA Technical Corrections Act amended 35 U.S.C. 154(b)(3)(B)(i) to eliminate the requirement that the Office provide a patent term adjustment determination with the notice of allowance. See Revisions to Patent Term Adjustment, 78 Fed. Reg. 19416, 19417 (Apr. 1, 2013). Therefore, the Office is no longer providing an initial patent term adjustment determination with the notice of allowance. The Office will continue to provide a patent term adjustment determination with the Issue Notification Letter that is mailed to applicant approximately three weeks prior to the issue date of the patent, and will include the patent term adjustment on the patent. Any request for reconsideration of the patent term adjustment determination (or reinstatement of patent term adjustment) should follow the process outlined in 37 CFR 1.705.

Any questions regarding the Patent Term Extension or Adjustment determination should be directed to the Office of Patent Legal Administration at (571)-272-7702. Questions relating to issue and publication fee payments should be directed to the Customer Service Center of the Office of Patent Publication at 1-(888)-786-0101 or (571)-272-4200.

OMB Clearance and PRA Burden Statement for PTOL-85 Part B

The Paperwork Reduction Act (PRA) of 1995 requires Federal agencies to obtain Office of Management and Budget approval before requesting most types of information from the public. When OMB approves an agency request to collect information from the public, OMB (i) provides a valid OMB Control Number and expiration date for the agency to display on the instrument that will be used to collect the information and (ii) requires the agency to inform the public about the OMB Control Number's legal significance in accordance with 5 CFR 1320.5(b).

The information collected by PTOL-85 Part B is required by 37 CFR 1.311. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 30 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, Virginia 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, Virginia 22313-1450. Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it displays a valid OMB control number.

Privacy Act Statement

The Privacy Act of 1974 (P.L. 93-579) requires that you be given certain information in connection with your submission of the attached form related to a patent application or patent. Accordingly, pursuant to the requirements of the Act, please be advised that: (1) the general authority for the collection of this information is 35 U.S.C. 2(b)(2); (2) furnishing of the information solicited is voluntary; and (3) the principal purpose for which the information is used by the U.S. Patent and Trademark Office is to process and/or examine your submission related to a patent application or patent. If you do not furnish the requested information, the U.S. Patent and Trademark Office may not be able to process and/or examine your submission, which may result in termination of proceedings or abandonment of the application or expiration of the patent.

The information provided by you in this form will be subject to the following routine uses:

1. The information on this form will be treated confidentially to the extent allowed under the Freedom of Information Act (5 U.S.C. 552) and the Privacy Act (5 U.S.C 552a). Records from this system of records may be disclosed to the Department of Justice to determine whether disclosure of these records is required by the Freedom of Information Act.
2. A record from this system of records may be disclosed, as a routine use, in the course of presenting evidence to a court, magistrate, or administrative tribunal, including disclosures to opposing counsel in the course of settlement negotiations.
3. A record in this system of records may be disclosed, as a routine use, to a Member of Congress submitting a request involving an individual, to whom the record pertains, when the individual has requested assistance from the Member with respect to the subject matter of the record.
4. A record in this system of records may be disclosed, as a routine use, to a contractor of the Agency having need for the information in order to perform a contract. Recipients of information shall be required to comply with the requirements of the Privacy Act of 1974, as amended, pursuant to 5 U.S.C. 552a(m).
5. A record related to an International Application filed under the Patent Cooperation Treaty in this system of records may be disclosed, as a routine use, to the International Bureau of the World Intellectual Property Organization, pursuant to the Patent Cooperation Treaty.
6. A record in this system of records may be disclosed, as a routine use, to another federal agency for purposes of National Security review (35 U.S.C. 181) and for review pursuant to the Atomic Energy Act (42 U.S.C. 218(c)).
7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (i.e., GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.
8. A record from this system of records may be disclosed, as a routine use, to the public after either publication of the application pursuant to 35 U.S.C. 122(b) or issuance of a patent pursuant to 35 U.S.C. 151. Further, a record may be disclosed, subject to the limitations of 37 CFR 1.14, as a routine use, to the public if the record was filed in an application which became abandoned or in which the proceedings were terminated and which application is referenced by either a published application, an application open to public inspection or an issued patent.
9. A record from this system of records may be disclosed, as a routine use, to a Federal, State, or local law enforcement agency, if the USPTO becomes aware of a violation or potential violation of law or regulation.

Notice of Allowability	Application No. 16/529,152	Applicant(s) Cavness et al.	
	Examiner CARLOS AMAYA	Art Unit 2836	AIA (FITF) Status Yes

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address--

All claims being allowable, PROSECUTION ON THE MERITS IS (OR REMAINS) CLOSED in this application. If not included herewith (or previously mailed), a Notice of Allowance (PTOL-85) or other appropriate communication will be mailed in due course. **THIS NOTICE OF ALLOWABILITY IS NOT A GRANT OF PATENT RIGHTS.** This application is subject to withdrawal from issue at the initiative of the Office or upon petition by the applicant. See 37 CFR 1.313 and MPEP 1308.

1. ☑ This communication is responsive to Amendments of 9/23/2020.
   ☐ A declaration(s)/affidavit(s) under **37 CFR 1.130(b)** was/were filed on _____.

2. ☐ An election was made by the applicant in response to a restriction requirement set forth during the interview on _____; the restriction requirement and election have been incorporated into this action.

3. ☑ The allowed claim(s) is/are 1-20 . As a result of the allowed claim(s), you may be eligible to benefit from the **Patent Prosecution Highway** program at a participating intellectual property office for the corresponding application. For more information, please see **http://www.uspto.gov/patents/init_events/pph/index.jsp** or send an inquiry to **PPHfeedback@uspto.gov.**

4. ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

   Certified copies:

   a) ☐ All b) ☐ Some *c) ☐ None of the:

   1. ☐ Certified copies of the priority documents have been received.
   2. ☐ Certified copies of the priority documents have been received in Application No. _____ .
   3. ☐ Copies of the certified copies of the priority documents have been received in this national stage application from the International Bureau (PCT Rule 17.2(a)).

   * Certified copies not received: _____ .

Applicant has THREE MONTHS FROM THE "MAILING DATE" of this communication to file a reply complying with the requirements noted below. Failure to timely comply will result in ABANDONMENT of this application.
THIS THREE-MONTH PERIOD IS NOT EXTENDABLE.

5. ☐ CORRECTED DRAWINGS (as "replacement sheets") must be submitted.
   ☐ including changes required by the attached Examiner's Amendment / Comment or in the Office action of Paper No./Mail Date _____ .

   Identifying indicia such as the application number (see 37 CFR 1.84(c)) should be written on the drawings in the front (not the back) of each sheet. Replacement sheet(s) should be labeled as such in the header according to 37 CFR 1.121(d).

6. ☐ DEPOSIT OF and/or INFORMATION about the deposit of BIOLOGICAL MATERIAL must be submitted. Note the attached Examiner's comment regarding REQUIREMENT FOR THE DEPOSIT OF BIOLOGICAL MATERIAL.

Attachment(s)

1. ☐ Notice of References Cited (PTO-892)
2. ☐ Information Disclosure Statements (PTO/SB/08), Paper No./Mail Date _____.
3. ☐ Examiner's Comment Regarding Requirement for Deposit of Biological Material _____.
4. ☐ Interview Summary (PTO-413), Paper No./Mail Date. _____.
5. ☑ Examiner's Amendment/Comment
6. ☑ Examiner's Statement of Reasons for Allowance
7. ☐ Other _____.

/CARLOS AMAYA/
Primary Examiner, Art Unit 2836

DETAILED ACTION

Notice of Pre-AIA or AIA Status

1. The present application, filed on or after March 16, 2013, is being examined under the first inventor to file provisions of the AIA.

EXAMINER'S AMENDMENT

2. An examiner's amendment to the record appears below. Should the changes and/or additions be unacceptable to applicant, an amendment may be filed as provided by 37 CFR 1.312. To ensure consideration of such an amendment, it MUST be submitted no later than the payment of the issue fee.

The application has been amended as follows:

Claim 18 line 1 delete "19" and replace it with --17--.

Remarks: Note that the above change was made to correct an obvious typographical error.

Reasons for Allowance

3. The following is an examiner's statement of reasons for allowance.

Claim 1 is allowable over the prior art of record, because the prior art of record does not disclose a flare mitigation system comprising: an electrical power generation system comprising: a one or more power generation modules, each adapted to: receive a fuel gas stream comprising a fuel gas associated with a heat value of at least about 1,000 Btu/scf; and consume the fuel gas stream to generate a high-voltage electrical output associated with a first voltage; and a parallel panel in electrical communication with each of the power generation modules, the parallel panel adapted to: receive the

high-voltage electrical output from each of the power generation modules: and combine and synchronize said high-voltage electrical outputs into a combined high-voltage electrical output; and an electrical transformation module in electrical communication with the parallel panel, the electrical transformation module adapted to: receive the combined high-voltage electrical output; and transform the combined high-voltage electrical output into a low-voltage electrical output associated with a second voltage that is lower than the first voltage; and a distributed computing system powered by the electrical power generation system, the distributed computing system comprising: a communications system comprising one or more data satellite antennas, the communications system adapted to provide a network; and a first mobile data center comprising: an enclosure defining an interior space; a plurality of distributed computing units located within the interior space of the enclosure, each of the plurality of distributed computing units in communication with the network; and a power system located at least partially within the interior space of the enclosure, the power system in electrical communication with the electrical transformation module and the plurality of distributed computing units such that the power system receives the low-voltage electrical output and powers each of the plurality of distributed computing units.

Claim 17 is allowable over the prior art of record, because the prior art of record does not disclose a flare mitigation system comprising: an electrical power generation system comprising: a first power generation module adapted to: receive a first fuel gas stream comprising a fuel gas associated with a heat value of at least about 1,000 Btu/scf; and consume the fuel gas stream to generate a first high-voltage electrical output associated with a first voltage; a second power generation module adapted to:

receive a second fuel gas stream comprising the fuel gas; and consume the second fuel gas stream to generate a second high-voltage electrical output associated with the first voltage; a parallel panel in electrical communication with the first power generation module and the second power generation module, the parallel panel adapted to: receive the first and second high-voltage electrical outputs; and combine and synchronize the first and second high-voltage electrical outputs into a combined high-voltage electrical output; and an electrical transformation module in electrical communication with the parallel panel, the electrical transformation module adapted to: receive the combined high-voltage electrical output; and transform the combined high-voltage electrical output into a low-voltage electrical output associated with a second voltage that is lower than the first voltage; and a distributed computing system powered by the electrical power generation system, the distributed computing system comprising: a communications system comprising one or more data satellite antennas, the communications system adapted to provide a network; and a first mobile data center comprising: an enclosure defining an interior space; a plurality of distributed computing units located within the interior space of the enclosure, each of the plurality of distributed computing units in communication with the network; and a power system located at least partially within the interior space of the enclosure, the power system in electrical communication with the electrical transformation module and the plurality of distributed computing units such that the power system receives the low-voltage electrical output and powers each of the plurality of distributed computing units.

Any comments considered necessary by applicant must be submitted no later than the payment of the issue fee and, to avoid processing delays, should preferably

accompany the issue fee. Such submissions should be clearly labeled "Comments on Statement of Reasons for Allowance."

Conclusion

Any inquiry concerning this communication or earlier communications from the examiner should be directed to CARLOS AMAYA whose telephone number is (571)272-8941. The examiner can normally be reached on M-F 7:00AM-4:00PM.

Examiner interviews are available via telephone, in-person, and video conferencing using a USPTO supplied web-based collaboration tool. To schedule an interview, applicant is encouraged to use the USPTO Automated Interview Request (AIR) at http://www.uspto.gov/interviewpractice.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Jared Fureman can be reached on (571) 272-2399. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see https://ppair-my.uspto.gov/pair/PrivatePair. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative or access to the automated information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

/CARLOS AMAYA/
Primary Examiner, Art Unit 2836

Search Notes	Application/Control No.	Applicant(s)/Patent Under Reexamination
	16/529,152	Cavness et al.
	Examiner	**Art Unit**
	CARLOS AMAYA	2836

CPC - Searched*		
Symbol	**Date**	**Examiner**
C10L3/104, E21B43/16, G06Q20/065, G06Q2220/00	10/28/2020	CA
H02J2300/10, H02J3/40, H02J3/38, H02J3/381	10/28/2020	CA

CPC Combination Sets - Searched*		
Symbol	**Date**	**Examiner**
C10L3/104, E21B43/16, G06Q20/065, G06Q2220/00	05/04/2020	CA

US Classification - Searched*			
Class	**Subclass**	**Date**	**Examiner**

* See search history printout included with this form or the SEARCH NOTES box below to determine the scope of the search.

Search Notes		
Search Notes	**Date**	**Examiner**
EAST Search	05/04/2020	CA
PLUS Search	05/04/2020	CA
Inventor Search	05/04/2020	CA
Updated	10/28/2020	CA

Interference Search			
US Class/CPC Symbol	**US Subclass/CPC Group**	**Date**	**Examiner**
See	Attachment	10/28/2020	CA

/CARLOS AMAYA/ Primary Examiner, Art Unit 2836	

Issue Classification	Application/Control No.	Applicant(s)/Patent Under Reexamination
	16/529,152	Cavness et al.
	Examiner	**Art Unit**
	CARLOS AMAYA	2836

CPC						
Symbol					**Type**	**Version**
H02J	/	3	/	38	F	2013-01-01
C10L	/	3	/	104	I	2013-01-01
G06Q	/	20	/	065	I	2013-01-01
E21B	/	43	/	16	I	2013-01-01
H02J	/	3	/	40	I	2013-01-01
G06Q	/	2220	/	00	A	2013-01-01
H02J	/	2300	/	10	A	2020-01-01

CPC Combination Sets							
Symbol					**Type**	**Set**	**Ranking**	**Version**
	/		/					

NONE		Total Claims Allowed:	
(Assistant Examiner)	(Date)	20	
/CARLOS AMAYA/ Primary Examiner, Art Unit 2836	28 October 2020	O.G. Print Claim(s)	O.G. Print Figure
(Primary Examiner)	(Date)	1	1

U.S. Patent and Trademark Office — Part of Paper No.: 20201028

Issue Classification	Application/Control No.	Applicant(s)/Patent Under Reexamination
	16/529,152	Cavness et al.
	Examiner	**Art Unit**
	CARLOS AMAYA	2836

INTERNATIONAL CLASSIFICATION				
CLAIMED				
H02J3/38	/	3	/	38
C10L3/10	/	3	/	10
G06Q20/06	/	20	/	06
E21B43/16	/	43	/	16
H02J3/40	/	3	/	40

NON-CLAIMED				
	/		/	

US ORIGINAL CLASSIFICATION	
CLASS	**SUBCLASS**

CROSS REFERENCES(S)						
CLASS	**SUBCLASS (ONE SUBCLASS PER BLOCK)**					

NONE		Total Claims Allowed:	
(Assistant Examiner)	(Date)	20	
/CARLOS AMAYA/ Primary Examiner, Art Unit 2836	28 October 2020	O.G. Print Claim(s)	O.G. Print Figure
(Primary Examiner)	(Date)	1	1

U.S. Patent and Trademark Office — Part of Paper No.: 20201028

Issue Classification	Application/Control No.	Applicant(s)/Patent Under Reexamination
	16/529,152	Cavness et al.
	Examiner	**Art Unit**
	CARLOS AMAYA	2836

☑ Claims renumbered in the same order as presented by applicant ☐ CPA ☐ T.D. ☐ R.1.47

CLAIMS

Final	Original	Final	Original	Final	Original	Final	Original	Final	Original	Final	Original	Final	Original	Final	Original

NONE		**Total Claims Allowed:**	
(Assistant Examiner)	(Date)	20	
/CARLOS AMAYA/ Primary Examiner, Art Unit 2836	28 October 2020	O.G. Print Claim(s)	O.G. Print Figure
(Primary Examiner)	(Date)	1	1

U.S. Patent and Trademark Office Part of Paper No.: 20201028

EAST Search History

EAST Search History (Prior Art)

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	Time Stamp
L2	1	("20200006938").PN.	US-PGPUB; USPAT; USOCR	OR	OFF	2020/10/28 14:09
L3	4	gas same flare same (generator turbine dynamo) same (transformer transformat$4) and (rack server network (data adj center) computing)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2020/10/28 14:26
L4	18	gas same flare same (generator turbine dynamo) same (transformer transformat$4)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2020/10/28 14:28
L5	1,472	gas same (generator turbine dynamo) same (transformer transformat$4) same (rack server network (data adj center) computing)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2020/10/28 14:33
L6	6	gas same flar$4 same (generator turbine dynamo) same (transformer transformat$4) same (rack server network (data adj center) computing)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2020/10/28 14:37
L7	53	gas same (generator turbine dynamo) same (transformer transformat$4) same (kw mw) same (v kv)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2020/10/28 14:38
L8	15	gas near (generator turbine dynamo) same (transformer transformat$4) same (kw mw) same (v kv)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO;	OR	ON	2020/10/28 14:39

			DERWENT; IBM_TDB			
L9	6	gas same (generator turbine dynamo) same (transformer transformat$4) same (rack server network (data adj center) computing) same parallel same (panel board cabinet (distribution adj center))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2020/10/28 14:43
L10	0	gas same (generator turbine dynamo) same (transformer transformat$4) same (rack server network (data adj center) computing) same (panel board cabinet (distribution adj center)) same (syncron$4)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2020/10/28 14:44
L11	0	gas same (generator turbine dynamo) same (transformer transformat$4) same (rack server network (data adj center) computing) same (panel board cabinet (distribution adj center)) and (syncron$4)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2020/10/28 14:44
L12	104	gas same (generator turbine dynamo) same (transformer transformat$4) same (rack server network (data adj center) computing) same (panel board cabinet (distribution adj center))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2020/10/28 14:45
L17	102,044	H02J2300/10, H02J3/40, H02J3/38, H02J3/381.CPC.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2020/10/28 15:24
L18	35,750	C10L3/104, E21B43/16, G06Q20/065, G06Q2220/00.CPC.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2020/10/28 15:24
L19	272	L18 and flar$4	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO;	OR	ON	2020/10/28 15:24

			DERWENT; IBM_TDB			
L20	59	L17 and flar$4	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2020/10/28 15:25
S1	12	("20110115425" | "20140372772" | "20170218843" | "20170271701" | "20180109112" | "20190022580" | "7998227" | "8070863" | "9337704" | "9637433" | "9673632" | "9719024").PN.	US-PGPUB; USPAT	OR	ON	2020/05/01 15:56
S2	41	("20030037567" | "20060076076" | "20070021513" | "20070130991" | "20090031756" | "20090277218" | "20100011663" | "20100281775" | "20110174016" | "20120096895" | "20120192580" | "20120279235" | "20130061632" | "20130186133" | "3110889" | "3254496" | "3354663" | "3763658" | "3786454" | "3996030" | "4016603" | "4404008" | "4456971" | "4857078" | "5992175" | "6105390" | "6182469" | "6250105" | "6553784" | "7017506" | "7041156" | "7594942" | "7713497" | "8156758" | "8293186" | "RE39826").PN. OR ("9719024").URPN.	US-PGPUB; USPAT; USOCR	OR	ON	2020/05/01 16:03
S3	0	gas same flare same (generator turbine dynamo) same (transformer transformat$4) same (rack server network (data adj center) computing)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2020/05/01 16:12
S4	4	gas same flare same (generator turbine dynamo) same (transformer transformat$4) and (rack server network (data adj center) computing)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2020/05/01 16:13
S5	22	("20070095536" | "20080197012" | "20150284811" | "3562115" | "3589313" | "3853498" | "4171017" | "4657290" | "4736111" | "5727903" | "6601543" | "7094388" | "7559367" | "7584789" | "7815713" | "7943014" |	US-PGPUB; USPAT; USOCR	OR	ON	2020/05/01 16:28

		"8070863" | "8151880" | "8156662" | "8480789" | "8999036").PN. OR ("9337704").URPN.				
S6	18	gas same flare same (generator turbine dynamo) same (transformer transformat$4)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2020/05/01 16:32
S7	99	("4911379" "5407647" "4425757" "4865817" "5192517" "5362464" "5727538" "6196056" "4255926" "4333764" "4448751" "4567916" "4821524" "4944496" "5565180" "6009900" "6210464" "6210464" "4273025" "4317540" "4452898" "4509456" "4560042" "4563982" "4583319" "4764085" "4779355" "4919826" "4960708" "4963329" "4978367" "4992301" "5023064" "5326835" "5450899" "5520858" "5662838" "5707424" "5824271" "5950572" "6228146" "6236894" "4265670" RE30935 "4341651" "4350665" "4363443" "4364753" "4381898" "4382908" "4391860" "4409301" "4410041" "4416332" "4445846" "4474612" "4528337" "4548765" "4557816" "4566565" "4582254" "4609541" "4774152" "4808534" "4818640" "4849191" "4871580" "4976685" "4991423" "5017348" "5231991" "5242564" "5259456" "5271725" "5282739" "5395050" "5439509" "5536489" "5542963" "5602435" "5716597" "5723055" "5782080" "5785902" "5791107" "5803938" "5833734" "5834519" "5839271" "5887418" "5904850" "5911336" "5922305" "5958377" "6030603" "6037683" "6066249" "6076517" "6097184" "6123523").pn.	US-PGPUB; USPAT	OR	ON	2020/05/04 09:49
S8	1,416	gas same (generator turbine dynamo) same (transformer transformat$4) same (rack server network (data adj center) computing)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2020/05/04 10:29

S9	0	("2020/0051184").URPN.	USPAT	OR	ON	2020/05/04 11:02
S10	0	("2020/0051184").URPN.	USPAT	OR	ON	2020/05/04 11:17
S11	16	S8 and flar$4	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2020/05/04 11:22
S12	2	(cavness-charles).in.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2020/05/04 11:32
S13	2	(lochmiller-chase).in.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2020/05/04 11:33
S14	50	(parker-kenneth).in.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2020/05/04 11:33
S15	33,834	C10L3/104, E21B43/16, G06Q20/065, G06Q2220/00.CPC.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2020/05/04 11:36
S16	2	S8 and S15	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2020/05/04 11:37
S17	260	S15 and flar$4	US-PGPUB; USPAT; USOCR;	OR	ON	2020/05/04 11:38

			FPRS; EPO; JPO; DERWENT; IBM_TDB			
S18	11	("20050189112" | "20120000660" | "20130220605" | "20140124208" | "20150167550" | "3368627" | "4511381").PN. OR ("9725644").URPN.	US-PGPUB; USPAT; USOCR	OR	ON	2020/05/04 11:46
S19	6	(US-20200087591-$ or US-20200040272-$ or US-20200051184-$).did. or (US-9719024-$ or US-9337704-$ or US-9725644-$).did.	US-PGPUB; USPAT	OR	ON	2020/05/04 11:49
S20	6	gas same flar$4 same (generator turbine dynamo) same (transformer transformat$4) same (rack server network (data adj center) computing)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2020/05/04 12:11
S21	53	gas same (generator turbine dynamo) same (transformer transformat$4) same (kw mw) same (v kv)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2020/05/04 12:13
S22	15	gas near (generator turbine dynamo) same (transformer transformat$4) same (kw mw) same (v kv)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2020/05/04 15:30
S23	99	("4911379" "5407647" "4425757" "4865817" "5192517" "5362464" "5727538" "6196056" "4255926" "4333764" "4448751" "4567916" "4821524" "4944496" "5565180" "6009900" "6210464" "6210464" "4273025" "4317540" "4452898" "4509456" "4560042" "4563982" "4583319" "4764085" "4779355" "4919826" "4960708" "4963329" "4978367" "4992301" "5023064" "5326835" "5450899" "5520858" "5662838" "5707424" "5824271" "5950572" "6228146" "6236894" "4265670" RE30935 "4341651" "4350665" "4363443" "4364753" "4381898" "4382908" "4391860"	US-PGPUB; USPAT	OR	ON	2020/05/04 17:53

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EAST Search History (Interference)

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	Time Stamp
L13	25	(gas and (generator turbine dynamo) and (transformer transformat$4) and (rack server network (data adj center) computing) and (panel board cabinet (distribution adj center))).clm.	US-PGPUB	OR	ON	2020/10/28 14:50
L14	13	(gas and (generator turbine dynamo) and (transformer transformat$4) and (rack server network (data adj center) computing) and parallel and (panel board cabinet (distribution adj center))).clm.	US-PGPUB	OR	ON	2020/10/28 14:52
L15	3	(gas and flare and (generator turbine dynamo) and (transformer transformat$4)).clm.	US-PGPUB	OR	ON	2020/10/28 14:53
L16	122	(gas and (generator turbine dynamo) and (transformer transformat$4) and (rack server network (data adj center) computing)).clm.	US-PGPUB	OR	ON	2020/10/28 14:56

10/28/2020 3:32:15 PM
C:\Users\camaya\Documents\EAST\Workspaces\16529152.wsp

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FEE ADDRESS INDICATION FORM

APPLICATION #	ATTORNEY DOCKET #	FILING DATE
16529152	CRUSOE-105002US1	08/01/2019

Title of Invention

Systems and Methods for Generating and Consuming Power from Natural Gas

Application Information

ART UNIT 2836 **FIRST NAMED INVENTOR** Charles Cavness

EXAMINER CARLOS AMAYA

INSTRUCTIONS: In order for the fee address identified on this form to be effective, the issue fee must have been paid for the application listed on this form. Only an address represented by a customer number can be established as the fee address for maintenance fee purposes (hereafter, fee address). A fee address should be established when correspondence related to maintenance fees should be mailed to a different address than the correspondence address for the application. For more information on customer numbers, see the Manual of Patent Examining Procedure (MPEP) § 403

Maintenance Fee Address

Please recognize as the Fee Address under the provisions of 37 CFR 1.363 the address associated with:

114903 - Zeller IP Group PLLC, Suite 6-6

155 Water St.
Suite 6-6
Brooklyn, NY 11201
UNITED STATES

Signature

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Signature	Name	Registration #	Date
/Kyle Zeller/	Kyle Zeller	64748	11/03/2020

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ELECTRONIC PAYMENT RECEIPT

APPLICATION #	RECEIPT DATE / TIME	ATTORNEY DOCKET #
16/529,152	11/03/2020 01:30:52 PM ET	CRUSOE-105002US1

Title of Invention

Systems and Methods for Generating and Consuming Power from Natural Gas

Application Information

APPLICATION TYPE	Utility - Nonprovisional Application under 35 USC 111(a)	PATENT #	-
CONFIRMATION #	9940	FILED BY	Kyle Zeller
PATENT CENTER #	60103350	AUTHORIZED BY	-
CUSTOMER #	114903	FILING DATE	08/01/2019
CORRESPONDENCE ADDRESS	-	FIRST NAMED INVENTOR	Charles Cavness

Payment Information

PAYMENT METHOD	PAYMENT TRANSACTION ID	PAYMENT AUTHORIZED BY
CARD / 2009	E2020A3D31176043	Kyle Zeller

FEE CODE	DESCRIPTION	ITEM PRICE($)	QUANTITY	ITEM TOTAL($)
2501	UTILITY ISSUE FEE	600.00	1	600.00
			TOTAL AMOUNT:	$600.00

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ELECTRONIC ACKNOWLEDGEMENT RECEIPT

APPLICATION #	RECEIPT DATE / TIME	ATTORNEY DOCKET #
16/529,152	**11/03/2020 01:30:52 PM ET**	**CRUSOE-105002US1**

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CONFIRMATION #	9940	FILED BY	Kyle Zeller
PATENT CENTER #	60103350	FILING DATE	08/01/2019
CUSTOMER #	114903	FIRST NAMED INVENTOR	Charles Cavness
CORRESPONDENCE ADDRESS	-	AUTHORIZED BY	-

Documents

TOTAL DOCUMENTS: 2

DOCUMENT	PAGES	DESCRIPTION	SIZE (KB)
web85bfeeaddress.pdf	1	Maintenance Fee Address Change	27 KB
web85b.pdf	3	Issue Fee Payment (PTO-85B)	62 KB

Digest

DOCUMENT	MESSAGE DIGEST(SHA-512)
web85bfeeaddress.pdf	1D6A1A9BC612A05C1BBD888B99209C5CC3FDDA09A33014AB 4857B874C410A54895229EC4DAF4A81399D5462864F78055999 BE2AF1A03F121ACB8AD0B91197C5A

web85b.pdf D6CDA9682D25575BB7A8D4CD356CC41C322BD48BFA784CE88B147A0F1195CC126B30E2877D6E8C88D43D271784B836A9BE8F913E7B3746C1C6E3127BEA574B95

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New International Application Filed with the USPTO as a Receiving Office

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ISSUE FEE TRANSMITTAL FORM

APPLICATION #	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET #
16529152	08/01/2019	Charles Cavness	CRUSOE-105002US1

Title of Invention

Systems and Methods for Generating and Consuming Power from Natural Gas

Application Information

APPLICATION TYPE	Nonprovisional Application under 35 USC 111(a)	DATE DUE	11/03/2020
CONFIRMATION #	9940	ISSUE FEE DUE	$ 600
EXAMINER	CARLOS AMAYA	PUBLICATION DUE	$ 0
GROUP ART UNIT	2836	TOTAL FEES DUE	$600
CLASS - SUBCLASS	307/154000	PREV. PAID FEE	$ 0
ENTITY STATUS	Small		

1. CHANGE OF CORRESPONDENCE ADDRESS AND/OR INDICATION OF FEE ADDRESS (37 CFR 1.33 & 1.363)

Correspondence Address

CURRENT ADDRESS

Maintenance Fee Address

CURRENT ADDRESS

☐ Change of correspondence address requested,system generated AIA/122-PC form attached

☑ Fee address indication requested, system generatedSB/47-PC form attached

2. ENTITY STATUS

Change in Entity Status

NEW STATUS

3. THE FOLLOWING FEES ARE SUBMITTED

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☑ Publication Fee

☐ Advance Order - # of copies:

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5. FIRM AND/OR ATTORNEY NAMES TO BE PRINTED

NOTE: If no name is listed, no name will be printed
For printing on the patent front page, list to be displayed as entered

Zeller IP Group PLLC
Kyle M. Zeller

6. ASSIGNEE NAME(S) AND RESIDENCE DATA TO BE PRINTED

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Crusoe Energy Systems Inc. Denver, CO UNITED STATES Organization

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Signature	Name	Registration #	Date
/Kyle Zeller/	Kyle Zeller	64748	11/03/2020

PTO/SB/06 (09-11)
Approved for use through 1/31/2014. OMB 0651-0032
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PATENT APPLICATION FEE DETERMINATION RECORD Substitute for Form PTO-875	Application or Docket Number 16/529,152	Filing Date 08/01/2019	☐ To be Mailed

ENTITY: ☐ LARGE ☑ SMALL ☐ MICRO

APPLICATION AS FILED - PART I

FOR	(Column 1) NUMBER FILED	(Column 2) NUMBER EXTRA		RATE ($)	FEE ($)
☐ BASIC FEE (37 CFR 1.16(a), (b), or (c))	N/A	N/A		N/A	
☐ SEARCH FEE (37 CFR 1.16(k), (i), or (m))	N/A	N/A		N/A	
☐ EXAMINATION FEE (37 CFR 1.16(o), (p), or (q))	N/A	N/A		N/A	
TOTAL CLAIMS (37 CFR 1.16(i))	minus 20 =	*		x $50 =	
INDEPENDENT CLAIMS (37 CFR 1.16(h))	minus 3 =	*		x $230 =	
☐ APPLICATION SIZE FEE (37 CFR 1.16(s))	If the specification and drawings exceed 100 sheets of paper, the application size fee due is $310 ($155 for small entity) for each additional 50 sheets or fraction thereof. See 35 U.S.C. 41(a)(1)(G) and 37 CFR 1.16(s).				
☐ MULTIPLE DEPENDENT CLAIM PRESENT (37 CFR 1.16(j))					
* If the difference in column 1 is less than zero, enter "0" in column 2.				TOTAL	

APPLICATION AS AMENDED - PART II

		(Column 1)		(Column 2)	(Column 3)			
AMENDMENT	09/23/2020	CLAIMS REMAINING AFTER AMENDMENT		HIGHEST NUMBER PREVIOUSLY PAID FOR	PRESENT EXTRA		RATE ($)	ADDITIONAL FEE ($)
	Total (37 CFR 1.16(i))	* 20	Minus	** 20	= 0		x $50 =	0
	Independent (37 CFR 1.16(h))	* 2	Minus	*** 3	= 0		x $230 =	0
	☐ Application Size Fee (37 CFR 1.16(s))							
	☐ FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))							
							TOTAL ADD'L FEE	0

		(Column 1)		(Column 2)	(Column 3)			
AMENDMENT		CLAIMS REMAINING AFTER AMENDMENT		HIGHEST NUMBER PREVIOUSLY PAID FOR	PRESENT EXTRA		RATE ($)	ADDITIONAL FEE ($)
	Total (37 CFR 1.16(i))	*	Minus	**	=		x $0 =	
	Independent (37 CFR 1.16(h))	*	Minus	***	=		x $0 =	
	☐ Application Size Fee (37 CFR 1.16(s))							
	☐ FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))							
							TOTAL ADD'L FEE	

* If the entry in column 1 is less than the entry in column 2, write "0" in column 3.	LIE
** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 20, enter "20".	/ROBERT J TALBERT/
*** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 3, enter "3".	
The "Highest Number Previously Paid For" (Total or Independent) is the highest number found in the appropriate box in column 1.	

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Systems and Methods for Generating and Consuming Power from Natural Gas

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] The present application claims benefit of U.S. provisional patent application no. 62/713,368, titled "Systems and Methods for Generating and Consuming Power from Natural Gas," filed August 1, 2018, which is incorporated by reference herein in its entirety.

BACKGROUND

[0002] This specification relates to enabling the utilization of raw natural gas, such as flare gas, stranded gas, and associated gas for power generation. More specifically, the specification relates to on-site generation of electricity from natural gas to power modular processing units adapted to perform distributed computing tasks.

[0003] Extracting oil from unconventional resources, such as shale gas formations, through the combination of horizontal drilling and hydraulic fracturing has increased at a rapid pace in recent years. The Bakken, Powder River Basin, Denver Julesburg ("D-J") Basin, North Park Basin, and Permian Basin are just some of the important "plays" in the United States. A "play" is the geographic area underlain by a gas- or oil-containing geologic formation.

[0004] Development of these gas plays and other unconventional resources presents significant potential for economic development and energy independence, but also presents the potential for environmental impacts on land, water and air. For example, although oil production represents the most important source of revenue for a given well, most wells also produce natural gas as a low-value byproduct. Unfortunately, the liquids-rich natural gas byproduct often cannot be economically transported by trucks or trains from remote well locations. Although such natural gases could be transported via pipelines, many oil and natural gas wells are located beyond the reach of such infrastructure. Absent gas pipeline infrastructure, oil well operators must either "vent" or "flare" produced gasses for safety reasons. Venting is the controlled release of natural gases into the atmosphere in the course of oil and gas production operations, however natural gas accumulations around the wellbore create significant safety hazards. Flaring is the controlled burning of natural gas produced in association with oil in the course of routine oil and gas

production operations, and is designed to minimize the safety and environmental risks associated with venting uncombusted natural gas.

[0005] As of April 2016, the NOAA estimates that there are over 6,200 individual flares in the United States, which burn about 35 billion ft3 of natural gas annually—enough to supply about 6 million homes. Such large-scale flaring of natural gas has raised serious environmental and health concerns and various state and federal regulators have begun to take action by implementing strict regulations and enforcement policies. For example, Colorado generally limits flaring to 60 days and many new well permits require producers to have a natural gas offtake solution prior to production; North Dakota has recently implemented a requirement that 90% of associated gas be captured by 2020; and Texas only allows new wells to flare for 10 days before an additional 45-day permit must be obtained. The EPA has also implemented flaring regulations where sites that exceed 100 tons per year of VOC, CO or NOX trigger Title V "Major Source Emitter" rules. Violations of state or federal rules can result in oil wells being "shut in," rejected permits and/or significant cash fines.

[0006] Stranded natural gas, particularly in the case where liquids-weighted wells are shut in due to gas takeaway constraints, represents a very low-cost power generation opportunity. Stranded gas exists across most prominent shale fields today including in the D-J Basin, Permian Basin, Bakken, SCOOP/STACK, etc. Many oil and gas operators in pipeline-constrained environments readily offer their natural gas for low cost—even at a loss to the operator in some cases—so that they can produce oil, which often represents the vast majority of a well's lifetime economics.

[0007] One potential solution to the natural gas problem lies in distributed computing. Cryptocurrency is a booming asset class with the combined market capitalization of digital currencies surpassing $380 billion in July 2018. Cryptocurrencies operate on a distributed system of computers "mining" the currencies – essentially processing the underlying algorithms to continuously verify transactions and account balances. The crypto mining process is a significant industry in its own right, projected to reach a value of $39 billion by 2025 with a projected CAGR of 29.7%.

[0008] This high-growth industry requires innovative and inexpensive electricity sources as it requires enormous amounts of power—approximately 29 TWh of electricity per year on a global basis. For perspective, cryptocurrency mining consumes more power annually than 159 countries,

including Hungary, Ireland, Nigeria or Slovakia. Indeed, electricity is typically the single largest lifetime cost to a cryptocurrency mining operation, with power costs offsetting approximately 30% of total mining revenues in the US.

[0009] Accordingly, there remains a need for systems and methods for generating electricity from natural gas produced from oil wells. It would be beneficial if such electricity could be produced and consumed on-site, for example, by using it to operate power-intensive, modular processing units. It would be further beneficial if such processing units could be employed to mine cryptocurrency or perform other distributed computing tasks to generate additional revenue.

SUMMARY

[0010] In accordance with the foregoing objectives and others, exemplary systems and methods are disclosed herein to convert raw natural gas into a fuel gas stream that may be used to power any number of on-site power generation modules. In turn, the power generation modules may convert the fuel gas stream into electricity, which may be employed to power any number of modular distributed computing units. In certain embodiments, the distributed computing units may be adapted to mine cryptocurrency or perform other distributed computing tasks to generate revenue.

[0011] In one embodiment, a flare mitigation system is provided. Such system may include an electrical power generation system, which may include a power generation module adapted to: receive a fuel gas stream, such as a fuel gas associated with a heat value of at least about 1,000 Btu/scf; and consume the fuel gas stream to generate a high-voltage electrical output associated with a first voltage. The electrical power generation system may also include an electrical transformation module in electrical communication with the power generation module, the electrical transformation module adapted to: receive the high-voltage electrical output generated by the power generation module; and transform the high-voltage electrical output into a low-voltage electrical output associated with a second voltage that is lower than the first voltage.

[0012] The flare mitigation system may also include a distributed computing system powered by the electrical power generation system. The distributed computing system may include a communications system with one or more data satellite antennas in order to provide a network; and a first mobile data center. The mobile data center may include an enclosure defining an interior

space; a plurality of distributed computing units located within the interior space of the enclosure, each of the plurality of distributed computing units in communication with the network; and a power system located at least partially within the interior space of the enclosure, the power system in electrical communication with the electrical transformation module and the plurality of distributed computing units such that the power system receives the low-voltage electrical output and powers each of the plurality of distributed computing units.

[0013] In some cases, the power generation module may be an engine-type generator that generates a high-voltage electrical output of from about 70 kW to about 2 MW (e.g., from about 70 kW to about 300 kW, from about 300 kW to about 400 kW, 400 kW to about 1 MW, or from about 1 MW to about 2 MW). The first voltage of the high-voltage electrical output may be from about 480 V to about 4.16 kV. And the second voltage of the low-voltage electrical output may be from about 208 V to about 240 V.

[0014] In other cases, the power generation module may be a turbine-type generator that generates a high-voltage electrical output of from about 2 MW to about 30 MW. In such cases, the first voltage of the high-voltage electrical output may be from about 4.16 kV to about 12 kV. And the second voltage of the low-voltage electrical output may be from about 208 V to about 240 V.

[0015] In another embodiment, a flare mitigation system is provided. The system may include an electrical power generation system having a first power generation module and a second power generation module. The first power generation module may be adapted to receive a first fuel gas stream, such as a fuel gas associated with a heat value of at least about 1,000 Btu/scf, and to consume the fuel gas stream to generate a first high-voltage electrical output associated with a first voltage. The second power generation module may be adapted to receive a second fuel gas stream including the fuel gas, and to consume the second fuel gas stream to generate a second high-voltage electrical output associated with the first voltage.

[0016] The electrical power generation system may also include a parallel panel in electrical communication with the first power generation module and the second power generation module. The parallel panel may be adapted to receive the first and second high-voltage electrical outputs; and combine and/or synchronize the first and second high-voltage electrical outputs into a combined high-voltage electrical output.

[0017] The electrical power generation system may also include an electrical transformation module in electrical communication with the parallel panel. The electrical transformation module may be adapted to receive the combined high-voltage electrical output; and transform the combined high-voltage electrical output into a low-voltage electrical output associated with a second voltage that is lower than the first voltage.

[0018] The flare mitigation system may further include a distributed computing system powered by the electrical power generation system. The distributed computing system may include a communications system having one or more data satellite antennas in order to provide a network. Moreover, the distributed computing system may include a first mobile data center having an enclosure defining an interior space; a plurality of distributed computing units located within the interior space of the enclosure, each of the plurality of distributed computing units in communication with the network; and a power system located at least partially within the interior space of the enclosure, the power system in electrical communication with the electrical transformation module and the plurality of distributed computing units such that the power system receives the low-voltage electrical output and powers each of the plurality of distributed computing units.

[0019] The details of one or more embodiments of the subject matter of this specification are set forth in the accompanying drawings and the description below. Other features, aspects, and advantages of the subject matter will become apparent from the description, the drawings, and the claims.

BRIEF DESCRIPTION OF THE DRAWINGS

[0020] FIG. 1 shows an exemplary flare mitigation system 100 according to an embodiment.

[0021] FIG. 2 shows an exemplary natural gas processing system 200 according to an embodiment.

[0022] FIG. 3 shows an exemplary electrical power generation system 300 comprising a power generation module 331 in electrical communication with an electrical transformation module 335.

[0023] FIG. 4 shows another exemplary electrical power generation system 400 comprising a plurality of power generation modules (431a, 431b) in electrical communication with an electrical transformation module 435 via a parallel panel 460.

[0024] FIG. 5 shows an exemplary distributed computing system 500 according to an embodiment.

[0025] FIG. 6 shows an exemplary computing machine 600 and modules 650 according to an embodiment.

DETAILED DESCRIPTION

System Overview

[0026] Referring to FIG. 1, an exemplary flare mitigation system 100 according to an embodiment is illustrated. As shown, the system 100 may comprise a natural gas processing system 120, an electrical power generation system 130, a distributed computing system 140, a communication system 155 and a monitoring and control system 180.

[0027] In one embodiment, the flare mitigation system 100 may comprise a natural gas processing system 120 adapted to receive a raw natural gas stream 101 from one or more wellheads 110 in an oil and/or gas reservoir. The natural gas processing system 120 is generally adapted to convert the received raw natural gas 101 into a fuel gas stream 102 that may be introduced to an electrical power generation system 130. As discussed in detail below with respect to FIG. 2, the natural gas processing system 120 may employ a separator module and, optionally, any number of additional modules (e.g., a compressor module, a carbon dioxide removal module, a desulfurization module and/or a refrigeration module) to produce a fuel gas stream 102 meeting the specific requirements of the electrical power generation system 130 and any number of secondary streams.

[0028] The electrical power generation system 130 generally comprises any number of power generation modules adapted to consume the fuel gas 102 and convert the same into electrical power. As discussed in detail below with respect to FIGs. 3-4, each power generation module may be in electrical communication with an electrical transformation module adapted to receive the electrical output of the power generation module(s) and convert the same into an electrical flow 105 that may be employed to power the electrical components of a distributed computing system 140.

[0029] In one embodiment, the distributed computing system 140 may comprise any number distributed computing units ("DCUs") in electrical communication with the electrical power

generation system 130, such that the DCUs are powered via the electrical flow 105 output by the system. The DCUs may comprise a modular computing installation, for example, a data center, cryptocurrency mine or graphics computing cell. And the DCUs are generally adapted to conduct any number of processing-intensive tasks. For example, the DCUs may be employed to execute graphics-intensive distributed computing processes, artificial intelligence ("AI") research, machine learning model training, data analysis, server functions, storage, virtual reality and/or augmented reality applications, tasks relating to the Golem Project, non-currency blockchain applications and/or cryptocurrency mining operations.

[0030] In certain embodiments, the DCUs may be employed to execute mathematical operations in relation to the mining of cryptocurrencies including computing the following hashing algorithms: SHA-256, ETHash, scrypt, CryptoNight, RIPEMD160, BLAKE256, X11, Dagger-Hashimoto, Equihash, LBRY, X13, NXT, Lyra2RE, Qubit, Skein, Groestl, BOINC, X11gost, Scrypt-jane, Quark, Keccak, Scrypt-OG, X14, Axiom, Momentum, SHA-512, Yescrypt, Scrypt-N, Cunningham, NIST5, Fresh, AES, 2Skein, Equilhash, KSHAKE320, Sidechain, Lyra2RE, HybridScryptHash256, Momentum, HEFTY1, Skein-SHA2, Qubit, SpreadX11, Pluck, and/or Fugue256. Additionally or alternatively, the DCUs may be adapted to execute mathematical operations in relation to training computationally intensive machine learning, artificial intelligence, statistical or deep learning models, such as neural networks, recurrent neural networks, convolutional neural networks, generative adversarial networks, gradient boosting machines, random forests, classification and regression trees, linear, polynomial, exponential and generalized linear regressions, logistic regression, reinforcement learning, deep reinforcement learning, hyperparameter optimization, cross validation, support vector machines, principal component analysis, singular value decomposition, convex optimization, and/or independent component analysis.

[0031] As discussed in detail below with respect to FIG. 5, the distributed computing system 140 may comprise one or more mobile data centers, wherein each mobile data center houses a plurality of DCUs therein. In addition to the DCUs, each mobile data center may further house an electrical power system, one or more backup power systems, an environment control system, and/or various monitoring and control equipment 183.

[0032] In certain embodiments, the mobile data center (and any electronic components contained therein) may be in communication with a communication system 155. For example, the mobile data center may be in direct communication with the communication system 155 via a wired connection. As another example, the DCUs may be in indirect communication with the communication system 155 via a network 150.

[0033] In one embodiment, the communication system 155 may comprise one or more data satellite antennas in communication with one or more high-orbit and/or low-orbit satellites. The antennas may be roof-mounted to one or more mobile data centers and/or may be pole-mounted into the ground nearby such mobile data centers. A typical configuration is for two antennas to serve a single mobile data center in order to provide reliability and redundancy; however, a single antenna may be sufficient depending on bandwidth requirements and total DCU count. Alternatively, many (e.g., three or more) antennas may be mounted to a roof of a single mobile data center, and communications cables may extend from the mobile data center to other nearby mobile data centers to provide a centralized communications solution.

[0034] The one or more data satellite antennas of the communication system 155 may be specified for continuous outdoor use, and may be installed using robust mounting hardware to ensure alignment even during heavy wind or other storms common in the oilfield. Antenna modems may be housed inside a mobile data center for warmth, security and weatherproofing, and such modems may be connected to the power system of the mobile data center.

[0035] In one embodiment, the communication system 155 may provide an internal network that includes automatic load-balancing functionality such that bandwidth is allocated proportionately among all active antennas. In such embodiment, if a single antenna fails, the lost bandwidth is automatically redistributed among all functioning antennas. This is an important reliability feature for oilfield operations, where equipment failures due to storms are possible.

[0036] In another embodiment, the antennas and satellite internet systems of the communication system 155 may be specified based on the needs of the distributed computing system 140, with specific attention paid to bandwidth and latency requirements. For lower bandwidth applications such as certain blockchain processing, cryptocurrency mining and/or long-term bulk data processing jobs, high-orbit satellite connectivity ranging from 10 MB/s to 100 MB/s may be specified. For higher bandwidth or low latency requirements such as artificial intelligence model

training, iterative dataset download and boundary spamming projects, visual processing such as images or videos, natural language processing, iterative protein folding simulation jobs, videogaming, or any other high capacity data streaming or rapid communication jobs, low-orbit satellites may be specified to provide significantly increased speeds and reduced latency.

[0037] In any event, the communication system 155 may provide a network 150 to which various components of the flare mitigation system 100 may be connected. The network 150 may include wide area networks ("WAN"), local area networks ("LAN"), intranets, the Internet, wireless access networks, wired networks, mobile networks, telephone networks, optical networks, or combinations thereof. The network 150 may be packet switched, circuit switched, of any topology, and may use any communication protocol. Communication links within the network 150 may involve various digital or an analog communication media such as fiber optic cables, free-space optics, waveguides, electrical conductors, wireless links, antennas, radio-frequency communications, and so forth.

[0038] As shown, the flare mitigation system further 100 comprises a MC system 180, which is generally adapted to maintain processing conditions within acceptable operational constraints throughout the system. Such constraints may be determined by economic, practical, and/or safety requirements. The MC system 180 may handle high-level operational control goals, low-level PID loops, communication with both local and remote operators, and communication with both local and remote systems. The MC system 180 may also be in communication with ancillary systems, such as storage systems, backup systems and/or power generation systems.

[0039] In one embodiment, the MC system 180 may be in communication with various monitoring and control equipment (181-183), such as sensors and/or controllers, via the network 150. Such monitoring and control equipment (181-183) may be in further communication with various components of the natural gas processing system 120, the electrical power generation system 130 and/or the distributed computing system 140, such that the MC system 180 may remotely monitor and control operating parameters throughout the flare mitigation system 100. Exemplary operating parameters may include, but are not limited to, profile of the raw natural gas supply, gas flow rate at various locations, gas pressure at various locations, temperature at various locations, electrical output at one or more locations, electrical load at one or more locations, and/or others.

[0040] As an example, the MC system 180 may determine a change in the profile, flow rate and/or pressure of the raw natural gas 101 and then automatically modulate electrical load of a mobile data center accordingly. And as another example, the MC system 180 may automatically reduce a processing rate of one or more DCUs in response to receiving an indication that supply gas pressure has decreased.

[0041] In one embodiment, any number of users may access the MC system 180 and/or the distributed computing system 140 via a client device 160 in communication with the network 150. Generally, a client device 160 may be any device capable of accessing such systems (e.g., via a native application or via a web browser). Exemplary client devices 160 may include general purpose desktop computers, laptop computers, smartphones, and/or tablets. In other embodiments, client devices 160 may comprise virtual reality ("VR") and/or augmented reality ("AR") hardware and software, which allow users to provide input via physical gestures.

[0042] The relationship of the client device 160 to such systems arises by virtue of computer programs running on the respective computers and having a client-server relationship to each other. Accordingly, each of the client devices 160 may have a client application running thereon, where the client application may be adapted to communicate with a MC application running on a MC system 180 and/or a distributed computing application running on a distributed computing system 140, for example, over a network 150. Thus, the client application may be remote from the MC system 180 and/or the distributed computing system 140. Such a configuration may allow users of client applications to interact with one or both of such systems from any location. Moreover, because the MC system 180 is capable of transceiving information to/from the various other systems (e.g., natural gas processing system 120, electrical power generation system 130, distributed computing system 140, and communication system 155), a user may interact with such systems via the MC system.

[0043] As discussed in detail below, one or more MC system applications and/or distributed computing system applications may be adapted to present various user interfaces to users. Such user interfaces may be based on information stored on the client device 160 and/or received from the respective systems. Accordingly, the application(s) may be written in any form of programming language, including compiled or interpreted languages, or declarative or procedural languages, and it can be deployed in any form, including as a standalone program or as a module,

component, subroutine, or other unit suitable for use in a computing environment. Such software may correspond to a file in a file system. A program can be stored in a portion of a file that holds other programs or data. For example, a program may include one or more scripts stored in a markup language document; in a single file dedicated to the program in question; or in multiple coordinated files (e.g., files that store one or more modules, sub programs, or portions of code).

[0044] Each of the MC system application(s) and/or distributed computing system application(s) can be deployed and/or executed on one or more computing machines that are located at one site or distributed across multiple sites and interconnected by a communication network. In one embodiment, an application may be installed on (or accessed by) one or more client devices 160.

[0045] In certain embodiments, the MC system 180 and/or the client device 160 may be adapted to receive, determine, record and/or transmit application information relating to one or more components of the flare mitigation system 100. The application information may be received from and/or transmitted to the natural gas processing system 120, the electrical power generation system 130 and/or the distributed computing system 140 via, for example, monitoring and/or control equipment (181, 182, 183, respectively) in communication with one or more components of such systems and in further communication with the network 150. Moreover, any of such application information may be stored in and/or retrieved from one or more local or remote databases (e.g., database 185).

[0046] In one embodiment, the MC system 180 may be connected to one or more third-party systems 170 via the network 150. Third-party systems 170 may store information in one or more databases that may be accessed by the MC system 180. The MC system 180 may be capable of retrieving and/or storing information from third-party systems 170, with or without user interaction. Moreover, the MC system may be capable of transmitting stored/received information to such third-party systems.

[0047] It will be appreciated that various components of the flare mitigation system 100 may be modular such that they may be combined to form a modular system. For example, the modular components that make up the natural gas processing system 120, the electrical power generation system 130, the distributed computing system, and/or the communication system 155 may be transported to an oil filed and assembled into the respective subsystems of the flare mitigation system 100.

[0048] In one embodiment, the natural gas processing system 120, electrical power generation system 130, distributed computing system 140 and the communication system 155 may be designed to allow all components of such systems to fit inside the height and width of a portable container, such as a shipping container or similar prefabricated enclosure that is transportable using a standard drop-deck semi-trailer. It will be appreciated that such configuration allows for enhanced mobility of the flare mitigation system 100 to various field sites.

[0049] Moreover, some or all of the aforementioned systems / components may be pre-mounted to a fixed skid, wheeled trailer or other form of mounting brackets in order to simplify and expedite transportation. Key benefits of this approach include reduced assembly time and expense in the field, where oilfield contract labor is often more expensive than shop labor, and where contractor availability (such as electricians) may be constrained. Wheel-mounted solutions may also qualify for special treatment as "temporary equipment," facilitating expedited or reduced regulatory processing in the oilfield environment. Pre-mounting equipment also allows for an operator to quickly re-mobilize the system 100 to a new site if the original gas flow associated with the original well declines or a new area experiences a greatly increased demand for flare mitigation.

[0050] It will be further appreciated that, the natural gas processing system 120, electrical power generation system 130, distributed computing system 140 and/or the communication system 155 may be designed to allow for individual components of such subsystems to be added or removed, as necessary, to provide a flare mitigation system 100 that aims to consume substantially all raw natural gas 101 produced at the wellhead 110. This configuration is important, as each well's gas flow rate, pressure and composition will be unique and may change over time.

[0051] For example, the electrical power generation system 130 may be modified to include additional power generation modules and/or electrical transformation modules and the distributed computing system 140 may be modified to include additional mobile data centers to mitigate increasingly larger volumes of gas during initial flow back and peak production phases of a well's life. Conversely, modules may be removed to accommodate declining flow rates. As another example, individual DCUs within a mobile data center of the distributed computing system 140 can also be remotely "turned down" or turned off to fit gas demand with gas production at each individual wellhead 110.

[0052] Using the above-described system 100, inexpensive and abundant stranded gas 101 can be used to power multi-megawatt-scale power generation equipment to produce power 105 for on-site or adjacent cryptocurrency mining operations. For example, the system may consume raw natural gas having a heat value of at least 1,000 Btu/scf at a rate of 1.3 MMscfd to power approximately 3,300 DCUs having a 14 TH/s mining hash rate (e.g., ANTMINER S9 mining rigs), which is equivalent to a moderate scale commercial mining operation. The cost to power this same mining operation would be about $2.6 million annually under a commercial power purchase agreement ($0.06/kwh).

Natural Gas Processing System

[0053] Referring to FIG. 2, an exemplary natural gas processing system 200 according to an embodiment is illustrated. As shown, the system 200 may comprise a separator module 210 and various optional components, such as a compressor module 215, a CO_2 removal module 222, a desulfurization module 224, a dehydrator module 226 and/or a refrigerator module 230.

[0054] Generally, the natural gas processing system 200 is adapted to convert a raw natural gas stream 201 received from one or more oil and/or gas wellheads 209 into a fuel gas stream 202 and, optionally, various secondary streams. As used herein, the term "raw natural gas" or "raw gas" means unprocessed natural gas released during oil and/or gas production. Raw natural gas 201 may also be referred to as "associated gas," "flare gas," "produced gas," and/or "stranded gas."

[0055] Raw natural gas 201 at a wellhead 209 is commonly a mixture of hydrocarbons, including methane (CH_4), ethane (C_2H_6), propane (C_3H_8), butane (C_4H_{10}), pentane (C_5H_{12}), hexane (C_6H_{14}) and higher hydrocarbons. The raw natural gas 201 also contains other compounds such as water vapor (H_2O), hydrogen sulfide (H_2S), carbon dioxide (CO_2), oxygen (O_2), and nitrogen (N_2). Table 1, below, shows properties of exemplary raw gas from wellheads in the Bakken Formation.

Table 1: Exemplary Raw Natural Gas Properties

Component	**Value**
Methane	48 - 85 mol %
Ethane	12- 20 mol %
Propane	5 - 15 mol %

Butane+ (C4+)	4 - 17 mol %
$CO_2 + N_2$	1.5 - 3.5 mol %
H_2S	0 - 2.0 mol %
Heat Value	1,200 - 1,715 Btu/scf
Wobbe Index	43 - 57
H_2O	10 - 50 lbs/MMscf

[0056] As used herein, the term "fuel gas" 202 refers to a natural gas stream that has been processed by a natural gas processing system 200 such that it may be used by an electrical power generation system (e.g., FIG. 1 at 130) to generate electrical power for a distributed computing system (FIG. 1 at 140). It will be appreciated that the properties of the fuel gas 202 produced by the natural gas processing system 200 may vary depending on the raw natural gas and requirements of the employed electrical power generation system.

[0057] Nevertheless, the fuel gas 202 will typically comprise a heat value of at least about 1,000 Btu/scf and a methane content of at least about 80%. In some embodiments, the fuel gas 202 may be processed to contain less than about 1% pentane and higher hydrocarbons (C5+) components. Moreover, such fuel gas 202 may be optionally be processed to contain less than about 5% propane and higher hydrocarbons (C3+) components.

[0058] In some embodiments, the produced fuel gas 202 may be substantially free of particulate solids and liquid water to prevent erosion, corrosion or other damage to equipment. Moreover, the fuel gas may be dehydrated of water vapor sufficiently to prevent the formation of hydrates during downstream processing. And, in certain embodiments, the produced fuel gas 202 may contain no more than trace amounts of components such as H_2S, CO_2, and N_2.

[0059] As shown, the raw natural gas 201 received from the wellhead 209 may first be introduced to a separator module 210 such that liquids (e.g., oil 291 and/or water 292) may be separated and removed therefrom. Generally, the separator module 210 may comprise at least one multi-phase separator, such as a 2-phase separator (separating liquids and gas), or a 3-phase separator (separating oil, water, and gas),

[0060] In one particular embodiment, the separator module 210 comprises a 3-phase separator. An exemplary 3-phase separator may comprise a vessel having an inlet to receive the raw natural gas 201, an outlet through which free gas exits the vessel, an outlet through which water exits the vessel, and an outlet through which oil exits the vessel. Upon entering the vessel, the raw gas 201 may encounter an inlet deflector, which causes initial separation of gas from a liquid mixture of oil and water. The free gas may then rise within the vessel, while the heavier liquid mixture descends therewithin. And, optionally, a divertor may be employed within the vessel to redirect flow of the liquid mixture and to allow it to settle more readily within the vessel.

[0061] Once separated from the liquid, the free gas may flow through a mist extractor that removes any entrained liquids remaining in the gas. The resulting gas stream then flows out of the top of the separator vessel, through the gas outlet.

[0062] As the liquid mixture settles within the separator vessel, the oil separates from the water and rises out of solution. In one embodiment, a weir plate may be employed to allow the oil to pour into an oil chamber or bucket, while preventing the water from entering the chamber. Additionally, the separator may include a metal protector plate to block any splashing liquid from entering the gas outlet.

[0063] Generally, the recovered oil 291 can be directed to an oil storage tank or may be transported for sale via truck, rail or pipe. And the water 292 may be sent to a water storage tank, treated on-site, disposed of, and/or transported to a wastewater treatment facility or other reclamation zone.

[0064] In one embodiment, the separator module 210 may comprise, or otherwise be placed in communication with, various monitoring and/or control equipment. Such equipment may be adapted to measure, determine and/or control various operating parameters at any number of locations throughout the separator module 210. As discussed above, such equipment may be in communication with a remote MC system (e.g., via a network) to allow for both (1) remote monitoring and control of the separator module 210 by any number of operators and (2) automatic control thereof.

[0065] As an example, the separator module 210 may comprise any number of pressure monitors, flow meters, regulators and/or control valves to monitor/control gas and/or liquid processing parameters (e.g., inlet/outlet pressure, inlet/outlet flow, level, etc.). Such equipment may be located

within one or more vessels, on one or more inlets and/or on one or more outlets of the separator module 210.

[0066] It will be appreciated that the separator module 210 may further comprise any number of safety valves adapted to direct flow to a safe and contained area upon overpressurization of the vessel. In one embodiment, the separator module may comply with ASME VIII, Division 1 and NACE MR-0175 for H2S environments. Additionally or alternatively, the separator module may comprise a skid designed to SEPCO OPS055 and/or API RP2A standards.

[0067] In certain embodiments, the separator module 210 may further comprise a heater-treater component located upstream of the multi-phase separator or integral therewith. Generally, the heater-treater may comprises a pressurized vessel, or a series of pressurized vessels, in which a bottom-mounted, heat source is operated. During operation, the heater-treater heats the raw natural gas 201 received from the wellhead 209 by means of direct contact with the heat source and the ensuing temperature increase reduces molecular attraction between oil and water molecules contained therein. Accordingly, when the heated raw natural gas is passed to the multi-phase separator, water droplets may settle out of the liquid more rapidly.

[0068] In one embodiment, the gas stream produced by the separator module 210 may be of a sufficient quality to be directly utilized as fuel gas 202 for a power generation module of the electrical power generation system. In such cases, the resulting gas stream 202 may not be introduced to any of the optional processing modules shown in FIG. 2; rather, it may be transferred directly to an electrical power generation module. It will be appreciated that, although the illustrated optional processing modules are not employed in this embodiment, the fuel gas 202 may be aggregated (e.g., in a field gathering pipeline) before being introduced to the electrical power generation module. Additionally or alternatively, conventional valves and/or compressors may be employed upstream of the electrical power generation module to regulate the pressure of the fuel gas 202.

[0069] In other embodiments, the gas stream produced by the separator module 210 may require additional processing upstream of the power generation module. In such cases, the natural gas processing system 200 may comprise one or more of: a compressor module 215, a CO_2 removal module 222, a desulfurization module 224, a dehydrator module 226 and/or a refrigeration module 230.

[0070] Generally, a compressor module 215 may be employed to increase the pressure of the gas stream from an initial pressure of from about 15 psi to about 50 psi, to a final pressure of from about 150 psi to about 350 psi. Such pressure increase may be desired or required when a refrigeration module 230 is employed (discussed below) and/or in cases where the fuel gas 202 is to be introduced to a power generation module comprising a turbine.

[0071] As a result of the pressure increase, the compressor module 215 may also remove heavy natural gas liquids ("NGLs") stream 293 comprising pentane and higher hydrocarbons (C5+) from the natural gas. To that end, the compressor module 215 may comprise any number of individual compressor units operating to raise and lower the pressure of the received gas stream, during any number of compression stages, such that the NGLs 293 contained therein may be liquified and removed. The resulting NGLs stream 293 may exit the compressor module 215 and may be stored in a storage tank and/or transported for sale via truck, rail or pipe.

[0072] Accordingly, the compressor module 215 may produce a resulting gas stream comprising methane, ethane, propane, and butane, wherein the gas stream is substantially free of pentane and higher hydrocarbons (C5+). That is, the resulting compressed gas stream will typically comprise less than about 1% C5+ hydrocarbons, such that the stream comprises a heat content of from about 1,200 Btu/scf to about 1,500 Btu/scf.

[0073] In one embodiment, the compressor module 215 may comprise any number of individual compressor units. The compressor units may be driven by either conventional piston engines or natural gas turbines, and such units are typically fueled by a portion of the natural gas (although some or all of the units may be electrically powered if required). The compressor units typically operate in parallel, although some or all of the compressor units may be operated in stages (serially) as desired or required.

[0074] As the gas is compressed, heat is generated and must be dissipated to cool the gas stream before leaving the compressor module. Accordingly, the compressor module 215 may comprise an aerial cooler system to dissipate excess heat (e.g., an "after cooler"). Additionally, the heat generated by operation of the individual compressor units may be dissipated via a sealed coolant system.

[0075] The compressor module 215 may comprise, or otherwise be placed in communication with, various monitoring and/or control equipment adapted to monitor and/or control operating

parameters (e.g., gas flow and/or pressure) across all compressor units. Such equipment may be in communication with the remote MC system (e.g., via a network) to allow for remote monitoring and control of the compressor module 215 by any number of operators and/or for automatic control thereof.

[0076] In certain embodiments, the natural gas processing system 200 may include a CO_2 removal module 222 to remove CO_2 294 from the gas stream. Generally, the CO_2 removal module 222 will be employed, as required, to meet pipeline specifications. For example, the CO_2 removal module 222 may be employed to reduce CO_2 content in the gas stream to less than about 1% CO_2.

[0077] In one embodiment, the CO_2 removal module 222 may comprise one or more membranes, such as a spiral-wound cellulose acetate membrane. Generally, the membrane operates on the principle of selective permeation, where components with higher permeation rates (e.g., CO_2) permeate through a membrane faster than those with lower permeation rates (e.g., methane, ethane and heavier hydrocarbons). Accordingly, the gas feed stream may be separated into a hydrocarbon-rich (residual) stream on the exterior of the membrane fiber and a CO_2-rich (permeate) stream on the interior of the membrane fiber.

[0078] It will be appreciated that the CO_2 removal module 222 may be adaptable to various gas volumes, CO_2 concentrations, and/or fuel gas specifications. Moreover, operational parameters of the CO_2 removal module, such as pressure difference between the feed gas and permeate gas and/or concentration of the permeating component, may be monitored and/or controlled via various equipment in communication with the remote MC system.

[0079] In another embodiment, the CO_2 removal module 222 may comprise an amine sorbent system. As known in the art, such systems are adapted to absorb CO_2 and then desorb the CO_2 to atmosphere.

[0080] In one embodiment, the natural gas processing system 200 may include a desulfurization module 224 adapted to remove sulfur 295 from the gas stream. Generally, sulfur exists in natural gas as hydrogen sulfide (H_2S), and the natural gas will typically require desulfurization when its H_2S content exceeds about 0.01 lbs/Mscf. It will be appreciated that gas containing high levels of H_2S (i.e., “sour gas”) is undesirable because it is both corrosive to equipment and dangerous to breathe.

[0081] The desulfurization module 224 may employ various technologies to "sweeten," or remove sulfur from, sour gas. In one embodiment, the desulfurization module 224 may employ dry sorbents to capture sulfur gases in solid form (e.g., as sulfates or sulfites). In one such embodiment, a fine sorbent may be injected into the feed gas and the resulting sulfur-containing solids 295 may be collected. Exemplary dry sorbents that may be employed include, but are not limited to, calcium oxide, magnesium oxide, and sodium carbonate.

[0082] In an alternative embodiment, the desulfurization module 224 may comprise a wet scrubber subsystem, such as venturi, packed-column, or tray-type systems. In this embodiment, the feed gas may be contacted with a scrubbing solution or slurry to absorb the H_2S and convert it to mercaptans, which are then drained from the spent bed in liquid form.

[0083] In yet another embodiment, the desulfurization module 224 may employ amine solutions to remove H_2S. During this process, the feed gas is run through a tower containing an amine solution that absorbs sulfur. Exemplary amine solutions may include, but are not limited to, monoethanolamine ("MEA") and diethanolamine ("DEA"). In one such embodiment, the amine solution may be regenerated (i.e., the absorbed sulfur may be removed) and reused.

[0084] In certain embodiments, the sulfur-containing discharge 295 may be discarded. However, in other embodiments, the sulfur may be reduced to its elemental form via further processing and then sold. One exemplary process employed to recover sulfur is known as the "Claus process" and involves using thermal and catalytic reactions to extract the elemental sulfur from the hydrogen sulfide solution.

[0085] It will be appreciated that, no matter which of the above technologies is employed by the desulfurization module 224, a resulting gas stream may be produced that is virtually free of sulfur compounds. That is, the resulting gas stream may comprise a sulfur content of less than about about 0.01 lbs/Mscf.

[0086] The natural gas processing system 200 may additionally or alternatively comprise a dehydrator module 226 adapted to remove water 296 from the gas stream. Generally, the dehydrator module 226 may be employed to reduce the moisture content of the gas stream to about 7 lbs/Mscf or less. This mitigates the risk of damage to pipes and process equipment from blocked flow and corrosion.

[0087] In one embodiment, the dehydrator module 226 may comprise any number of dryer beds including one or more desiccants. Exemplary desiccants include, but are not limited to: activated charcoal/carbon, alumina, calcium oxide, calcium chloride, calcium sulfate, silica, silica alumina, molecular sieves (e.g., zeolites), and/or montmorillonite clay. In one particular embodiment, desiccant materials may be present in a packed-bed configuration.

[0088] It will be appreciated that most desiccants have a limited adsorption capacity and must be replaced or regenerated at given service intervals. Accordingly, for continuous dehydration service, a multi-bed system may be employed where one or more beds are utilized while the others are being replaced/regenerated. The active bed(s) can then be switched in and out of service as required or desired.

[0089] In another embodiment, the dehydrator module 226 may comprise a Triethylene Glycol ("TEG") system. This system contacts the wet gas with TEG, which absorbs the water from the wet gas stream to produce a rich TEG stream. The rich TEG stream is heated with a gas-fired heater and the water is driven off in the form of water vapor to atmosphere. The lean TEG stream may then be cooled and pumped back to contact the gas stream.

[0090] In other embodiments, the dehydrator module 226 may remove water through the use of additives, such as methanol or ethylene glycol, which may be sprayed into the natural gas stream to suppress the freezing point of liquid water. In yet other embodiments, dehydration may comprise a number of steps, including active dehydration, depressurization, regeneration, and repressurization.

[0091] In certain embodiments, the natural gas processing system 200 may include a refrigeration module 230 comprising one or more mechanical refrigeration units ("MRU"). Generally, the refrigeration module may be employed to cool natural gas in an effort to reduce the hydrocarbon dew point of the gas (e.g., to meet pipeline quality specifications) and/or to maximize NGLs recovery (e.g., to improve the overall monetary return of a natural gas stream).

[0092] In one embodiment, the refrigeration module 230 may be adapted to lower the temperature of the received gas stream to a target temperature, such that NGLs comprising propane and higher hydrocarbons (C3+) 297 may be separated therefrom. The target temperature may be selected to allow the NGLs stream 297 to be condensed (e.g., in a single column), without condensing substantial amounts of methane or ethane. Accordingly, the condensed NGLs stream 297 may be

separated and transported for sale via truck, rail or pipe; and the resulting fuel gas stream 202, which comprises mostly methane and ethane, may be transferred to the electrical power generation module.

[0093] In certain embodiments, the refrigeration module 230 may lower the temperature of the received gas stream via heat exchange with a low temperature fluid (i.e., a refrigerant). Exemplary refrigerants include, but are not limited to, propane, propylene (C_3H_6), n-butane, and/or ethylene (C_2H_4). It will be appreciated that other hydrocarbon and non-hydrocarbon refrigerants may additionally or alternatively be employed.

[0094] Generally, the refrigeration module 230 may cool the received gas stream to a target temperature of from about -10 °F to about -32 °F, depending on the composition of the received gas stream. During cooling, the pressure may be adjusted to, or maintained at, from about 70 psi to about 510 psi.

[0095] In one particular embodiment, the refrigeration module 230 may comprise a cascade refrigerator that employs two or more refrigeration stages in series to achieve a lower temperature than is otherwise achievable in a single stage. For example, the refrigerator may cool the gas to a first temperature during a first stage (i.e., a "high stage"), and then cool the gas to a second temperature that is lower than the first temperature during a second stage (i.e., a "low stage").

[0096] It will be appreciated that operational parameters of the refrigeration module 230 may be monitored and/or controlled across any number of refrigeration units via various equipment in communication with the remote MC system. Such operational parameters may include, but are not limited to, temperature and/or coolant recirculation rate.

[0097] It will be appreciated that many aspects of the system 200 depicted in FIG. 2 may be modified or altered to produce fuel gas 202 from raw natural gas 201 received from one or more wellheads 209 in an oil and gas reservoir. The illustrated system 200 is exemplary, and is intended to show broadly the relationship between the various aspects of the system.

Electrical Power Generation System

[0098] FIGs. 3-4 show exemplary electrical power generation systems (300, 400) according to various embodiments. FIG. 3 shows an exemplary electrical power generation system 300 comprising a power generation module 331 in electrical communication with an electrical

transformation module 335. And FIG. 4 shows an exemplary electrical power generation system 500 comprising a plurality of power generation modules (431a, 431b) in a parallel configuration, wherein such modules are in electrical communication with a single electrical transformation module 435.

[0099] Referring to FIG. 3, an exemplary electrical power generation system 300 is illustrated. As shown, the system 300 comprises a power generation module 331 in communication with a gas supply line 320 such that it may receive fuel gas 302 therefrom. The power generation module 331 is further shown to be in electrical communication with an electrical transformation module 335 such that an electrical output 303 may be transmitted from the power generation module to the electrical transformation module.

[0100] Generally, the power generation modules 331 may comprise a generator component adapted to convert fuel gas 302 into electrical energy 303, various equipment for monitoring and controlling the generator component, and ancillary equipment to support the generator component. As discussed below, each of these components may be contained within a protective housing such that the entire power generation module 331 is transportable.

[0101] In one embodiment, the power generation module 331 may comprise a generator component adapted to generate an electrical output 303 via combustion of the fuel gas 302. Generally, the generator component may employ either a fuel-gas-driven reciprocating engine or a fuel-gas-driven rotating turbine to combust the fuel gas 302 and drive an electrical generator.

[0102] The generator component may be associated with various properties, such as various input fuel requirements, a fuel gas consumption rate and an electrical output. The input fuel requirements of a given generator component specify the required properties of fuel received by the generator. As discussed above, the employed power generation modules 331 may be specified to operate with fuel gas 302 having a wide variety of properties. For example, certain modules may include a generator components adapted to utilize rich gas, delivered directly downstream of a separator module. Additionally or alternatively, the power generation module 331 may comprise a generator adapted to utilize fuel gas that has been processed to such that it is substantially free of propane and higher hydrocarbons (C3+) components.

[0103] The fuel gas consumption rate of a given generator refers to the volume of fuel gas consumed by the generator within a given time period. The fuel gas consumption rate may be

determined for continuous operation of the generator at standard ambient conditions. Generally, the fuel gas consumption rate of engine-type generators may range from about 40 Mscfd to about 500 Mscfd. And the fuel gas consumption rate of turbine-type generators may range from about 1 MMscfd to about 6 MMscfd.

[0104] Electrical output refers to the electrical energy output by a given generator after efficiency losses within the generator. This property is often referred to as "real power" or "kWe." The electrical output may be provided as "continuous power," which refers to the real power obtained from the generator when the module is operating continuously at standard ambient conditions.

[0105] Although nearly any generator may be employed in the power generation modules 331, it has been found that generators that produce an electrical output of from about 70 kW to about 30 MW are preferred because these sizes correlate with the quantities of fuel available in a typical application.

[0106] Generally, engine-type generators may produce an electrical output ranging from about 70 kW to about 2 MW, with an associated voltage ranging from about 480 V to about 4.16 kV. And turbine-type generators may produce an electrical output ranging from about 2 MW to 30 MW, with an associated voltage ranging from about 4.16 kV to about 12 kV.

[0107] It will be appreciated that the various generator components employed in the power generation module 331 may be adapted to operate reliably in harsh oilfield conditions, and with variability in gas rates, composition and heating values. Moreover, it will be appreciated that the specific generator employed in a power generation module 331 may be selected and configured based on the specifications of the raw natural gas and the amount of such raw natural gas that is produced at the wellhead.

[0108] As shown, the power generation module 331 may be in further communication with a backup fuel supply 337 containing a backup fuel 308. In one embodiment, the backup fuel supply 337 may comprise a natural gas storage tank containing pressurised natural gas (e.g., received from the natural gas processing system). In another embodiment, the backup fuel supply 337 may comprise an on-site reserve of propane. At times of low wellhead gas pressure, the backup fuel 308 may be piped directly to the generator of the power generation module 331, from the backup fuel supply 337.

[0109] In one embodiment, the power generation module 331 may be adapted to automatically switch between the fuel gas 302 and the backup fuel 308. In such embodiments, the generator may utilize fuel gas 302 as long as the pressure and/or flow rate of the fuel gas is greater than or equal to a predetermined value (e.g., from about 20 psig to about 25 psig); and the generator may switch to the backup fuel 308 when the pressure and/or flow rate drops below the predetermined value. It will be appreciated that the fuel switching process may be seamless, resulting in uninterrupted electrical power generation regardless of instantaneous natural gas supply rates.

[0110] In one embodiment, the power generation module 331 may comprise various monitoring and control equipment in direct communication with the generator component and in remote communication with the MC system (e.g., via a network). Such equipment may allow for automatic monitoring of operational parameters, including but not limited to, fuel gas supply pressure, fuel gas flow rate, fuel gas characteristics, electrical output (e.g., frequency, voltage, amperage, etc.) and/or emissions. And this configuration may further allow for automatic and/or manual control of the generator, which enables greater reliability and efficiency in remote oilfield locations where human operators are not always present.

[0111] Typically, the power generation module 331 will further comprise various ancillary components (commonly referred to as the "balance of plant"). Such components may include, but are not limited to, compressors, lubrication systems, emissions control systems, catalysts, and exhaust systems.

[0112] As an example, the power generation module 331 may comprise integrated emissions reduction technologies, such as but not limited to, a non-selective catalytic reduction ("NSCR") system or a selective catalytic reduction ("SCR") system. However, even without employing such emissions technology, the internal combustion process employed by the disclosed embodiments, may significantly reduce emissions of NOx, CO and volatile organic compounds ("VOCs") relative to flaring. For example, an exemplary electrical power generation system 300 that does not include an NSCR or SCR may reduce emissions of such compounds by about 95% or more, as compared to flaring (e.g., at least 95%, at least 96%, at least 97%, at least 98%, or at least 99%).

[0113] It will be appreciated that emissions monitoring and control are key permitting requirements in the oilfield. By reducing emissions, the disclosed embodiments help oil and gas

operators achieve environmental and regulatory benefits as well as improved community relationships.

[0114] In one embodiment, the power generation module 331 may comprise a housing designed to contain and protect the above-described components of the module. Such housing may provide features such as, but not limited to, weatherproofing, skid or trailer mounting for portability, and sound attenuation.

[0115] In certain embodiments, the power generation module 331 may be supported by a transportable chassis, trailer, or railcar to facilitate positioning and/or repositioning of the module. More particularly, the transportable chassis, trailers, or railcars may be coupled to vehicles, such as trucks or trains, and transported over a geographic area. The generator skids can range in size from an enclosed trailer hauled behind a pickup truck, to a plurality of semi-trailer loads for the generator and its required ancillary equipment.

[0116] As shown, the electrical power generation system 300 further comprises an electrical transformation module 335 in electrical communication with the power generation module 331. Generally, the electrical power 303 generated by the power generation module 331 may be transmitted through the electrical transformation module 335 such that it may be converted into an electrical flow 305 that is suitable for consumption by computing equipment (e.g., a mobile data center and any number of DCUs of a distributed computing system).

[0117] To that end, the electrical transformation module 335 may comprise power conditioning equipment typically including one or more step-down transformers. Such module 335 may be adapted to reduce the voltage of an incoming electrical flow 303 by one or more "steps down" into a secondary electrical flow 305 comprising a lower voltage.

[0118] In one embodiment, the electrical transformation module 335 may comprise a 1 MVA step-down transformer adapted to step down the voltage of an incoming electrical flow 303 having a voltage of from about 480 V to about 4.16 kV. In such cases, the electrical transformation module 335 may convert the incoming electrical flow 303 to a reduced-power output electrical flow 305 having a voltage of about 208 V or about 240 V.

[0119] Alternatively, when larger turbine-type power generation modules 331 are employed, the electrical transformation module 335 may reduce voltage in a plurality of steps. For example, the

electrical transformation module may receive an incoming electrical flow 303 having a voltage of from about 4.16 kV to about 12 kV to and may step down the voltage to about 480 V in a first step. And the module may then further reduce the voltage, via one or more additional steps down, in order to provide a reduced-power output electrical flow 305 having a voltage of about 208 V.

[0120] In certain embodiments, the electrical transformer module 335 may also comprise a main breaker capable of cutting off all downstream electrical flows, which allows an operator to quickly de-power any attached computing equipment in the case of operational work or emergency shut-down. Additionally or alternatively, terminals of the electrical transformation module 335 may be fitted with "quick connects," which are pre-terminated inside the module. Such quick connects allow oilfield electricians to quickly connect the electrical transformation module 335 to the power generation module 331 and to a component of the distributed computing system without extensive on-site fabrication and termination work.

[0121] In the illustrated embodiment, only one power generation module 331 provides electrical power 303 to the electrical transformation module 335. Accordingly, the power generation module 331 may be directly wired from a terminal of the power generation module 331 into a primary side of the electrical transformation module 335.

[0122] Although only one power generation module 331 and one electrical transformation module 335 is shown in FIG. 3, it will be appreciated that any number of such components may be included in the power generation system 300. For example, two or more sets of power generation modules 331 and electrical transformation modules 335 may be employed, in a series configuration, to power any number of computing components (e.g., mobile data centers and DCUs).

[0123] Generally, such equipment may be added and/or removed, as required, to consume substantially all available natural gas supply. Moreover, the specific generators employed in the power generation modules 331, the number of such modules, and the configuration of such modules may also be selected with this goal in mind. For example, such equipment may be selected, configured, added to and/or removed from the electrical power generation system 300, as necessary to allow the system to consume at least about 75% (e.g., at least about 80%, at least about 85%, at least about 90%, or at least about 95%) of the natural gas supply. In this way, the system 300 may substantially reduce the amount of natural gas that must be flared during oil production.

[0124] Referring to FIG. 4, another exemplary electrical power generation system 400 is illustrated. As shown, the system 400 comprises a plurality of power generation modules (431a, 431b) in communication with a gas supply line 420 such that they may receive fuel gas 402 therefrom. The power generation modules (431a, 431b) are also in electrical communication with an electrical transformation module 435 via a parallel panel 460. And, as discussed above, the power generation modules (431a, 431b) may be in communication with one or more backup fuel supplies 437, such that they may receive backup fuel 408 (e.g., propane) therefrom.

[0125] As shown, the electrical power generation system 400 may comprise multiple power generation modules (431a, 431b) connected in parallel to a single electrical transformation module 435. In such embodiments, the multiple electrical power generation modules (431a, 431b) may be phase-synced such that their output electrical flows (403a, 403b) may be combined down-stream without misalignment of wave frequency.

[0126] Specifically, the multiple phase-synced electrical flows (403a, 403b) may be wired into a parallel panel 460, which merges and synchronizes the electrical flows into a single down-stream flow 404 with singular voltage, frequency, current and power metrics. This singular down-stream flow 404 may then be wired into a primary side of an electrical transformation module 435 for voltage modulation. For example, as discussed above, the singular down-stream flow 404 may be transmitted to the electrical transformation module 435 such that the flow may be converted into an output electrical flow 405 that is suitable for consumption by computing equipment (e.g., one or more mobile data centers of a distributed computing system including any number of DCUs).

[0127] In such embodiments, each of the power generation modules (431a, 431b) and/or the parallel panel 460 may comprise a control system that allows for the module to be synchronized and paralleled with other power generation modules. The control system may allow load-sharing of up to 32 power generation modules via a data link and may provide power management capabilities, such as load-dependent starting and stopping, asymmetric load-sharing, and priority selection. Such functionality may allow an operator to optimize load-sharing based on running hours and/or fuel consumption.

Distributed Computing System

[0128] Referring to FIG. 5, an exemplary distributed computing system 500 according to an embodiment is illustrated. As shown, the system 500 may include one or more mobile data centers 510 comprising various electrical components, such as but not limited to: any number of DCUs 520, a communications system 555, an electrical power system 530, a backup power system 540, and/or a monitoring and control system 580.

[0129] Generally, each of the mobile data centers 510 may comprise a prefabricated housing or enclosure to contain and protect the various electronics. The enclosure may comprise a customized shipping container or other modular housing system designed for portability, durability, safety, stack-ability, ventilation, weatherproofing, dust control and operation in rugged oilfield conditions.

[0130] As shown, each of the mobile data centers 510 may comprise an electrical power system 530 adapted to receive electrical power 505 from an electrical transformation module of an electrical power generation system, as discussed above. More particularly, the power system 530 may receive an output electrical flow 505 from a secondary terminal of an electrical transformation module via cable trays, buried lines and/or overhead suspended lines. In certain embodiments, each mobile data center 510 may be fitted with quick connects (discussed above), which are pre-terminated into the power system 530.

[0131] In one embodiment, the electrical power system 530 ~~of a~~ may comprise one or more breaker panels in electrical communication with a series of power distribution units ("PDUs") or power channels. Such PDUs may also be in communication with the various electrical components of the mobile data center 510, such as DCUs 520, backup power systems 540 (e.g., batteries and/or solar panels), a communication system 555, and/or a monitoring and control system 580.

[0132] In certain embodiments, the breaker panels and/or PDUs of the power system 530 may be in communication with a monitoring and control system 580 of the mobile data center 510. And such monitoring and control system 580 may be in communication with the remote MC system (FIG. 1 at 180) via a network such that an operator may remotely control (activate and/or deactivate) these components and all electrical equipment in electrical communication therewith. This remote power control feature is important for efficiency and cost reduction in remote oilfield locations, where a human operator may not be present. For example, PDUs may be remotely

"power cycled" to reset, reboot or restart malfunctioning equipment without the expense or time required to deploy a human. As another example, breaker panel switches may be remotely controlled to turn on / off power to downstream systems without the need for human dispatch.

[0133] As shown, each of the mobile data centers 510 may comprise a plurality of DCUs 520, wherein the DCUs are powered via the power system 530 and, optionally, via the backup power system 540. As discussed above, the DCUs are adapted to conduct any number of processing-intensive tasks, such as but not limited to, graphics-intensive distributed computing processes, server functions, storage, virtual reality and/or augmented reality applications, tasks relating to the Golem Project, non-currency blockchain applications and/or cryptocurrency mining operations.

[0134] It will be appreciated that the number of mobile data centers, the number of DCUs contained in each mobile data center, and/or the processing power of such DCUs may be selected to utilize substantially all electrical power generated by the electrical power generation system. Moreover, such equipment may be added and/or removed from the distributed computing system 500, as desired or required, to consume substantially all electrical power generated by the electrical power generation system. For example, the components of the distributed computing system may be selected, configured, added and/or removed, as necessary to allow the system 500 to consume the maximum practical amount of the power generated by the electrical power generation system (typically in excess of 90% of the available power). This allows for revenue generated from distributed computing tasks to be maximized, while also maximizing consumption of produced natural gas via the electrical power generation system.

[0135] As discussed above, the mobile data centers 510 and the various electronic components contained there (e.g., DCUs 520, monitoring and control system 580, power system 530 and/or backup power system 540) may be connected to a network via wired or wireless connection to a communication system 555. The communication system 555 may comprise one or more modems, network switches, and network management computers to provide connectivity to the network, such as the Internet, via a fiber optic cable, fixed point wireless (laser, millimeter wave towers, microwave towers or the like used to relay high speed internet on a line-of-sight basis), satellite internet, cell-based internet or any other means of internet connection. And the components of the communication system 555 may be distributed throughout the mobile data center 510 as required

to connect all DCUs 520 into the network and to supply sufficient data input and output bandwidth for all connected components.

[0136] It will be appreciated that heat and airflow management are important considerations when operating in an oilfield, as outside air temperatures may vary widely from extreme cold to extreme heat. Moreover, excessive dust and precipitation must also be monitored and controlled during oilfield operation. Accordingly, in one embodiment, the monitoring and control system 580 may be adapted to control various parameters of the mobile data center 510, such as temperature, moisture, oxygen, power and/or others.

[0137] In one embodiment, the mobile data center 510 may be designed with a cold aisle and a hot aisle. For example, the DCUs 520 may be located within vertically stacked, horizontal racks extending along a row within the mobile data center; and all of the DCUs may be positioned within the racks such that their intake fans point towards the cold aisle, while their exhaust fans point in an opposite direction, towards the hot aisle. It will be appreciated that one or more air inlets of the mobile data center 510 may be aligned with the cold aisle and one or more exhausts of the mobile data center be aligned with the hot aisle.

[0138] In one embodiment, the hot and cold aisles may be isolated / separated by employing a faceplate that extends along the row of stacked DCUs 520, adjacent to the exhaust-side thereof. Generally, the faceplate may comprise a metal, plastic, composite, wood or other thin and flat material having a plurality of precut apertures disposed therein. The apertures may be positioned such that each aperture is aligned with an exhaust fan of one of the DCUs. And the apertures may be sized/shaped to complement the size/shape of the DCU exhaust fans, such that each fan substantially fills/covers each aperture and such that each fan may transmit exhaust through one of the apertures. Accordingly, the faceplate forms a physical barrier between gaps in DCU exhaust fans, which helps to ensure that hot air does not recirculate from the hot aisle back to the cold aisle.

[0139] The hot aisle may be naturally vented to an exterior of the mobile data center 510, for example, with direct exhaust via one or more exhaust panels or vents. Alternatively, the mobile data center may include a forced air exhaust system, wherein exhaust fans force air out of the hot aisle and exhaust to the exterior. In such embodiments, the exhaust fans may communicate with the monitoring and control system 580 such that the fans may be automatically activated/deactivated as the temperature within the mobile data center increases/decreases.

[0140] In another embodiment, the mobile data center 510 may comprise various louvers, dampers, filters and/or awnings designed to protect against direct and wind-blown precipitation, as well as excessive dust intake. In such cases, dampers may be connected to the monitoring and control system 580 such that they may be automatically closed to seal and the mobile data center in the event of a power failure.

[0141] It will be appreciated that the mobile data center 510 may be further designed with various safety and security features specific to oilfield operations. For example, the mobile data center 510 may comprise one or more wireless cameras controlled by the monitoring and control system 580 and powered by the power system 530 and/or the backup power system 540. Such cameras may be specified for continuous remote monitoring and/or motion-activated recording. As another example, the mobile data center 510 ~~may comprise~~ may comprise motion activated lighting systems that serve as an additional crime deterrent and/or that may provide sufficient light to facilitate work during nighttime operations.

[0142] And as yet another example, the mobile data center 510 may comprise a fire suppression system designed to retard gas and electrical fires. In one embodiment, the monitoring and control system 580 may cause the dampers to automatically seal when extreme temperatures are detected (i.e., to cut off oxygen flow to a fire inside the mobile data center).

Computing Machines

[0143] Referring to FIG. 6, a block diagram is provided illustrating an exemplary computing machine 600 and modules 650 in accordance with one or more embodiments presented herein. The computing machine 600 may represent any of the various computing systems discussed herein, such as but not limited to, the DCUs (FIG. 5 at 520), the MC system (Fig. 1 at 180), the client devices (FIG. 1 at 160) and/or the third-party systems (FIG. 1 at 170). And the modules 650 may comprise one or more hardware or software elements configured to facilitate the computing machine 600 in performing the various methods and processing functions presented herein.

[0144] The computing machine 600 may comprise all kinds of apparatuses, devices, and machines for processing data, including but not limited to, a programmable processor, a computer, and/or multiple processors or computers. As shown, an exemplary computing machine 600 may include various internal and/or attached components, such as a processor 610, system bus 670, system

memory 620, storage media 640, input/output interface 680, and network interface 660 for communicating with a network 630.

[0145] The computing machine 600 may be implemented as a conventional computer system, an embedded controller, a server, a laptop, a mobile device, a smartphone, a wearable device, a set-top box, over-the-top content TV ("OTT TV"), Internet Protocol television ("IPTV"), a kiosk, a vehicular information system, one more processors associated with a television, a customized machine, any other hardware platform and/or combinations thereof. Moreover, a computing machine may be embedded in another device, such as but not limited to, a smartphone, a personal digital assistant ("PDA"), a tablet, a mobile audio or video player, a game console, a Global Positioning System ("GPS") receiver, or a portable storage device (e.g., a universal serial bus ("USB") flash drive). In some embodiments, such as the DCUs, the computing machine 600 may be a distributed system configured to function using multiple computing machines interconnected via a data network or system bus 670.

[0146] The processor 610 may be configured to execute code or instructions to perform the operations and functionality described herein, manage request flow and address mappings, and to perform calculations and generate commands. The processor 610 may be configured to monitor and control the operation of the components in the computing machine 600. The processor 610 may be a general-purpose processor, a processor core, a multiprocessor, a reconfigurable processor, a microcontroller, a digital signal processor ("DSP"), an application specific integrated circuit ("ASIC"), a graphics processing unit ("GPU"), a field programmable gate array ("FPGA"), a programmable logic device ("PLD"), a controller, a state machine, gated logic, discrete hardware components, any other processing unit, or any combination or multiplicity thereof. The processor 610 may be a single processing unit, multiple processing units, a single processing core, multiple processing cores, special purpose processing cores, coprocessors, or any combination thereof. In addition to hardware, exemplary apparatuses may comprise code that creates an execution environment for the computer program (e.g., code that constitutes one or more of: processor firmware, a protocol stack, a database management system, an operating system, and a combination thereof). According to certain embodiments, the processor 610 and/or other components of the computing machine 600 may be a virtualized computing machine executing within one or more other computing machines.

[0147] The system memory 620 may include non-volatile memories such as read-only memory ("ROM"), programmable read-only memory ("PROM"), erasable programmable read-only memory ("EPROM"), flash memory, or any other device capable of storing program instructions or data with or without applied power. The system memory 620 also may include volatile memories, such as random-access memory ("RAM"), static random-access memory ("SRAM"), dynamic random-access memory ("DRAM"), and synchronous dynamic random-access memory ("SDRAM"). Other types of RAM also may be used to implement the system memory. The system memory 620 may be implemented using a single memory module or multiple memory modules. While the system memory is depicted as being part of the computing machine 600, one skilled in the art will recognize that the system memory may be separate from the computing machine without departing from the scope of the subject technology. It should also be appreciated that the system memory may include, or operate in conjunction with, a non-volatile storage device such as the storage media 640.

[0148] The storage media 640 may include a hard disk, a compact disc read only memory ("CD-ROM"), a digital versatile disc ("DVD"), a Blu-ray disc, a magnetic tape, a flash memory, other non-volatile memory device, a solid-state drive ("SSD"), any magnetic storage device, any optical storage device, any electrical storage device, any semiconductor storage device, any physical-based storage device, any other data storage device, or any combination or multiplicity thereof. The storage media 640 may store one or more operating systems, application programs and program modules such as module, data, or any other information. The storage media may be part of, or connected to, the computing machine 600. The storage media may also be part of one or more other computing machines that are in communication with the computing machine such as servers, database servers, cloud storage, network attached storage, and so forth.

[0149] The modules 650 may comprise one or more hardware or software elements configured to facilitate the computing machine 600 with performing the various methods and processing functions presented herein. The modules 650 may include one or more sequences of instructions stored as software or firmware in association with the system memory 620, the storage media 640, or both. The storage media 640 may therefore represent examples of machine or computer readable media on which instructions or code may be stored for execution by the processor. Machine or computer readable media may generally refer to any medium or media used to provide instructions to the processor. Such machine or computer readable media associated with the modules may

comprise a computer software product. It should be appreciated that a computer software product comprising the modules may also be associated with one or more processes or methods for delivering the module to the computing machine 600 via the network, any signal-bearing medium, or any other communication or delivery technology. The modules 650 may also comprise hardware circuits or information for configuring hardware circuits such as microcode or configuration information for an FPGA or other PLD.

[0150] The input/output ("I/O") interface 680 may be configured to couple to one or more external devices, to receive data from the one or more external devices, and to send data to the one or more external devices. Such external devices along with the various internal devices may also be known as peripheral devices. The I/O interface 680 may include both electrical and physical connections for operably coupling the various peripheral devices to the computing machine 600 or the processor 610. The I/O interface 680 may be configured to communicate data, addresses, and control signals between the peripheral devices, the computing machine, or the processor. The I/O interface 680 may be configured to implement any standard interface, such as small computer system interface ("SCSI"), serial-attached SCSI ("SAS"), fiber channel, peripheral component interconnect ("PCI"), PCI express (PCIe), serial bus, parallel bus, advanced technology attachment ("ATA"), serial ATA ("SATA"), universal serial bus ("USB"), Thunderbolt, FireWire, various video buses, and the like. The I/O interface may be configured to implement only one interface or bus technology. Alternatively, the I/O interface may be configured to implement multiple interfaces or bus technologies. The I/O interface may be configured as part of, all of, or to operate in conjunction with, the system bus 670. The I/O interface 680 may include one or more buffers for buffering transmissions between one or more external devices, internal devices, the computing machine 600, or the processor 610.

[0151] The I/O interface 680 may couple the computing machine 600 to various input devices including mice, touch-screens, scanners, biometric readers, electronic digitizers, sensors, receivers, touchpads, trackballs, cameras, microphones, keyboards, any other pointing devices, or any combinations thereof. When coupled to the computing device, such input devices may receive input from a user in any form, including acoustic, speech, visual, or tactile input.

[0152] The I/O interface 680 may couple the computing machine 600 to various output devices such that feedback may be provided to a user via any form of sensory feedback (e.g., visual

feedback, auditory feedback, or tactile feedback). For example, a computing machine can interact with a user by sending documents to and receiving documents from a device that is used by the user (e.g., by sending web pages to a web browser on a user's client device in response to requests received from the web browser). Exemplary output devices may include, but are not limited to, displays, speakers, printers, projectors, tactile feedback devices, automation control, robotic components, actuators, motors, fans, solenoids, valves, pumps, transmitters, signal emitters, lights, and so forth. And exemplary displays include, but are not limited to, one or more of: projectors, cathode ray tube ("CRT") monitors, liquid crystal displays ("LCD"), light-emitting diode ("LED") monitors and/or organic light-emitting diode ("OLED") monitors.

[0153] Embodiments of the subject matter described in this specification can be implemented in a computing machine 600 that includes one or more of the following components: a backend component (e.g., a data server); a middleware component (e.g., an application server); a frontend component (e.g., a client computer having a graphical user interface ("GUI") and/or a web browser through which a user can interact with an implementation of the subject matter described in this specification); and/or combinations thereof. The components of the system can be interconnected by any form or medium of digital data communication, such as but not limited to, a communication network. Accordingly, the computing machine 600 may operate in a networked environment using logical connections through the network interface 660 to one or more other systems or computing machines across a network.

[0154] The processor 610 may be connected to the other elements of the computing machine 600 or the various peripherals discussed herein through the system bus 670. It should be appreciated that the system bus 670 may be within the processor, outside the processor, or both. According to some embodiments, any of the processor 610, the other elements of the computing machine 600, or the various peripherals discussed herein may be integrated into a single device such as a system on chip ("SOC"), system on package ("SOP"), or ASIC device.

Experiments

Experiment 1

[0155] In a first experiment, a flare mitigation system was deployed at a well site within the Bakken Field. The flare mitigation system included an electrical power generation system having

six engine-type power generation modules adapted to receive fuel gas from a fuel gas supply line. Specifically, the system included a first set of power generation modules including two 350 kW engine-type power generation modules and one 225 kW engine-type power generation module; and a second set of power generation modules that also included two 350 kW engine-type power generation modules and one 225 kW engine-type power generation module.

[0156] The first set of power generation modules was connected, via a first parallel panel, to a first electrical transformation module comprising a 1 MVA step down transformer. And the second set of power generation modules was connected, via a second parallel panel, to a second electrical transformation module comprising a 1 MVA step down transformer.

[0157] The first electrical transformation module received a first input electrical flow from the first parallel panel having a voltage of 480 V and transformed the flow into a first output electrical flow having a voltage of 208 V. The first output electrical flow was then distributed, via diesel locomotive ("DLO") cables on a cable tray, to an electrical power system of a first mobile data center. Specifically, the DLO cables were distributed to a plurality of breaker panels (e.g., 4 or 5) associated with the first mobile data center; each of the breaker panels was in electrical communication with 25 to 35 PDUs; and each of the PDUs was in electrical communication with up to 4 DCUs racked within the first mobile data center. Accordingly the first set of power generation modules was able to support from about 400 DCUs to about 700 DCUs (depending on the number of breaker panels and PDUs employed).

[0158] The second electrical transformation module received a second input electrical flow from the second parallel panel having a voltage of 480 V and transformed the flow into a second output electrical flow having a voltage of 208 V. The second output electrical flow was then distributed to up to 700 DCUs contained within a second mobile center, substantially as described above with respect to the first mobile data center.

[0159] Each of the first and second mobile data centers measured approximately 40' by 8' by 9.5' (e.g., the size of a High Cube shipping container). Both mobile data centers employed forced air with cold air entering through louvered, screened and filtered intakes on one long axis, and hot air exhausting through louvered and screened fan exhausts on the other long axis.

[0160] The above system was found to consume fuel gas at a rate of about 300 Mscfd. The system was further found to generate an electrical output of about 2 MW, wherein substantially all of such electrical output was utilized to power the DCUs contained within the mobile data centers.

Experiment 2

[0161] In a second experiment, a flare mitigation system was deployed at a well site within the D-J Basin. The flare mitigation system included an electrical power generation system having three engine-type power generation modules adapted to receive fuel gas from a fuel gas supply line. A first 1.8 MW engine-type power generation module was connected to both a first electrical transformation module and a second electrical transformation module. A second 1.8 MW engine-type power generation module was connected to both a third and a fourth electrical transformation module. And a third 1.8 MW engine-type power generation module was connected to both a fifth and a sixth electrical transformation module.

[0162] Each of the first, second, third, fourth, fifth and sixth electrical transformation modules comprised a 1 MVA step-down transformer adapted to receive a 480 V input electrical flow from a respective, connected power generation module and to transform such flow into an output electrical flow having a voltage of 208 V or 240 V. Each of the six electrical transformation modules was also in electrical communication with a separate mobile data center (substantially as described above with respect to Experiment 1), such that a total of six mobile data centers comprising a total of 2,100 DCUs were powered via the three 1.8 MW power generation modules.

[0163] The above system was found to consume fuel gas at a rate of about 900 Mscfd. The system was further found to generate an electrical output of about 5.4 MW, wherein substantially all of such electrical output was utilized to power the DCUs contained within the mobile data centers.

Experiment 3

[0164] In a third experiment, a flare mitigation system was deployed at a well site within the D-J Basin. The flare mitigation system included an electrical power generation system comprising a 350 kW or 385 kW engine-type power generation module adapted to receive fuel gas from a fuel gas supply line. The power generation module was connected to an electrical transformation

module comprising a 0.5 MVA step-down transformer, which transformed a 480 V electrical flow from the generator to a 208 V or 240 V output electrical flow (as described above).

[0165] The output electrical flow was then distributed to an electrical power system of a single 20' by 8' by 9.5' mobile data center, which employed power channels (rather than PDUs to support 264 ~~DSUs~~ DCUs). For ventilation, the mobile data center utilized natural aspiration via direct exhaust of DCUs to the container's exterior. Specifically, the mobile data center included a pair of awnings and protective walls extending from the air intake (a wall of metal gridding and filtration material on one long axis), as well as the air exhaust wall (a metal grid against which DCU exhaust fans were mounted directly on the other long axis).

[0166] The above system was found to consume fuel gas at a rate of about 70 Mscfd to about 80 Mscfd. Moreover, it was found that, in some cases, two paralleled 170 kW engine-type generators could be substituted for a single 350 kW or 385 kW engine-type generator.

* * *

[0167] Various embodiments are described in this specification, with reference to the detailed discussed above, the accompanying drawings, and the claims. Numerous specific details are described to provide a thorough understanding of various embodiments. However, in certain instances, well-known or conventional details are not described in order to provide a concise discussion. The figures are not necessarily to scale, and some features may be exaggerated or minimized to show details of particular components. Therefore, specific structural and functional details disclosed herein are not to be interpreted as limiting, but merely as a basis for the claims and as a representative basis for teaching one skilled in the art to variously employ the embodiments.

[0168] The embodiments described and claimed herein and drawings are illustrative and are not to be construed as limiting the embodiments. The subject matter of this specification is not to be limited in scope by the specific examples, as these examples are intended as illustrations of several aspects of the embodiments. Any equivalent examples are intended to be within the scope of the specification. Indeed, various modifications of the disclosed embodiments in addition to those shown and described herein will become apparent to those skilled in the art, and such modifications are also intended to fall within the scope of the appended claims.

[0169] It will be understood by those skilled in the art that the drawings are diagrammatic and that further items of equipment such as temperature sensors, pressure sensors, pressure relief valves, control valves, flow controllers, level controllers, holding tanks, storage tanks, and the like may be required in a commercial plant.

[0170] While this specification contains many specific implementation details, these should not be construed as limitations on the scope of any invention or of what may be claimed, but rather as descriptions of features that may be specific to particular embodiments of particular inventions. Certain features that are described in this specification in the context of separate embodiments can also be implemented in combination in a single embodiment. Conversely, various features that are described in the context of a single embodiment can also be implemented in multiple embodiments separately or in any suitable subcombination. Moreover, although features may be described above as acting in certain combinations and even initially claimed as such, one or more features from a claimed combination can in some cases be excised from the combination, and the claimed combination may be directed to a subcombination or variation of a subcombination.

[0171] Similarly, while operations are depicted in the drawings in a particular order, this should not be understood as requiring that such operations be performed in the particular order shown or in sequential order, or that all illustrated operations be performed, to achieve desirable results. In certain circumstances, multitasking and parallel processing may be advantageous. Moreover, the separation of various system modules and components in the embodiments described above should not be understood as requiring such separation in all embodiments, and it should be understood that the described program components and systems can generally be integrated together in a single software product or packaged into multiple software products.

[0172] All references including patents, patent applications and publications cited herein are incorporated herein by reference in their entirety and for all purposes to the same extent as if each individual publication or patent or patent application was specifically and individually indicated to be incorporated by reference in its entirety for all purposes.

CLAIMS

[0173] What is claimed is:

1. A flare mitigation system comprising:

an electrical power generation system comprising:

a power generation module adapted to:

receive a fuel gas stream comprising a fuel gas associated with a heat value of at least about 1,000 Btu/scf; and

consume the fuel gas stream to generate a high-voltage electrical output associated with a first voltage; and

an electrical transformation module in electrical communication with the power generation module, the electrical transformation module adapted to:

receive the high-voltage electrical output generated by the power generation module; and

transform the high-voltage electrical output into a low-voltage electrical output associated with a second voltage that is lower than the first voltage; and

a distributed computing system powered by the electrical power generation system, the distributed computing system comprising:

a communications system comprising one or more data satellite antennas, the communications system adapted to provide a network; and

a first mobile data center comprising:

an enclosure defining an interior space;

a plurality of distributed computing units located within the interior space of the enclosure, each of the plurality of distributed computing units in communication with the network; and

a power system located at least partially within the interior space of the enclosure, the power system in electrical communication with the electrical transformation module and the plurality of distributed computing units such

that the power system receives the low-voltage electrical output and powers each of the plurality of distributed computing units.

2. A system according to claim 1, wherein:

the power generation module comprises an engine-type generator;

the high-voltage electrical output is from about 70 kW to about 2 MW; and

the first voltage is from about 480 V to about 4.16 kV.

3. A system according to claim 2, wherein the second voltage is from about 208 V to about 240 V.

4. A system according to claim 3, wherein:

the high-voltage electrical output is from about 300 kW to about 400 kW;

the first voltage is about 480 V;

the enclosure of the first mobile data center comprises:

a length of about 20 feet;

a width of about 8 feet; and

a height of from about 8.5 feet to about 9.5 feet; and

the plurality of distributed computing units comprises at least about 200 distributed computing units.

5. A system according to claim 4, wherein the electrical power generation system is adapted to consume from about 50 Mscf to about 100 Mscf of fuel gas per day.

6. A system according to claim 3, wherein:

the high-voltage electrical output is from about 1 MW to about 2 MW;

the first voltage is about 480 V;

the enclosure of the first mobile data center comprises:

a length of about 40 feet;

a width of about 8 feet; and

a height of from about 8.5 feet to about 9.5 feet; and

the plurality of distributed computing units comprises at least about 400 distributed computing units.

7. A system according to claim 6, wherein the electrical power generation system is adapted to consume from about 100 Mscf to about 500 Mscf of fuel gas per day.

8. A system according to claim 6, wherein the distributed computing system further comprises a second mobile data center comprising:

a second enclosure defining an interior space, the second enclosure having a length, width and height substantially similar to the respective length, width and height of the enclosure of the first mobile data center;

a second plurality of distributed computing units located within the interior space of the second enclosure, each of the second plurality of distributed computing units in communication with the network; and

a second power system located at least partially within the interior space of the second enclosure, the second power system in electrical communication with the electrical transformation module and the second plurality of distributed computing units such that the power system receives the low-voltage electrical output and powers each of the second plurality of distributed computing units.

9. A system according to claim 6, wherein:

the electrical power generation system further comprises:

a second electrical transformation module in electrical communication with the power generation module, the second electrical transformation module adapted to:

receive the high-voltage electrical output generated by the power generation module; and

transform the high-voltage electrical output into a second low-voltage electrical output associated with the second voltage; and

the distributed computing system further comprises:

a second mobile data center comprising:

a second enclosure defining an interior space, the second enclosure having a length, width and height substantially similar to the respective length, width and height of the enclosure of the first mobile data center;

a second plurality of distributed computing units located within the interior space of the second enclosure, each of the second plurality of distributed computing units in communication with the network; and

a second power system located at least partially within the interior space of the second enclosure, the second power system in electrical communication with the electrical transformation module and the second plurality of distributed computing units such that the power system receives the low-voltage electrical output and powers each of the second plurality of distributed computing units.

10. A system according to claim 1, wherein:

the power generation module comprises a turbine-type generator;

the high-voltage electrical output comprises from about 2 MW to about 30 MW; and

the first voltage is from about 4.16 kV to about 12 kV.

11. A system according to claim 10, wherein the distributed computing system further comprises a second mobile data center comprising:

a second enclosure defining an interior space, the second enclosure having a length, width and height substantially similar to the respective length, width and height of the enclosure of the first mobile data center;

a second plurality of distributed computing units located within the interior space of the second enclosure, each of the second plurality of distributed computing units in communication with the network; and

a second power system located at least partially within the interior space of the second enclosure, the second power system in electrical communication with the electrical

transformation module and the second plurality of distributed computing units such that the second power system receives the low-voltage electrical output and powers each of the second plurality of distributed computing units.

12. A system according to claim 10, wherein:

the electrical power generation system further comprises:

a second electrical transformation module in electrical communication with the power generation module, the second electrical transformation module adapted to:

receive the high-voltage electrical output generated by the power generation module; and

transform the high-voltage electrical output into a second low-voltage electrical output associated with the second voltage; and

the distributed computing system further comprises:

a second mobile data center comprising:

a second enclosure defining an interior space, the second enclosure having a length, width and height substantially similar to the respective length, width and height of the enclosure of the first mobile data center;

a second plurality of distributed computing units located within the interior space of the second enclosure, each of the second plurality of distributed computing units in communication with the network; and

a second power system located at least partially within the interior space of the second enclosure, the second power system in electrical communication with the electrical transformation module and the second plurality of distributed computing units such that the second power system receives the low-voltage electrical output and powers each of the second plurality of distributed computing units.

13. A system according to claim 10, wherein the second voltage is from about 208 V to about 240 V.

14. A system according to claim 1, further comprising a monitoring and control system in communication with the distributed computing system via the network.

15. A system according to claim 1, further comprising a natural gas processing system in communication with the electrical power generation system, the natural gas processing system adapted to process raw natural gas into the fuel gas.

16. A system according to claim 1, wherein the plurality of distributed computing units are adapted to mine a cryptocurrency.

17. A flare mitigation system comprising:

an electrical power generation system comprising:

a first power generation module adapted to:

receive a first fuel gas stream comprising a fuel gas associated with a heat value of at least about 1,000 Btu/scf; and

consume the fuel gas stream to generate a first high-voltage electrical output associated with a first voltage;

a second power generation module adapted to:

receive a second fuel gas stream comprising the fuel gas; and

consume the second fuel gas stream to generate a second high-voltage electrical output associated with the first voltage;

a parallel panel in electrical communication with the first power generation module and the second power generation module, the parallel panel adapted to:

receive the first and second high-voltage electrical outputs; and

combine and synchronize the first and second high-voltage electrical outputs into a combined high-voltage electrical output; and

an electrical transformation module in electrical communication with the parallel panel, the electrical transformation module adapted to:

receive the combined high-voltage electrical output; and

transform the combined high-voltage electrical output into a low-voltage electrical output associated with a second voltage that is lower than the first voltage; and

a distributed computing system powered by the electrical power generation system, the distributed computing system comprising:

a communications system comprising one or more data satellite antennas, the communications system adapted to provide a network; and

a first mobile data center comprising:

an enclosure defining an interior space;

a plurality of distributed computing units located within the interior space of the enclosure, each of the plurality of distributed computing units in communication with the network; and

a power system located at least partially within the interior space of the enclosure, the power system in electrical communication with the electrical transformation module and the plurality of distributed computing units such that the power system receives the low-voltage electrical output and powers each of the plurality of distributed computing units.

18. A system according to claim 19, wherein:

the first power generation module comprises an engine-type generator;

the first high-voltage electrical output is from about 70 kW to about 2 MW;

the second power generation module comprises an engine-type generator;

the second high-voltage electrical output is from about 70 kW to about 2 MW; and

the first voltage is from about 480 V to about 4.16 kV.

19. A system according to claim 18, wherein the second voltage is from about 208 V to about 240 V.

20. A system according to claim 19, wherein the distributed computing system further comprises a second mobile data center comprising:

a second enclosure defining an interior space;

a second plurality of distributed computing units located within the interior space of the second enclosure, each of the second plurality of distributed computing units in communication with the network; and

a second power system located at least partially within the interior space of the second enclosure, the second power system in electrical communication with the electrical transformation module and the second plurality of distributed computing units such that the second power system receives the low-voltage electrical output and powers each of the second plurality of distributed computing units.

ABSTRACT

[0174] Systems and methods are provided to mitigate flaring of natural gas. A natural gas processing system may process raw natural gas into a fuel gas stream that may be used to power any number of on-site power generation modules. In turn, the power generation modules may convert the fuel gas stream into an electrical output, which may be employed to power any number of distributed computing units housed within one or more mobile data centers. In certain embodiments, the distributed computing units may be adapted to mine cryptocurrency or perform other distributed computing tasks to generate revenue.

PTO/AIA/22 (03-13)
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PETITION FOR EXTENSION OF TIME UNDER 37 CFR 1.136(a)

Docket Number (Optional): CRUSOE-105002US1

Application Number: 16/529,152

Filed: 2019-08-01

For: Systems and Methods for Generating and Consuming Power from Natural Gas

Art Unit: 2836

Examiner: AMAYA, CARLOS DAVID

This is a request under the provisions of 37 CFR 1.136(a) to extend the period for filing a reply in the above-identified application.

The requested extension and fee are as follows (check time period desired and enter the appropriate fee below):

	Fee	Small Entity Fee	Micro Entity Fee	
☐ One month (37 CFR 1.17(a)(1))	$200	$100	$50	$
☑ Two months (37 CFR 1.17(a)(2))	$600	$300	$150	$ 300
☐ Three months (37 CFR 1.17(a)(3))	$1,400	$700	$350	$
☐ Four months (37 CFR 1.17(a)(4))	$2,200	$1,100	$550	$
☐ Five months (37 CFR 1.17(a)(5))	$3,000	$1,500	$750	$

☑ Applicant asserts small entity status. See 37 CFR 1.27.

☐ Applicant certifies micro entity status. See 37 CFR 1.29.
Form PTO/SB/15A or B or equivalent must either be enclosed or have been submitted previously.

☐ A check in the amount of the fee is enclosed.

☐ Payment by credit card. Form PTO-2038 is attached.

☑ The Director has already been authorized to charge fees in this application to a Deposit Account.

☑ The Director is hereby authorized to charge any fees which may be required, or credit any overpayment, to Deposit Account Number 506138.

☑ Payment made via EFS-Web.

WARNING: Information on this form may become public. Credit card information should not be included on this form. Provide credit card information and authorization on PTO-2038.

I am the

☐ applicant.

☑ attorney or agent of record. Registration number 64748.

☐ attorney or agent acting under 37 CFR 1.34. Registration number _____.

/Kyle Zeller/ — Signature

2020-09-23 — Date

Kyle Zeller — Typed or printed name

_____ — Telephone Number

NOTE: This form must be signed in accordance with 37 CFR 1.33. See 37 CFR 1.4 for signature requirements and certifications. Submit multiple forms if more than one signature is required, see below*.

☐ * Total of _____ forms are submitted.

This collection of information is required by 37 CFR 1.136(a). The information is required to obtain or retain a benefit by the public, which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.11 and 1.14. This collection is estimated to take 6 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. SEND TO: Mail Stop PCT, Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.

Privacy Act Statement

The **Privacy Act of 1974 (P.L. 93-579)** requires that you be given certain information in connection with your submission of the attached form related to a patent application or patent. Accordingly, pursuant to the requirements of the Act, please be advised that: (1) the general authority for the collection of this information is 35 U.S.C. 2(b)(2); (2) furnishing of the information solicited is voluntary; and (3) the principal purpose for which the information is used by the U.S. Patent and Trademark Office is to process and/or examine your submission related to a patent application or patent. If you do not furnish the requested information, the U.S. Patent and Trademark Office may not be able to process and/or examine your submission, which may result in termination of proceedings or abandonment of the application or expiration of the patent.

The information provided by you in this form will be subject to the following routine uses:

1. The information on this form will be treated confidentially to the extent allowed under the Freedom of Information Act (5 U.S.C. 552) and the Privacy Act (5 U.S.C 552a). Records from this system of records may be disclosed to the Department of Justice to determine whether disclosure of these records is required by the Freedom of Information Act.
2. A record from this system of records may be disclosed, as a routine use, in the course of presenting evidence to a court, magistrate, or administrative tribunal, including disclosures to opposing counsel in the course of settlement negotiations.
3. A record in this system of records may be disclosed, as a routine use, to a Member of Congress submitting a request involving an individual, to whom the record pertains, when the individual has requested assistance from the Member with respect to the subject matter of the record.
4. A record in this system of records may be disclosed, as a routine use, to a contractor of the Agency having need for the information in order to perform a contract. Recipients of information shall be required to comply with the requirements of the Privacy Act of 1974, as amended, pursuant to 5 U.S.C. 552a(m).
5. A record related to an International Application filed under the Patent Cooperation Treaty in this system of records may be disclosed, as a routine use, to the International Bureau of the World Intellectual Property Organization, pursuant to the Patent Cooperation Treaty.
6. A record in this system of records may be disclosed, as a routine use, to another federal agency for purposes of National Security review (35 U.S.C. 181) and for review pursuant to the Atomic Energy Act (42 U.S.C. 218(c)).
7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (*i.e.*, GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.
8. A record from this system of records may be disclosed, as a routine use, to the public after either publication of the application pursuant to 35 U.S.C. 122(b) or issuance of a patent pursuant to 35 U.S.C. 151. Further, a record may be disclosed, subject to the limitations of 37 CFR 1.14, as a routine use, to the public if the record was filed in an application which became abandoned or in which the proceedings were terminated and which application is referenced by either a published application, an application open to public inspection or an issued patent.
9. A record from this system of records may be disclosed, as a routine use, to a Federal, State, or local law enforcement agency, if the USPTO becomes aware of a violation or potential violation of law or regulation.

Electronic Patent Application Fee Transmittal

Application Number:	16529152
Filing Date:	01-Aug-2019
Title of Invention:	Systems and Methods for Generating and Consuming Power from Natural Gas
First Named Inventor/Applicant Name:	Charles Cavness
Filer:	Kyle Montgomery Zeller
Attorney Docket Number:	CRUSOE-105002US1

Filed as Small Entity

Filing Fees for Utility under 35 USC 111(a)

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Basic Filing:				
Pages:				
Claims:				
Miscellaneous-Filing:				
Petition:				
Patent-Appeals-and-Interference:				
Post-Allowance-and-Post-Issuance:				
Extension-of-Time:				

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Extension - 2 months with $0 paid	2252	1	300	300
Miscellaneous:				
			Total in USD ($)	**300**

Electronic Acknowledgement Receipt

EFS ID:	40649458
Application Number:	16529152
International Application Number:	
Confirmation Number:	9940
Title of Invention:	Systems and Methods for Generating and Consuming Power from Natural Gas
First Named Inventor/Applicant Name:	Charles Cavness
Customer Number:	114903
Filer:	Kyle Montgomery Zeller
Filer Authorized By:	
Attorney Docket Number:	CRUSOE-105002US1
Receipt Date:	23-SEP-2020
Filing Date:	01-AUG-2019
Time Stamp:	19:26:19
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	yes
Payment Type	CARD
Payment was successfully received in RAM	$300
RAM confirmation Number	E20209MJ27284279
Deposit Account	506138
Authorized User	Kyle Zeller

The Director of the USPTO is hereby authorized to charge indicated fees and credit any overpayment as follows:

37 CFR 1.16 (National application filing, search, and examination fees)

37 CFR 1.17 (Patent application and reexamination processing fees)

37 CFR 1.19 (Document supply fees)

37 CFR 1.20 (Post Issuance fees)

37 CFR 1.21 (Miscellaneous fees and charges)

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Amendment/Req. Reconsideration-After Non-Final Reject	Response.pdf	147178 ebe2818b3cfab7b9642ccb526a21813230ced5e2	no	15
Warnings:					
Information:					
2	Specification	Substitute_Specification_Markup.pdf	318095 dcb3d14e2aff15da73386f3f1bc9a741f6adf2e8	no	48
Warnings:					
Information:					
3	Specification	Substitute_Specification_Clean.pdf	314417 9582d5f948597092adb2ad93ca56bb7ddb9e4236	no	48
Warnings:					
Information:					
4	Extension of Time	aia0022.pdf	140533 28e3f1c67a53d873a1ae654b8e0d74e20cc83b4f	no	2
Warnings:					
Information:					
5	Fee Worksheet (SB06)	fee-info.pdf	30359 c07f1ea3c6f609feea5f4951e5874b270196e052	no	2
Warnings:					
Information:					
		Total Files Size (in bytes):	950582		

This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.

New Applications Under 35 U.S.C. 111

If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

National Stage of an International Application under 35 U.S.C. 371

If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office

If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

Serial No.: 16/529,152
Docket: CRUSOE-105002US1

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant:	Crusoe Energy Systems Inc.	**Art Unit:**	2836
Serial No.:	16/529,152	**Examiner:**	AMAYA, CARLOS DAVID
Filed:	2019-08-01	**Conf. No.:**	9940
Title:	Systems and Methods for Generating and Consuming Power from Natural Gas		

RESPONSE TO NON-FINAL OFFICE ACTION

Electronically Filed
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Sir:

In response to the Non-Final Office Action having a Notification Date of May 7, 2020, Applicant requests consideration of the following amendments and remarks.

Amendments to the Specification begin on page **2**

Amendments to the Claims are reflected in the listing of claims beginning on page **4**.

Remarks begin on page **13** of this paper.

AMENDMENTS TO THE SPECIFICATION

Please replace paragraph [0131] of the specification with the following amended paragraph:

> **[0131]** In one embodiment, the electrical power system 530 ~~of a~~ may comprise one or more breaker panels in electrical communication with a series of power distribution units ("PDUs") or power channels. Such PDUs may also be in communication with the various electrical components of the mobile data center 510, such as DCUs 520, backup power systems 540 (e.g., batteries and/or solar panels), a communication system 555, and/or a monitoring and control system 580.

Please also replace paragraph [0141] of the specification with the following amended paragraph:

> **[0141]** It will be appreciated that the mobile data center 510 may be further designed with various safety and security features specific to oilfield operations. For example, the mobile data center 510 may comprise one or more wireless cameras controlled by the monitoring and control system 580 and powered by the power system 530 and/or the backup power system 540. Such cameras may be specified for continuous remote monitoring and/or motion-activated recording. As another example, the mobile data center 510 ~~may comprise~~ may comprise motion activated lighting systems that serve as an additional crime deterrent and/or that may provide sufficient light to facilitate work during nighttime operations.

And please replace paragraph [0165] of the specification with the following amended paragraph:

> **[0165]** The output electrical flow was then distributed to an electrical power system of a single 20' by 8' by 9.5' mobile data center, which employed power channels (rather than PDUs to support 264 ~~DSUs~~ DCUs). For ventilation, the mobile data center utilized natural aspiration via direct exhaust of DCUs to the container's exterior. Specifically, the mobile data center included a pair of awnings and protective walls extending from the air intake (a wall of metal gridding and filtration material on one long axis), as well as the air exhaust wall (a metal grid against which DCU exhaust fans were mounted directly on the other long axis).

The above paragraphs are amended herein to correct typographical errors and Applicant respectfully submits that no new matter has been added. Applicant has attached a Substitute Specification showing the above changes relative to the immediate prior version of the

specification of record as required by 37 CFR § 1.125(c). Additionally, Applicant has attached a "clean" copy of the Substitute Specification for the Examiner's convenience.

AMENDMENTS TO THE CLAIMS

The following listing of claims will replace all prior versions and listings of claims in this application.

Listing of Claims:

1. (Currently Amended) A flare mitigation system comprising:

an electrical power generation system comprising:

~~a~~ one or more power generation modules, each adapted to:

receive a fuel gas stream comprising a fuel gas associated with a heat value of at least about 1,000 Btu/scf; and

consume the fuel gas stream to generate a high-voltage electrical output associated with a first voltage; and

a parallel panel in electrical communication with each of the power generation modules, the parallel panel adapted to:

receive the high-voltage electrical output from each of the power generation modules; and

combine and synchronize said high-voltage electrical outputs into a combined high-voltage electrical output; and

an electrical transformation module in electrical communication with the ~~power generation module~~ parallel panel, the electrical transformation module adapted to:

receive the combined high-voltage electrical output ~~generated by the power generation module~~; and

transform the combined high-voltage electrical output into a low-voltage electrical output associated with a second voltage that is lower than the first voltage; and

a distributed computing system powered by the electrical power generation system, the distributed computing system comprising:

a communications system comprising one or more data satellite antennas, the communications system adapted to provide a network; and

a first mobile data center comprising:

an enclosure defining an interior space;

a plurality of distributed computing units located within the interior space of the enclosure, each of the plurality of distributed computing units in communication with the network; and

a power system located at least partially within the interior space of the enclosure, the power system in electrical communication with the electrical transformation module and the plurality of distributed computing units such that the power system receives the low-voltage electrical output and powers each of the plurality of distributed computing units.

2. (Currently Amended) A system according to claim 1, wherein:

at least one of the power generation modules comprises an engine-type generator;

the high-voltage electrical output generated by the engine-type generator is from about 70 kW to about 2 MW; and

the first voltage is from about 480 V to about 4.16 kV.

3. (Original) A system according to claim 2, wherein the second voltage is from about 208 V to about 240 V.

4. (Currently Amended) A system according to claim 3, wherein:

the high-voltage electrical output generated by the engine-type generator is from about 300 kW to about 400 kW;

the first voltage is about 480 V;

the enclosure of the first mobile data center comprises:

a length of about 20 feet;

a width of about 8 feet; and

a height of from about 8.5 feet to about 9.5 feet; and

the plurality of distributed computing units comprises at least about 200 distributed computing units.

5. (Original) A system according to claim 4, wherein the electrical power generation system is adapted to consume from about 50 Mscf to about 100 Mscf of fuel gas per day.

6. (Currently Amended) A system according to claim 3, wherein:

the high-voltage electrical output generated by the engine-type generator is from about 1 MW to about 2 MW;

the first voltage is about 480 V;

the enclosure of the first mobile data center comprises:

a length of about 40 feet;

a width of about 8 feet; and

a height of from about 8.5 feet to about 9.5 feet; and

the plurality of distributed computing units comprises at least about 400 distributed computing units.

7. (Original) A system according to claim 6, wherein the electrical power generation system is adapted to consume from about 100 Mscf to about 500 Mscf of fuel gas per day.

8. (Original) A system according to claim 6, wherein the distributed computing system further comprises a second mobile data center comprising:

a second enclosure defining an interior space, the second enclosure having a length, width and height substantially similar to the respective length, width and height of the enclosure of the first mobile data center;

a second plurality of distributed computing units located within the interior space of the second enclosure, each of the second plurality of distributed computing units in communication with the network; and

a second power system located at least partially within the interior space of the second enclosure, the second power system in electrical communication with the electrical transformation module and the second plurality of distributed computing units such that the power system receives the low-voltage electrical output and powers each of the second plurality of distributed computing units.

9. (Currently Amended) A system according to claim 6, wherein:

the electrical power generation system further comprises:

a second electrical transformation module in electrical communication with the ~~power generation module~~ parallel panel, the second electrical transformation module adapted to:

receive the combined high-voltage electrical output ~~generated by the power generation module~~; and

transform the combined high-voltage electrical output into a second low-voltage electrical output associated with the second voltage; and

the distributed computing system further comprises:

a second mobile data center comprising:

a second enclosure defining an interior space, the second enclosure having a length, width and height substantially similar to the respective length, width and height of the enclosure of the first mobile data center;

a second plurality of distributed computing units located within the interior space of the second enclosure, each of the second plurality of distributed computing units in communication with the network; and

a second power system located at least partially within the interior space of the second enclosure, the second power system in electrical communication with

the second electrical transformation module and the second plurality of distributed computing units such that the second power system receives the second low-voltage electrical output and powers each of the second plurality of distributed computing units.

10. (Currently Amended) A system according to claim 1, wherein:

at least one of the power generation modules comprises a turbine-type generator; and

the high-voltage electrical output generated by the turbine-type generator comprises from about 2 MW to about 30 MW~~; and~~

~~the first voltage is from about 4.16 kV to about 12 kV~~.

11. (Original) A system according to claim 10, wherein the distributed computing system further comprises a second mobile data center comprising:

a second enclosure defining an interior space, the second enclosure having a length, width and height substantially similar to the respective length, width and height of the enclosure of the first mobile data center;

a second plurality of distributed computing units located within the interior space of the second enclosure, each of the second plurality of distributed computing units in communication with the network; and

a second power system located at least partially within the interior space of the second enclosure, the second power system in electrical communication with the electrical transformation module and the second plurality of distributed computing units such that the second power system receives the low-voltage electrical output and powers each of the second plurality of distributed computing units.

12. (Currently Amended) A system according to claim 10, wherein:

the electrical power generation system further comprises:

a second electrical transformation module in electrical communication with the parallel panel ~~power generation module~~, the second electrical transformation module adapted to:

receive the combined high-voltage electrical output ~~generated by the power generation module~~; and

transform the combined high-voltage electrical output into a second low-voltage electrical output associated with the second voltage; and

the distributed computing system further comprises:

a second mobile data center comprising:

a second enclosure defining an interior space, the second enclosure having a length, width and height substantially similar to the respective length, width and height of the enclosure of the first mobile data center;

a second plurality of distributed computing units located within the interior space of the second enclosure, each of the second plurality of distributed computing units in communication with the network; and

a second power system located at least partially within the interior space of the second enclosure, the second power system in electrical communication with the second electrical transformation module and the second plurality of distributed computing units such that the second power system receives the second low-voltage electrical output and powers each of the second plurality of distributed computing units.

13. (Original) A system according to claim 10, wherein the second voltage is from about 208 V to about 240 V.

14. (Original) A system according to claim 1, further comprising a monitoring and control system in communication with the distributed computing system via the network.

15. (Original) A system according to claim 1, further comprising a natural gas processing system in communication with the electrical power generation system, the natural gas processing system adapted to process raw natural gas into the fuel gas.

16. (Original) A system according to claim 1, wherein the plurality of distributed computing units are adapted to mine a cryptocurrency.

17. (Original) A flare mitigation system comprising:

an electrical power generation system comprising:

a first power generation module adapted to:

receive a first fuel gas stream comprising a fuel gas associated with a heat value of at least about 1,000 Btu/scf; and

consume the fuel gas stream to generate a first high-voltage electrical output associated with a first voltage;

a second power generation module adapted to:

receive a second fuel gas stream comprising the fuel gas; and

consume the second fuel gas stream to generate a second high-voltage electrical output associated with the first voltage;

a parallel panel in electrical communication with the first power generation module and the second power generation module, the parallel panel adapted to:

receive the first and second high-voltage electrical outputs; and

combine and synchronize the first and second high-voltage electrical outputs into a combined high-voltage electrical output; and

an electrical transformation module in electrical communication with the parallel panel, the electrical transformation module adapted to:

receive the combined high-voltage electrical output; and

transform the combined high-voltage electrical output into a low-voltage electrical output associated with a second voltage that is lower than the first voltage; and

a distributed computing system powered by the electrical power generation system, the distributed computing system comprising:

a communications system comprising one or more data satellite antennas, the communications system adapted to provide a network; and

a first mobile data center comprising:

an enclosure defining an interior space;

a plurality of distributed computing units located within the interior space of the enclosure, each of the plurality of distributed computing units in communication with the network; and

a power system located at least partially within the interior space of the enclosure, the power system in electrical communication with the electrical transformation module and the plurality of distributed computing units such that the power system receives the low-voltage electrical output and powers each of the plurality of distributed computing units.

18. (Original) A system according to claim 19, wherein:

the first power generation module comprises an engine-type generator;

the first high-voltage electrical output is from about 70 kW to about 2 MW;

the second power generation module comprises an engine-type generator;

the second high-voltage electrical output is from about 70 kW to about 2 MW; and

the first voltage is from about 480 V to about 4.16 kV.

19. (Original) A system according to claim 18, wherein the second voltage is from about 208 V to about 240 V.

20. (Original) A system according to claim 19, wherein the distributed computing system further comprises a second mobile data center comprising:

a second enclosure defining an interior space;

a second plurality of distributed computing units located within the interior space of the second enclosure, each of the second plurality of distributed computing units in communication with the network; and

a second power system located at least partially within the interior space of the second enclosure, the second power system in electrical communication with the electrical transformation module and the second plurality of distributed computing units such that the second power system receives the low-voltage electrical output and powers each of the second plurality of distributed computing units.

REMARKS

Status of the Claims

Claims 1-20 are pending.

Claims 1, 2, 4, 6, 9, 10 and 12 are amended herein. No new matter is added.

Objections to the Specification

The specification is objected to because of various informalities contained in paragraphs [0131], [0141] and [0165].[1] The Examiner is requested above to replace original paragraphs [0131], [0141] and [0165] with the corresponding amended paragraphs. Withdrawal of the objections to the specification is respectfully requested.

Objections to the Claims

Claims 9 and 12 are objected to because of the following informalities: "Claims 9 and 12 lines 19 and 20 recite 'the electrical transformation' and 'the low-voltage'; however, it appears that [the claims] should read 'the second electrical transformation' and 'the second low-voltage.'"[2] Claims 9 and 12 are amended herein to correct the above informalities and withdrawal of the objections to the claims is respectfully requested.

Claim Rejections

35 U.S.C. §§ 102(a)(2) and 103

Claim 1 is rejected under 35 U.S.C. § 102(a)(2) as allegedly being anticipated by U.S. Pat. App. Pub. No. 2020/0051184 ("Barbour").[3] And claims 2-16 are rejected under 35 U.S.C. § 103 as allegedly being unpatentable over Barbour in view of US Pat. App. Pub. 2020/0006938 ("Torvund").[4] The rejections are respectfully traversed.

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[1] Office Action at 2.
[2] *Id.*
[3] *Id.*
[4] *Id* at 3.

Claims 17-20

As an initial matter, Applicant respectfully notes that claims 17-20 are not rejected under 35 U.S.C. §§ 102/103 as allegedly being anticipated by Barbour and/or unpatentable over Barbour in view of Torvund. Independent claim 17 recites the following element, which was not included in original independent claim 1: "a parallel panel in electrical communication with the first power generation module and the second power generation module, the parallel panel adapted to: receive the first and second high-voltage electrical outputs; and combine and synchronize the first and second high-voltage electrical outputs into a combined high-voltage electrical output." Both Barbour and Torvund are wholly silent with respect to the claimed parallel panel and the Examiner does not assert that either references teaches/suggests such element. Accordingly, claims 17-20 are believed to be allowable over the cited references.

Claims 1-16

Independent claim 1 is amended herein to recite the "parallel panel" found in original claim 17. Accordingly, amended independent claim 1 is believed to be allowable over the cited references for at least the reasons discussed above with respect to claim 17. Claims 2-16 are also believed to be allowable, as each of the claims depends directly or indirectly from claim 1.

Double Patenting

Claims 1-20 of the instant application are provisionally rejected under 35 U.S.C. § 101 as claiming the same invention as that of claims 1-20 of co-pending Application No. 16/694,883 (the "'883 Application").[5] Applicant notes that independent claim 1 of the instant application is amended herein. Moreover, on September 23, 2020 Applicant submitted a Response to Non-Final Office Action in the '883 Application. The Response includes amendments to independent claims 1 and 17 of the '883 Application. Accordingly, the claims of the instant application are no longer coextensive in scope with those of the '883 Application. Withdrawal of the provisional statutory double patenting rejection is respectfully requested.

[5] *Id* at 8.

CONCLUSION

In light of the above, Applicant respectfully submits that the instant application is in condition for allowance. An action passing this case to issue is therefore respectfully requested. In the event that a telephone conference would facilitate examination of this application, the Examiner is invited to contact the undersigned representative at the number provided.

AUTHORIZATION

The Commissioner is hereby authorized to charge any fees which may be required for this amendment, or credit any overpayment to Deposit Account No. **50-6138**. Furthermore, in the event that an extension of time is required, the Commissioner is requested to grant a petition for that extension of time which is required to make this response timely and is hereby authorized to charge any fee for such an extension of time or credit any overpayment for an extension of time to the above Deposit Account.

Respectfully Submitted,
Zeller IP Group, PLLC

Dated: September 23, 2020

/Kyle M. Zeller/
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Systems and Methods for Generating and Consuming Power from Natural Gas

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] The present application claims benefit of U.S. provisional patent application no. 62/713,368, titled "Systems and Methods for Generating and Consuming Power from Natural Gas," filed August 1, 2018, which is incorporated by reference herein in its entirety.

BACKGROUND

[0002] This specification relates to enabling the utilization of raw natural gas, such as flare gas, stranded gas, and associated gas for power generation. More specifically, the specification relates to on-site generation of electricity from natural gas to power modular processing units adapted to perform distributed computing tasks.

[0003] Extracting oil from unconventional resources, such as shale gas formations, through the combination of horizontal drilling and hydraulic fracturing has increased at a rapid pace in recent years. The Bakken, Powder River Basin, Denver Julesburg ("D-J") Basin, North Park Basin, and Permian Basin are just some of the important "plays" in the United States. A "play" is the geographic area underlain by a gas- or oil-containing geologic formation.

[0004] Development of these gas plays and other unconventional resources presents significant potential for economic development and energy independence, but also presents the potential for environmental impacts on land, water and air. For example, although oil production represents the most important source of revenue for a given well, most wells also produce natural gas as a low-value byproduct. Unfortunately, the liquids-rich natural gas byproduct often cannot be economically transported by trucks or trains from remote well locations. Although such natural gases could be transported via pipelines, many oil and natural gas wells are located beyond the reach of such infrastructure. Absent gas pipeline infrastructure, oil well operators must either "vent" or "flare" produced gasses for safety reasons. Venting is the controlled release of natural gases into the atmosphere in the course of oil and gas production operations, however natural gas accumulations around the wellbore create significant safety hazards. Flaring is the controlled burning of natural gas produced in association with oil in the course of routine oil and gas

production operations, and is designed to minimize the safety and environmental risks associated with venting uncombusted natural gas.

[0005] As of April 2016, the NOAA estimates that there are over 6,200 individual flares in the United States, which burn about 35 billion ft3 of natural gas annually—enough to supply about 6 million homes. Such large-scale flaring of natural gas has raised serious environmental and health concerns and various state and federal regulators have begun to take action by implementing strict regulations and enforcement policies. For example, Colorado generally limits flaring to 60 days and many new well permits require producers to have a natural gas offtake solution prior to production; North Dakota has recently implemented a requirement that 90% of associated gas be captured by 2020; and Texas only allows new wells to flare for 10 days before an additional 45-day permit must be obtained. The EPA has also implemented flaring regulations where sites that exceed 100 tons per year of VOC, CO or NOX trigger Title V "Major Source Emitter" rules. Violations of state or federal rules can result in oil wells being "shut in," rejected permits and/or significant cash fines.

[0006] Stranded natural gas, particularly in the case where liquids-weighted wells are shut in due to gas takeaway constraints, represents a very low-cost power generation opportunity. Stranded gas exists across most prominent shale fields today including in the D-J Basin, Permian Basin, Bakken, SCOOP/STACK, etc. Many oil and gas operators in pipeline-constrained environments readily offer their natural gas for low cost—even at a loss to the operator in some cases—so that they can produce oil, which often represents the vast majority of a well's lifetime economics.

[0007] One potential solution to the natural gas problem lies in distributed computing. Cryptocurrency is a booming asset class with the combined market capitalization of digital currencies surpassing $380 billion in July 2018. Cryptocurrencies operate on a distributed system of computers "mining" the currencies – essentially processing the underlying algorithms to continuously verify transactions and account balances. The crypto mining process is a significant industry in its own right, projected to reach a value of $39 billion by 2025 with a projected CAGR of 29.7%.

[0008] This high-growth industry requires innovative and inexpensive electricity sources as it requires enormous amounts of power—approximately 29 TWh of electricity per year on a global basis. For perspective, cryptocurrency mining consumes more power annually than 159 countries,

including Hungary, Ireland, Nigeria or Slovakia. Indeed, electricity is typically the single largest lifetime cost to a cryptocurrency mining operation, with power costs offsetting approximately 30% of total mining revenues in the US.

[0009] Accordingly, there remains a need for systems and methods for generating electricity from natural gas produced from oil wells. It would be beneficial if such electricity could be produced and consumed on-site, for example, by using it to operate power-intensive, modular processing units. It would be further beneficial if such processing units could be employed to mine cryptocurrency or perform other distributed computing tasks to generate additional revenue.

SUMMARY

[0010] In accordance with the foregoing objectives and others, exemplary systems and methods are disclosed herein to convert raw natural gas into a fuel gas stream that may be used to power any number of on-site power generation modules. In turn, the power generation modules may convert the fuel gas stream into electricity, which may be employed to power any number of modular distributed computing units. In certain embodiments, the distributed computing units may be adapted to mine cryptocurrency or perform other distributed computing tasks to generate revenue.

[0011] In one embodiment, a flare mitigation system is provided. Such system may include an electrical power generation system, which may include a power generation module adapted to: receive a fuel gas stream, such as a fuel gas associated with a heat value of at least about 1,000 Btu/scf; and consume the fuel gas stream to generate a high-voltage electrical output associated with a first voltage. The electrical power generation system may also include an electrical transformation module in electrical communication with the power generation module, the electrical transformation module adapted to: receive the high-voltage electrical output generated by the power generation module; and transform the high-voltage electrical output into a low-voltage electrical output associated with a second voltage that is lower than the first voltage.

[0012] The flare mitigation system may also include a distributed computing system powered by the electrical power generation system. The distributed computing system may include a communications system with one or more data satellite antennas in order to provide a network; and a first mobile data center. The mobile data center may include an enclosure defining an interior

space; a plurality of distributed computing units located within the interior space of the enclosure, each of the plurality of distributed computing units in communication with the network; and a power system located at least partially within the interior space of the enclosure, the power system in electrical communication with the electrical transformation module and the plurality of distributed computing units such that the power system receives the low-voltage electrical output and powers each of the plurality of distributed computing units.

[0013] In some cases, the power generation module may be an engine-type generator that generates a high-voltage electrical output of from about 70 kW to about 2 MW (e.g., from about 70 kW to about 300 kW, from about 300 kW to about 400 kW, 400 kW to about 1 MW, or from about 1 MW to about 2 MW). The first voltage of the high-voltage electrical output may be from about 480 V to about 4.16 kV. And the second voltage of the low-voltage electrical output may be from about 208 V to about 240 V.

[0014] In other cases, the power generation module may be a turbine-type generator that generates a high-voltage electrical output of from about 2 MW to about 30 MW. In such cases, the first voltage of the high-voltage electrical output may be from about 4.16 kV to about 12 kV. And the second voltage of the low-voltage electrical output may be from about 208 V to about 240 V.

[0015] In another embodiment, a flare mitigation system is provided. The system may include an electrical power generation system having a first power generation module and a second power generation module. The first power generation module may be adapted to receive a first fuel gas stream, such as a fuel gas associated with a heat value of at least about 1,000 Btu/scf, and to consume the fuel gas stream to generate a first high-voltage electrical output associated with a first voltage. The second power generation module may be adapted to receive a second fuel gas stream including the fuel gas, and to consume the second fuel gas stream to generate a second high-voltage electrical output associated with the first voltage.

[0016] The electrical power generation system may also include a parallel panel in electrical communication with the first power generation module and the second power generation module. The parallel panel may be adapted to receive the first and second high-voltage electrical outputs; and combine and/or synchronize the first and second high-voltage electrical outputs into a combined high-voltage electrical output.

[0017] The electrical power generation system may also include an electrical transformation module in electrical communication with the parallel panel. The electrical transformation module may be adapted to receive the combined high-voltage electrical output; and transform the combined high-voltage electrical output into a low-voltage electrical output associated with a second voltage that is lower than the first voltage.

[0018] The flare mitigation system may further include a distributed computing system powered by the electrical power generation system. The distributed computing system may include a communications system having one or more data satellite antennas in order to provide a network. Moreover, the distributed computing system may include a first mobile data center having an enclosure defining an interior space; a plurality of distributed computing units located within the interior space of the enclosure, each of the plurality of distributed computing units in communication with the network; and a power system located at least partially within the interior space of the enclosure, the power system in electrical communication with the electrical transformation module and the plurality of distributed computing units such that the power system receives the low-voltage electrical output and powers each of the plurality of distributed computing units.

[0019] The details of one or more embodiments of the subject matter of this specification are set forth in the accompanying drawings and the description below. Other features, aspects, and advantages of the subject matter will become apparent from the description, the drawings, and the claims.

BRIEF DESCRIPTION OF THE DRAWINGS

[0020] FIG. 1 shows an exemplary flare mitigation system 100 according to an embodiment.

[0021] FIG. 2 shows an exemplary natural gas processing system 200 according to an embodiment.

[0022] FIG. 3 shows an exemplary electrical power generation system 300 comprising a power generation module 331 in electrical communication with an electrical transformation module 335.

[0023] FIG. 4 shows another exemplary electrical power generation system 400 comprising a plurality of power generation modules (431a, 431b) in electrical communication with an electrical transformation module 435 via a parallel panel 460.

[0024] FIG. 5 shows an exemplary distributed computing system 500 according to an embodiment.

[0025] FIG. 6 shows an exemplary computing machine 600 and modules 650 according to an embodiment.

DETAILED DESCRIPTION

System Overview

[0026] Referring to FIG. 1, an exemplary flare mitigation system 100 according to an embodiment is illustrated. As shown, the system 100 may comprise a natural gas processing system 120, an electrical power generation system 130, a distributed computing system 140, a communication system 155 and a monitoring and control system 180.

[0027] In one embodiment, the flare mitigation system 100 may comprise a natural gas processing system 120 adapted to receive a raw natural gas stream 101 from one or more wellheads 110 in an oil and/or gas reservoir. The natural gas processing system 120 is generally adapted to convert the received raw natural gas 101 into a fuel gas stream 102 that may be introduced to an electrical power generation system 130. As discussed in detail below with respect to FIG. 2, the natural gas processing system 120 may employ a separator module and, optionally, any number of additional modules (e.g., a compressor module, a carbon dioxide removal module, a desulfurization module and/or a refrigeration module) to produce a fuel gas stream 102 meeting the specific requirements of the electrical power generation system 130 and any number of secondary streams.

[0028] The electrical power generation system 130 generally comprises any number of power generation modules adapted to consume the fuel gas 102 and convert the same into electrical power. As discussed in detail below with respect to FIGs. 3-4, each power generation module may be in electrical communication with an electrical transformation module adapted to receive the electrical output of the power generation module(s) and convert the same into an electrical flow 105 that may be employed to power the electrical components of a distributed computing system 140.

[0029] In one embodiment, the distributed computing system 140 may comprise any number distributed computing units ("DCUs") in electrical communication with the electrical power

generation system 130, such that the DCUs are powered via the electrical flow 105 output by the system. The DCUs may comprise a modular computing installation, for example, a data center, cryptocurrency mine or graphics computing cell. And the DCUs are generally adapted to conduct any number of processing-intensive tasks. For example, the DCUs may be employed to execute graphics-intensive distributed computing processes, artificial intelligence ("AI") research, machine learning model training, data analysis, server functions, storage, virtual reality and/or augmented reality applications, tasks relating to the Golem Project, non-currency blockchain applications and/or cryptocurrency mining operations.

[0030] In certain embodiments, the DCUs may be employed to execute mathematical operations in relation to the mining of cryptocurrencies including computing the following hashing algorithms: SHA-256, ETHash, scrypt, CryptoNight, RIPEMD160, BLAKE256, X11, Dagger-Hashimoto, Equihash, LBRY, X13, NXT, Lyra2RE, Qubit, Skein, Groestl, BOINC, X11gost, Scrypt-jane, Quark, Keccak, Scrypt-OG, X14, Axiom, Momentum, SHA-512, Yescrypt, Scrypt-N, Cunningham, NIST5, Fresh, AES, 2Skein, Equilhash, KSHAKE320, Sidechain, Lyra2RE, HybridScryptHash256, Momentum, HEFTY1, Skein-SHA2, Qubit, SpreadX11, Pluck, and/or Fugue256. Additionally or alternatively, the DCUs may be adapted to execute mathematical operations in relation to training computationally intensive machine learning, artificial intelligence, statistical or deep learning models, such as neural networks, recurrent neural networks, convolutional neural networks, generative adversarial networks, gradient boosting machines, random forests, classification and regression trees, linear, polynomial, exponential and generalized linear regressions, logistic regression, reinforcement learning, deep reinforcement learning, hyperparameter optimization, cross validation, support vector machines, principal component analysis, singular value decomposition, convex optimization, and/or independent component analysis.

[0031] As discussed in detail below with respect to FIG. 5, the distributed computing system 140 may comprise one or more mobile data centers, wherein each mobile data center houses a plurality of DCUs therein. In addition to the DCUs, each mobile data center may further house an electrical power system, one or more backup power systems, an environment control system, and/or various monitoring and control equipment 183.

[0032] In certain embodiments, the mobile data center (and any electronic components contained therein) may be in communication with a communication system 155. For example, the mobile data center may be in direct communication with the communication system 155 via a wired connection. As another example, the DCUs may be in indirect communication with the communication system 155 via a network 150.

[0033] In one embodiment, the communication system 155 may comprise one or more data satellite antennas in communication with one or more high-orbit and/or low-orbit satellites. The antennas may be roof-mounted to one or more mobile data centers and/or may be pole-mounted into the ground nearby such mobile data centers. A typical configuration is for two antennas to serve a single mobile data center in order to provide reliability and redundancy; however, a single antenna may be sufficient depending on bandwidth requirements and total DCU count. Alternatively, many (e.g., three or more) antennas may be mounted to a roof of a single mobile data center, and communications cables may extend from the mobile data center to other nearby mobile data centers to provide a centralized communications solution.

[0034] The one or more data satellite antennas of the communication system 155 may be specified for continuous outdoor use, and may be installed using robust mounting hardware to ensure alignment even during heavy wind or other storms common in the oilfield. Antenna modems may be housed inside a mobile data center for warmth, security and weatherproofing, and such modems may be connected to the power system of the mobile data center.

[0035] In one embodiment, the communication system 155 may provide an internal network that includes automatic load-balancing functionality such that bandwidth is allocated proportionately among all active antennas. In such embodiment, if a single antenna fails, the lost bandwidth is automatically redistributed among all functioning antennas. This is an important reliability feature for oilfield operations, where equipment failures due to storms are possible.

[0036] In another embodiment, the antennas and satellite internet systems of the communication system 155 may be specified based on the needs of the distributed computing system 140, with specific attention paid to bandwidth and latency requirements. For lower bandwidth applications such as certain blockchain processing, cryptocurrency mining and/or long-term bulk data processing jobs, high-orbit satellite connectivity ranging from 10 MB/s to 100 MB/s may be specified. For higher bandwidth or low latency requirements such as artificial intelligence model

training, iterative dataset download and boundary spamming projects, visual processing such as images or videos, natural language processing, iterative protein folding simulation jobs, videogaming, or any other high capacity data streaming or rapid communication jobs, low-orbit satellites may be specified to provide significantly increased speeds and reduced latency.

[0037] In any event, the communication system 155 may provide a network 150 to which various components of the flare mitigation system 100 may be connected. The network 150 may include wide area networks ("WAN"), local area networks ("LAN"), intranets, the Internet, wireless access networks, wired networks, mobile networks, telephone networks, optical networks, or combinations thereof. The network 150 may be packet switched, circuit switched, of any topology, and may use any communication protocol. Communication links within the network 150 may involve various digital or an analog communication media such as fiber optic cables, free-space optics, waveguides, electrical conductors, wireless links, antennas, radio-frequency communications, and so forth.

[0038] As shown, the flare mitigation system further 100 comprises a MC system 180, which is generally adapted to maintain processing conditions within acceptable operational constraints throughout the system. Such constraints may be determined by economic, practical, and/or safety requirements. The MC system 180 may handle high-level operational control goals, low-level PID loops, communication with both local and remote operators, and communication with both local and remote systems. The MC system 180 may also be in communication with ancillary systems, such as storage systems, backup systems and/or power generation systems.

[0039] In one embodiment, the MC system 180 may be in communication with various monitoring and control equipment (181-183), such as sensors and/or controllers, via the network 150. Such monitoring and control equipment (181-183) may be in further communication with various components of the natural gas processing system 120, the electrical power generation system 130 and/or the distributed computing system 140, such that the MC system 180 may remotely monitor and control operating parameters throughout the flare mitigation system 100. Exemplary operating parameters may include, but are not limited to, profile of the raw natural gas supply, gas flow rate at various locations, gas pressure at various locations, temperature at various locations, electrical output at one or more locations, electrical load at one or more locations, and/or others.

[0040] As an example, the MC system 180 may determine a change in the profile, flow rate and/or pressure of the raw natural gas 101 and then automatically modulate electrical load of a mobile data center accordingly. And as another example, the MC system 180 may automatically reduce a processing rate of one or more DCUs in response to receiving an indication that supply gas pressure has decreased.

[0041] In one embodiment, any number of users may access the MC system 180 and/or the distributed computing system 140 via a client device 160 in communication with the network 150. Generally, a client device 160 may be any device capable of accessing such systems (e.g., via a native application or via a web browser). Exemplary client devices 160 may include general purpose desktop computers, laptop computers, smartphones, and/or tablets. In other embodiments, client devices 160 may comprise virtual reality ("VR") and/or augmented reality ("AR") hardware and software, which allow users to provide input via physical gestures.

[0042] The relationship of the client device 160 to such systems arises by virtue of computer programs running on the respective computers and having a client-server relationship to each other. Accordingly, each of the client devices 160 may have a client application running thereon, where the client application may be adapted to communicate with a MC application running on a MC system 180 and/or a distributed computing application running on a distributed computing system 140, for example, over a network 150. Thus, the client application may be remote from the MC system 180 and/or the distributed computing system 140. Such a configuration may allow users of client applications to interact with one or both of such systems from any location. Moreover, because the MC system 180 is capable of transceiving information to/from the various other systems (e.g., natural gas processing system 120, electrical power generation system 130, distributed computing system 140, and communication system 155), a user may interact with such systems via the MC system.

[0043] As discussed in detail below, one or more MC system applications and/or distributed computing system applications may be adapted to present various user interfaces to users. Such user interfaces may be based on information stored on the client device 160 and/or received from the respective systems. Accordingly, the application(s) may be written in any form of programming language, including compiled or interpreted languages, or declarative or procedural languages, and it can be deployed in any form, including as a standalone program or as a module,

component, subroutine, or other unit suitable for use in a computing environment. Such software may correspond to a file in a file system. A program can be stored in a portion of a file that holds other programs or data. For example, a program may include one or more scripts stored in a markup language document; in a single file dedicated to the program in question; or in multiple coordinated files (e.g., files that store one or more modules, sub programs, or portions of code).

[0044] Each of the MC system application(s) and/or distributed computing system application(s) can be deployed and/or executed on one or more computing machines that are located at one site or distributed across multiple sites and interconnected by a communication network. In one embodiment, an application may be installed on (or accessed by) one or more client devices 160.

[0045] In certain embodiments, the MC system 180 and/or the client device 160 may be adapted to receive, determine, record and/or transmit application information relating to one or more components of the flare mitigation system 100. The application information may be received from and/or transmitted to the natural gas processing system 120, the electrical power generation system 130 and/or the distributed computing system 140 via, for example, monitoring and/or control equipment (181, 182, 183, respectively) in communication with one or more components of such systems and in further communication with the network 150. Moreover, any of such application information may be stored in and/or retrieved from one or more local or remote databases (e.g., database 185).

[0046] In one embodiment, the MC system 180 may be connected to one or more third-party systems 170 via the network 150. Third-party systems 170 may store information in one or more databases that may be accessed by the MC system 180. The MC system 180 may be capable of retrieving and/or storing information from third-party systems 170, with or without user interaction. Moreover, the MC system may be capable of transmitting stored/received information to such third-party systems.

[0047] It will be appreciated that various components of the flare mitigation system 100 may be modular such that they may be combined to form a modular system. For example, the modular components that make up the natural gas processing system 120, the electrical power generation system 130, the distributed computing system, and/or the communication system 155 may be transported to an oil filed and assembled into the respective subsystems of the flare mitigation system 100.

[0048] In one embodiment, the natural gas processing system 120, electrical power generation system 130, distributed computing system 140 and the communication system 155 may be designed to allow all components of such systems to fit inside the height and width of a portable container, such as a shipping container or similar prefabricated enclosure that is transportable using a standard drop-deck semi-trailer. It will be appreciated that such configuration allows for enhanced mobility of the flare mitigation system 100 to various field sites.

[0049] Moreover, some or all of the aforementioned systems / components may be pre-mounted to a fixed skid, wheeled trailer or other form of mounting brackets in order to simplify and expedite transportation. Key benefits of this approach include reduced assembly time and expense in the field, where oilfield contract labor is often more expensive than shop labor, and where contractor availability (such as electricians) may be constrained. Wheel-mounted solutions may also qualify for special treatment as "temporary equipment," facilitating expedited or reduced regulatory processing in the oilfield environment. Pre-mounting equipment also allows for an operator to quickly re-mobilize the system 100 to a new site if the original gas flow associated with the original well declines or a new area experiences a greatly increased demand for flare mitigation.

[0050] It will be further appreciated that, the natural gas processing system 120, electrical power generation system 130, distributed computing system 140 and/or the communication system 155 may be designed to allow for individual components of such subsystems to be added or removed, as necessary, to provide a flare mitigation system 100 that aims to consume substantially all raw natural gas 101 produced at the wellhead 110. This configuration is important, as each well's gas flow rate, pressure and composition will be unique and may change over time.

[0051] For example, the electrical power generation system 130 may be modified to include additional power generation modules and/or electrical transformation modules and the distributed computing system 140 may be modified to include additional mobile data centers to mitigate increasingly larger volumes of gas during initial flow back and peak production phases of a well's life. Conversely, modules may be removed to accommodate declining flow rates. As another example, individual DCUs within a mobile data center of the distributed computing system 140 can also be remotely "turned down" or turned off to fit gas demand with gas production at each individual wellhead 110.

[0052] Using the above-described system 100, inexpensive and abundant stranded gas 101 can be used to power multi-megawatt-scale power generation equipment to produce power 105 for on-site or adjacent cryptocurrency mining operations. For example, the system may consume raw natural gas having a heat value of at least 1,000 Btu/scf at a rate of 1.3 MMscfd to power approximately 3,300 DCUs having a 14 TH/s mining hash rate (e.g., ANTMINER S9 mining rigs), which is equivalent to a moderate scale commercial mining operation. The cost to power this same mining operation would be about $2.6 million annually under a commercial power purchase agreement ($0.06/kwh).

Natural Gas Processing System

[0053] Referring to FIG. 2, an exemplary natural gas processing system 200 according to an embodiment is illustrated. As shown, the system 200 may comprise a separator module 210 and various optional components, such as a compressor module 215, a CO_2 removal module 222, a desulfurization module 224, a dehydrator module 226 and/or a refrigerator module 230.

[0054] Generally, the natural gas processing system 200 is adapted to convert a raw natural gas stream 201 received from one or more oil and/or gas wellheads 209 into a fuel gas stream 202 and, optionally, various secondary streams. As used herein, the term "raw natural gas" or "raw gas" means unprocessed natural gas released during oil and/or gas production. Raw natural gas 201 may also be referred to as "associated gas," "flare gas," "produced gas," and/or "stranded gas."

[0055] Raw natural gas 201 at a wellhead 209 is commonly a mixture of hydrocarbons, including methane (CH_4), ethane (C_2H_6), propane (C_3H_8), butane (C_4H_{10}), pentane (C_5H_{12}), hexane (C_6H_{14}) and higher hydrocarbons. The raw natural gas 201 also contains other compounds such as water vapor (H_2O), hydrogen sulfide (H_2S), carbon dioxide (CO_2), oxygen (O_2), and nitrogen (N_2). Table 1, below, shows properties of exemplary raw gas from wellheads in the Bakken Formation.

Table 1: Exemplary Raw Natural Gas Properties

Component	Value
Methane	48 - 85 mol %
Ethane	12- 20 mol %
Propane	5 - 15 mol %

Butane+ (C4+)	4 - 17 mol %
$CO_2 + N_2$	1.5 - 3.5 mol %
H_2S	0 - 2.0 mol %
Heat Value	1,200 - 1,715 Btu/scf
Wobbe Index	43 - 57
H_2O	10 - 50 lbs/MMscf

[0056] As used herein, the term "fuel gas" 202 refers to a natural gas stream that has been processed by a natural gas processing system 200 such that it may be used by an electrical power generation system (e.g., FIG. 1 at 130) to generate electrical power for a distributed computing system (FIG. 1 at 140). It will be appreciated that the properties of the fuel gas 202 produced by the natural gas processing system 200 may vary depending on the raw natural gas and requirements of the employed electrical power generation system.

[0057] Nevertheless, the fuel gas 202 will typically comprise a heat value of at least about 1,000 Btu/scf and a methane content of at least about 80%. In some embodiments, the fuel gas 202 may be processed to contain less than about 1% pentane and higher hydrocarbons (C5+) components. Moreover, such fuel gas 202 may be optionally be processed to contain less than about 5% propane and higher hydrocarbons (C3+) components.

[0058] In some embodiments, the produced fuel gas 202 may be substantially free of particulate solids and liquid water to prevent erosion, corrosion or other damage to equipment. Moreover, the fuel gas may be dehydrated of water vapor sufficiently to prevent the formation of hydrates during downstream processing. And, in certain embodiments, the produced fuel gas 202 may contain no more than trace amounts of components such as H_2S, CO_2, and N_2.

[0059] As shown, the raw natural gas 201 received from the wellhead 209 may first be introduced to a separator module 210 such that liquids (e.g., oil 291 and/or water 292) may be separated and removed therefrom. Generally, the separator module 210 may comprise at least one multi-phase separator, such as a 2-phase separator (separating liquids and gas), or a 3-phase separator (separating oil, water, and gas),

[0060] In one particular embodiment, the separator module 210 comprises a 3-phase separator. An exemplary 3-phase separator may comprise a vessel having an inlet to receive the raw natural gas 201, an outlet through which free gas exits the vessel, an outlet through which water exits the vessel, and an outlet through which oil exits the vessel. Upon entering the vessel, the raw gas 201 may encounter an inlet deflector, which causes initial separation of gas from a liquid mixture of oil and water. The free gas may then rise within the vessel, while the heavier liquid mixture descends therewithin. And, optionally, a divertor may be employed within the vessel to redirect flow of the liquid mixture and to allow it to settle more readily within the vessel.

[0061] Once separated from the liquid, the free gas may flow through a mist extractor that removes any entrained liquids remaining in the gas. The resulting gas stream then flows out of the top of the separator vessel, through the gas outlet.

[0062] As the liquid mixture settles within the separator vessel, the oil separates from the water and rises out of solution. In one embodiment, a weir plate may be employed to allow the oil to pour into an oil chamber or bucket, while preventing the water from entering the chamber. Additionally, the separator may include a metal protector plate to block any splashing liquid from entering the gas outlet.

[0063] Generally, the recovered oil 291 can be directed to an oil storage tank or may be transported for sale via truck, rail or pipe. And the water 292 may be sent to a water storage tank, treated on-site, disposed of, and/or transported to a wastewater treatment facility or other reclamation zone.

[0064] In one embodiment, the separator module 210 may comprise, or otherwise be placed in communication with, various monitoring and/or control equipment. Such equipment may be adapted to measure, determine and/or control various operating parameters at any number of locations throughout the separator module 210. As discussed above, such equipment may be in communication with a remote MC system (e.g., via a network) to allow for both (1) remote monitoring and control of the separator module 210 by any number of operators and (2) automatic control thereof.

[0065] As an example, the separator module 210 may comprise any number of pressure monitors, flow meters, regulators and/or control valves to monitor/control gas and/or liquid processing parameters (e.g., inlet/outlet pressure, inlet/outlet flow, level, etc.). Such equipment may be located

within one or more vessels, on one or more inlets and/or on one or more outlets of the separator module 210.

[0066] It will be appreciated that the separator module 210 may further comprise any number of safety valves adapted to direct flow to a safe and contained area upon overpressurization of the vessel. In one embodiment, the separator module may comply with ASME VIII, Division 1 and NACE MR-0175 for H2S environments. Additionally or alternatively, the separator module may comprise a skid designed to SEPCO OPS055 and/or API RP2A standards.

[0067] In certain embodiments, the separator module 210 may further comprise a heater-treater component located upstream of the multi-phase separator or integral therewith. Generally, the heater-treater may comprises a pressurized vessel, or a series of pressurized vessels, in which a bottom-mounted, heat source is operated. During operation, the heater-treater heats the raw natural gas 201 received from the wellhead 209 by means of direct contact with the heat source and the ensuing temperature increase reduces molecular attraction between oil and water molecules contained therein. Accordingly, when the heated raw natural gas is passed to the multi-phase separator, water droplets may settle out of the liquid more rapidly.

[0068] In one embodiment, the gas stream produced by the separator module 210 may be of a sufficient quality to be directly utilized as fuel gas 202 for a power generation module of the electrical power generation system. In such cases, the resulting gas stream 202 may not be introduced to any of the optional processing modules shown in FIG. 2; rather, it may be transferred directly to an electrical power generation module. It will be appreciated that, although the illustrated optional processing modules are not employed in this embodiment, the fuel gas 202 may be aggregated (e.g., in a field gathering pipeline) before being introduced to the electrical power generation module. Additionally or alternatively, conventional valves and/or compressors may be employed upstream of the electrical power generation module to regulate the pressure of the fuel gas 202.

[0069] In other embodiments, the gas stream produced by the separator module 210 may require additional processing upstream of the power generation module. In such cases, the natural gas processing system 200 may comprise one or more of: a compressor module 215, a CO_2 removal module 222, a desulfurization module 224, a dehydrator module 226 and/or a refrigeration module 230.

[0070] Generally, a compressor module 215 may be employed to increase the pressure of the gas stream from an initial pressure of from about 15 psi to about 50 psi, to a final pressure of from about 150 psi to about 350 psi. Such pressure increase may be desired or required when a refrigeration module 230 is employed (discussed below) and/or in cases where the fuel gas 202 is to be introduced to a power generation module comprising a turbine.

[0071] As a result of the pressure increase, the compressor module 215 may also remove heavy natural gas liquids ("NGLs") stream 293 comprising pentane and higher hydrocarbons (C5+) from the natural gas. To that end, the compressor module 215 may comprise any number of individual compressor units operating to raise and lower the pressure of the received gas stream, during any number of compression stages, such that the NGLs 293 contained therein may be liquified and removed. The resulting NGLs stream 293 may exit the compressor module 215 and may be stored in a storage tank and/or transported for sale via truck, rail or pipe.

[0072] Accordingly, the compressor module 215 may produce a resulting gas stream comprising methane, ethane, propane, and butane, wherein the gas stream is substantially free of pentane and higher hydrocarbons (C5+). That is, the resulting compressed gas stream will typically comprise less than about 1% C5+ hydrocarbons, such that the stream comprises a heat content of from about 1,200 Btu/scf to about 1,500 Btu/scf.

[0073] In one embodiment, the compressor module 215 may comprise any number of individual compressor units. The compressor units may be driven by either conventional piston engines or natural gas turbines, and such units are typically fueled by a portion of the natural gas (although some or all of the units may be electrically powered if required). The compressor units typically operate in parallel, although some or all of the compressor units may be operated in stages (serially) as desired or required.

[0074] As the gas is compressed, heat is generated and must be dissipated to cool the gas stream before leaving the compressor module. Accordingly, the compressor module 215 may comprise an aerial cooler system to dissipate excess heat (e.g., an "after cooler"). Additionally, the heat generated by operation of the individual compressor units may be dissipated via a sealed coolant system.

[0075] The compressor module 215 may comprise, or otherwise be placed in communication with, various monitoring and/or control equipment adapted to monitor and/or control operating

parameters (e.g., gas flow and/or pressure) across all compressor units. Such equipment may be in communication with the remote MC system (e.g., via a network) to allow for remote monitoring and control of the compressor module 215 by any number of operators and/or for automatic control thereof.

[0076] In certain embodiments, the natural gas processing system 200 may include a CO_2 removal module 222 to remove CO_2 294 from the gas stream. Generally, the CO_2 removal module 222 will be employed, as required, to meet pipeline specifications. For example, the CO_2 removal module 222 may be employed to reduce CO_2 content in the gas stream to less than about 1% CO_2.

[0077] In one embodiment, the CO_2 removal module 222 may comprise one or more membranes, such as a spiral-wound cellulose acetate membrane. Generally, the membrane operates on the principle of selective permeation, where components with higher permeation rates (e.g., CO_2) permeate through a membrane faster than those with lower permeation rates (e.g., methane, ethane and heavier hydrocarbons). Accordingly, the gas feed stream may be separated into a hydrocarbon-rich (residual) stream on the exterior of the membrane fiber and a CO_2-rich (permeate) stream on the interior of the membrane fiber.

[0078] It will be appreciated that the CO_2 removal module 222 may be adaptable to various gas volumes, CO_2 concentrations, and/or fuel gas specifications. Moreover, operational parameters of the CO_2 removal module, such as pressure difference between the feed gas and permeate gas and/or concentration of the permeating component, may be monitored and/or controlled via various equipment in communication with the remote MC system.

[0079] In another embodiment, the CO_2 removal module 222 may comprise an amine sorbent system. As known in the art, such systems are adapted to absorb CO_2 and then desorb the CO_2 to atmosphere.

[0080] In one embodiment, the natural gas processing system 200 may include a desulfurization module 224 adapted to remove sulfur 295 from the gas stream. Generally, sulfur exists in natural gas as hydrogen sulfide (H_2S), and the natural gas will typically require desulfurization when its H_2S content exceeds about 0.01 lbs/Mscf. It will be appreciated that gas containing high levels of H_2S (i.e., “sour gas”) is undesirable because it is both corrosive to equipment and dangerous to breathe.

[0081] The desulfurization module 224 may employ various technologies to "sweeten," or remove sulfur from, sour gas. In one embodiment, the desulfurization module 224 may employ dry sorbents to capture sulfur gases in solid form (e.g., as sulfates or sulfites). In one such embodiment, a fine sorbent may be injected into the feed gas and the resulting sulfur-containing solids 295 may be collected. Exemplary dry sorbents that may be employed include, but are not limited to, calcium oxide, magnesium oxide, and sodium carbonate.

[0082] In an alternative embodiment, the desulfurization module 224 may comprise a wet scrubber subsystem, such as venturi, packed-column, or tray-type systems. In this embodiment, the feed gas may be contacted with a scrubbing solution or slurry to absorb the H_2S and convert it to mercaptans, which are then drained from the spent bed in liquid form.

[0083] In yet another embodiment, the desulfurization module 224 may employ amine solutions to remove H_2S. During this process, the feed gas is run through a tower containing an amine solution that absorbs sulfur. Exemplary amine solutions may include, but are not limited to, monoethanolamine ("MEA") and diethanolamine ("DEA"). In one such embodiment, the amine solution may be regenerated (i.e., the absorbed sulfur may be removed) and reused.

[0084] In certain embodiments, the sulfur-containing discharge 295 may be discarded. However, in other embodiments, the sulfur may be reduced to its elemental form via further processing and then sold. One exemplary process employed to recover sulfur is known as the "Claus process" and involves using thermal and catalytic reactions to extract the elemental sulfur from the hydrogen sulfide solution.

[0085] It will be appreciated that, no matter which of the above technologies is employed by the desulfurization module 224, a resulting gas stream may be produced that is virtually free of sulfur compounds. That is, the resulting gas stream may comprise a sulfur content of less than about about 0.01 lbs/Mscf.

[0086] The natural gas processing system 200 may additionally or alternatively comprise a dehydrator module 226 adapted to remove water 296 from the gas stream. Generally, the dehydrator module 226 may be employed to reduce the moisture content of the gas stream to about 7 lbs/Mscf or less. This mitigates the risk of damage to pipes and process equipment from blocked flow and corrosion.

[0087] In one embodiment, the dehydrator module 226 may comprise any number of dryer beds including one or more desiccants. Exemplary desiccants include, but are not limited to: activated charcoal/carbon, alumina, calcium oxide, calcium chloride, calcium sulfate, silica, silica alumina, molecular sieves (e.g., zeolites), and/or montmorillonite clay. In one particular embodiment, desiccant materials may be present in a packed-bed configuration.

[0088] It will be appreciated that most desiccants have a limited adsorption capacity and must be replaced or regenerated at given service intervals. Accordingly, for continuous dehydration service, a multi-bed system may be employed where one or more beds are utilized while the others are being replaced/regenerated. The active bed(s) can then be switched in and out of service as required or desired.

[0089] In another embodiment, the dehydrator module 226 may comprise a Triethylene Glycol ("TEG") system. This system contacts the wet gas with TEG, which absorbs the water from the wet gas stream to produce a rich TEG stream. The rich TEG stream is heated with a gas-fired heater and the water is driven off in the form of water vapor to atmosphere. The lean TEG stream may then be cooled and pumped back to contact the gas stream.

[0090] In other embodiments, the dehydrator module 226 may remove water through the use of additives, such as methanol or ethylene glycol, which may be sprayed into the natural gas stream to suppress the freezing point of liquid water. In yet other embodiments, dehydration may comprise a number of steps, including active dehydration, depressurization, regeneration, and repressurization.

[0091] In certain embodiments, the natural gas processing system 200 may include a refrigeration module 230 comprising one or more mechanical refrigeration units ("MRU"). Generally, the refrigeration module may be employed to cool natural gas in an effort to reduce the hydrocarbon dew point of the gas (e.g., to meet pipeline quality specifications) and/or to maximize NGLs recovery (e.g., to improve the overall monetary return of a natural gas stream).

[0092] In one embodiment, the refrigeration module 230 may be adapted to lower the temperature of the received gas stream to a target temperature, such that NGLs comprising propane and higher hydrocarbons (C3+) 297 may be separated therefrom. The target temperature may be selected to allow the NGLs stream 297 to be condensed (e.g., in a single column), without condensing substantial amounts of methane or ethane. Accordingly, the condensed NGLs stream 297 may be

separated and transported for sale via truck, rail or pipe; and the resulting fuel gas stream 202, which comprises mostly methane and ethane, may be transferred to the electrical power generation module.

[0093] In certain embodiments, the refrigeration module 230 may lower the temperature of the received gas stream via heat exchange with a low temperature fluid (i.e., a refrigerant). Exemplary refrigerants include, but are not limited to, propane, propylene (C_3H_6), n-butane, and/or ethylene (C_2H_4). It will be appreciated that other hydrocarbon and non-hydrocarbon refrigerants may additionally or alternatively be employed.

[0094] Generally, the refrigeration module 230 may cool the received gas stream to a target temperature of from about -10 °F to about -32 °F, depending on the composition of the received gas stream. During cooling, the pressure may be adjusted to, or maintained at, from about 70 psi to about 510 psi.

[0095] In one particular embodiment, the refrigeration module 230 may comprise a cascade refrigerator that employs two or more refrigeration stages in series to achieve a lower temperature than is otherwise achievable in a single stage. For example, the refrigerator may cool the gas to a first temperature during a first stage (i.e., a "high stage"), and then cool the gas to a second temperature that is lower than the first temperature during a second stage (i.e., a "low stage").

[0096] It will be appreciated that operational parameters of the refrigeration module 230 may be monitored and/or controlled across any number of refrigeration units via various equipment in communication with the remote MC system. Such operational parameters may include, but are not limited to, temperature and/or coolant recirculation rate.

[0097] It will be appreciated that many aspects of the system 200 depicted in FIG. 2 may be modified or altered to produce fuel gas 202 from raw natural gas 201 received from one or more wellheads 209 in an oil and gas reservoir. The illustrated system 200 is exemplary, and is intended to show broadly the relationship between the various aspects of the system.

Electrical Power Generation System

[0098] FIGs. 3-4 show exemplary electrical power generation systems (300, 400) according to various embodiments. FIG. 3 shows an exemplary electrical power generation system 300 comprising a power generation module 331 in electrical communication with an electrical

transformation module 335. And FIG. 4 shows an exemplary electrical power generation system 500 comprising a plurality of power generation modules (431a, 431b) in a parallel configuration, wherein such modules are in electrical communication with a single electrical transformation module 435.

[0099] Referring to FIG. 3, an exemplary electrical power generation system 300 is illustrated. As shown, the system 300 comprises a power generation module 331 in communication with a gas supply line 320 such that it may receive fuel gas 302 therefrom. The power generation module 331 is further shown to be in electrical communication with an electrical transformation module 335 such that an electrical output 303 may be transmitted from the power generation module to the electrical transformation module.

[0100] Generally, the power generation modules 331 may comprise a generator component adapted to convert fuel gas 302 into electrical energy 303, various equipment for monitoring and controlling the generator component, and ancillary equipment to support the generator component. As discussed below, each of these components may be contained within a protective housing such that the entire power generation module 331 is transportable.

[0101] In one embodiment, the power generation module 331 may comprise a generator component adapted to generate an electrical output 303 via combustion of the fuel gas 302. Generally, the generator component may employ either a fuel-gas-driven reciprocating engine or a fuel-gas-driven rotating turbine to combust the fuel gas 302 and drive an electrical generator.

[0102] The generator component may be associated with various properties, such as various input fuel requirements, a fuel gas consumption rate and an electrical output. The input fuel requirements of a given generator component specify the required properties of fuel received by the generator. As discussed above, the employed power generation modules 331 may be specified to operate with fuel gas 302 having a wide variety of properties. For example, certain modules may include a generator components adapted to utilize rich gas, delivered directly downstream of a separator module. Additionally or alternatively, the power generation module 331 may comprise a generator adapted to utilize fuel gas that has been processed to such that it is substantially free of propane and higher hydrocarbons (C3+) components.

[0103] The fuel gas consumption rate of a given generator refers to the volume of fuel gas consumed by the generator within a given time period. The fuel gas consumption rate may be

determined for continuous operation of the generator at standard ambient conditions. Generally, the fuel gas consumption rate of engine-type generators may range from about 40 Mscfd to about 500 Mscfd. And the fuel gas consumption rate of turbine-type generators may range from about 1 MMscfd to about 6 MMscfd.

[0104] Electrical output refers to the electrical energy output by a given generator after efficiency losses within the generator. This property is often referred to as "real power" or "kWe." The electrical output may be provided as "continuous power," which refers to the real power obtained from the generator when the module is operating continuously at standard ambient conditions.

[0105] Although nearly any generator may be employed in the power generation modules 331, it has been found that generators that produce an electrical output of from about 70 kW to about 30 MW are preferred because these sizes correlate with the quantities of fuel available in a typical application.

[0106] Generally, engine-type generators may produce an electrical output ranging from about 70 kW to about 2 MW, with an associated voltage ranging from about 480 V to about 4.16 kV. And turbine-type generators may produce an electrical output ranging from about 2 MW to 30 MW, with an associated voltage ranging from about 4.16 kV to about 12 kV.

[0107] It will be appreciated that the various generator components employed in the power generation module 331 may be adapted to operate reliably in harsh oilfield conditions, and with variability in gas rates, composition and heating values. Moreover, it will be appreciated that the specific generator employed in a power generation module 331 may be selected and configured based on the specifications of the raw natural gas and the amount of such raw natural gas that is produced at the wellhead.

[0108] As shown, the power generation module 331 may be in further communication with a backup fuel supply 337 containing a backup fuel 308. In one embodiment, the backup fuel supply 337 may comprise a natural gas storage tank containing pressurised natural gas (e.g., received from the natural gas processing system). In another embodiment, the backup fuel supply 337 may comprise an on-site reserve of propane. At times of low wellhead gas pressure, the backup fuel 308 may be piped directly to the generator of the power generation module 331, from the backup fuel supply 337.

[0109] In one embodiment, the power generation module 331 may be adapted to automatically switch between the fuel gas 302 and the backup fuel 308. In such embodiments, the generator may utilize fuel gas 302 as long as the pressure and/or flow rate of the fuel gas is greater than or equal to a predetermined value (e.g., from about 20 psig to about 25 psig); and the generator may switch to the backup fuel 308 when the pressure and/or flow rate drops below the predetermined value. It will be appreciated that the fuel switching process may be seamless, resulting in uninterrupted electrical power generation regardless of instantaneous natural gas supply rates.

[0110] In one embodiment, the power generation module 331 may comprise various monitoring and control equipment in direct communication with the generator component and in remote communication with the MC system (e.g., via a network). Such equipment may allow for automatic monitoring of operational parameters, including but not limited to, fuel gas supply pressure, fuel gas flow rate, fuel gas characteristics, electrical output (e.g., frequency, voltage, amperage, etc.) and/or emissions. And this configuration may further allow for automatic and/or manual control of the generator, which enables greater reliability and efficiency in remote oilfield locations where human operators are not always present.

[0111] Typically, the power generation module 331 will further comprise various ancillary components (commonly referred to as the "balance of plant"). Such components may include, but are not limited to, compressors, lubrication systems, emissions control systems, catalysts, and exhaust systems.

[0112] As an example, the power generation module 331 may comprise integrated emissions reduction technologies, such as but not limited to, a non-selective catalytic reduction ("NSCR") system or a selective catalytic reduction ("SCR") system. However, even without employing such emissions technology, the internal combustion process employed by the disclosed embodiments, may significantly reduce emissions of NOx, CO and volatile organic compounds ("VOCs") relative to flaring. For example, an exemplary electrical power generation system 300 that does not include an NSCR or SCR may reduce emissions of such compounds by about 95% or more, as compared to flaring (e.g., at least 95%, at least 96%, at least 97%, at least 98%, or at least 99%).

[0113] It will be appreciated that emissions monitoring and control are key permitting requirements in the oilfield. By reducing emissions, the disclosed embodiments help oil and gas

operators achieve environmental and regulatory benefits as well as improved community relationships.

[0114] In one embodiment, the power generation module 331 may comprise a housing designed to contain and protect the above-described components of the module. Such housing may provide features such as, but not limited to, weatherproofing, skid or trailer mounting for portability, and sound attenuation.

[0115] In certain embodiments, the power generation module 331 may be supported by a transportable chassis, trailer, or railcar to facilitate positioning and/or repositioning of the module. More particularly, the transportable chassis, trailers, or railcars may be coupled to vehicles, such as trucks or trains, and transported over a geographic area. The generator skids can range in size from an enclosed trailer hauled behind a pickup truck, to a plurality of semi-trailer loads for the generator and its required ancillary equipment.

[0116] As shown, the electrical power generation system 300 further comprises an electrical transformation module 335 in electrical communication with the power generation module 331. Generally, the electrical power 303 generated by the power generation module 331 may be transmitted through the electrical transformation module 335 such that it may be converted into an electrical flow 305 that is suitable for consumption by computing equipment (e.g., a mobile data center and any number of DCUs of a distributed computing system).

[0117] To that end, the electrical transformation module 335 may comprise power conditioning equipment typically including one or more step-down transformers. Such module 335 may be adapted to reduce the voltage of an incoming electrical flow 303 by one or more "steps down" into a secondary electrical flow 305 comprising a lower voltage.

[0118] In one embodiment, the electrical transformation module 335 may comprise a 1 MVA step-down transformer adapted to step down the voltage of an incoming electrical flow 303 having a voltage of from about 480 V to about 4.16 kV. In such cases, the electrical transformation module 335 may convert the incoming electrical flow 303 to a reduced-power output electrical flow 305 having a voltage of about 208 V or about 240 V.

[0119] Alternatively, when larger turbine-type power generation modules 331 are employed, the electrical transformation module 335 may reduce voltage in a plurality of steps. For example, the

electrical transformation module may receive an incoming electrical flow 303 having a voltage of from about 4.16 kV to about 12 kV to and may step down the voltage to about 480 V in a first step. And the module may then further reduce the voltage, via one or more additional steps down, in order to provide a reduced-power output electrical flow 305 having a voltage of about 208 V.

[0120] In certain embodiments, the electrical transformer module 335 may also comprise a main breaker capable of cutting off all downstream electrical flows, which allows an operator to quickly de-power any attached computing equipment in the case of operational work or emergency shut-down. Additionally or alternatively, terminals of the electrical transformation module 335 may be fitted with "quick connects," which are pre-terminated inside the module. Such quick connects allow oilfield electricians to quickly connect the electrical transformation module 335 to the power generation module 331 and to a component of the distributed computing system without extensive on-site fabrication and termination work.

[0121] In the illustrated embodiment, only one power generation module 331 provides electrical power 303 to the electrical transformation module 335. Accordingly, the power generation module 331 may be directly wired from a terminal of the power generation module 331 into a primary side of the electrical transformation module 335.

[0122] Although only one power generation module 331 and one electrical transformation module 335 is shown in FIG. 3, it will be appreciated that any number of such components may be included in the power generation system 300. For example, two or more sets of power generation modules 331 and electrical transformation modules 335 may be employed, in a series configuration, to power any number of computing components (e.g., mobile data centers and DCUs).

[0123] Generally, such equipment may be added and/or removed, as required, to consume substantially all available natural gas supply. Moreover, the specific generators employed in the power generation modules 331, the number of such modules, and the configuration of such modules may also be selected with this goal in mind. For example, such equipment may be selected, configured, added to and/or removed from the electrical power generation system 300, as necessary to allow the system to consume at least about 75% (e.g., at least about 80%, at least about 85%, at least about 90%, or at least about 95%) of the natural gas supply. In this way, the system 300 may substantially reduce the amount of natural gas that must be flared during oil production.

[0124] Referring to FIG. 4, another exemplary electrical power generation system 400 is illustrated. As shown, the system 400 comprises a plurality of power generation modules (431a, 431b) in communication with a gas supply line 420 such that they may receive fuel gas 402 therefrom. The power generation modules (431a, 431b) are also in electrical communication with an electrical transformation module 435 via a parallel panel 460. And, as discussed above, the power generation modules (431a, 431b) may be in communication with one or more backup fuel supplies 437, such that they may receive backup fuel 408 (e.g., propane) therefrom.

[0125] As shown, the electrical power generation system 400 may comprise multiple power generation modules (431a, 431b) connected in parallel to a single electrical transformation module 435. In such embodiments, the multiple electrical power generation modules (431a, 431b) may be phase-synced such that their output electrical flows (403a, 403b) may be combined down-stream without misalignment of wave frequency.

[0126] Specifically, the multiple phase-synced electrical flows (403a, 403b) may be wired into a parallel panel 460, which merges and synchronizes the electrical flows into a single down-stream flow 404 with singular voltage, frequency, current and power metrics. This singular down-stream flow 404 may then be wired into a primary side of an electrical transformation module 435 for voltage modulation. For example, as discussed above, the singular down-stream flow 404 may be transmitted to the electrical transformation module 435 such that the flow may be converted into an output electrical flow 405 that is suitable for consumption by computing equipment (e.g., one or more mobile data centers of a distributed computing system including any number of DCUs).

[0127] In such embodiments, each of the power generation modules (431a, 431b) and/or the parallel panel 460 may comprise a control system that allows for the module to be synchronized and paralleled with other power generation modules. The control system may allow load-sharing of up to 32 power generation modules via a data link and may provide power management capabilities, such as load-dependent starting and stopping, asymmetric load-sharing, and priority selection. Such functionality may allow an operator to optimize load-sharing based on running hours and/or fuel consumption.

Distributed Computing System

[0128] Referring to FIG. 5, an exemplary distributed computing system 500 according to an embodiment is illustrated. As shown, the system 500 may include one or more mobile data centers 510 comprising various electrical components, such as but not limited to: any number of DCUs 520, a communications system 555, an electrical power system 530, a backup power system 540, and/or a monitoring and control system 580.

[0129] Generally, each of the mobile data centers 510 may comprise a prefabricated housing or enclosure to contain and protect the various electronics. The enclosure may comprise a customized shipping container or other modular housing system designed for portability, durability, safety, stack-ability, ventilation, weatherproofing, dust control and operation in rugged oilfield conditions.

[0130] As shown, each of the mobile data centers 510 may comprise an electrical power system 530 adapted to receive electrical power 505 from an electrical transformation module of an electrical power generation system, as discussed above. More particularly, the power system 530 may receive an output electrical flow 505 from a secondary terminal of an electrical transformation module via cable trays, buried lines and/or overhead suspended lines. In certain embodiments, each mobile data center 510 may be fitted with quick connects (discussed above), which are pre-terminated into the power system 530.

[0131] In one embodiment, the electrical power system 530 may comprise one or more breaker panels in electrical communication with a series of power distribution units ("PDUs") or power channels. Such PDUs may also be in communication with the various electrical components of the mobile data center 510, such as DCUs 520, backup power systems 540 (e.g., batteries and/or solar panels), a communication system 555, and/or a monitoring and control system 580.

[0132] In certain embodiments, the breaker panels and/or PDUs of the power system 530 may be in communication with a monitoring and control system 580 of the mobile data center 510. And such monitoring and control system 580 may be in communication with the remote MC system (FIG. 1 at 180) via a network such that an operator may remotely control (activate and/or deactivate) these components and all electrical equipment in electrical communication therewith. This remote power control feature is important for efficiency and cost reduction in remote oilfield locations, where a human operator may not be present. For example, PDUs may be remotely

"power cycled" to reset, reboot or restart malfunctioning equipment without the expense or time required to deploy a human. As another example, breaker panel switches may be remotely controlled to turn on / off power to downstream systems without the need for human dispatch.

[0133] As shown, each of the mobile data centers 510 may comprise a plurality of DCUs 520, wherein the DCUs are powered via the power system 530 and, optionally, via the backup power system 540. As discussed above, the DCUs are adapted to conduct any number of processing-intensive tasks, such as but not limited to, graphics-intensive distributed computing processes, server functions, storage, virtual reality and/or augmented reality applications, tasks relating to the Golem Project, non-currency blockchain applications and/or cryptocurrency mining operations.

[0134] It will be appreciated that the number of mobile data centers, the number of DCUs contained in each mobile data center, and/or the processing power of such DCUs may be selected to utilize substantially all electrical power generated by the electrical power generation system. Moreover, such equipment may be added and/or removed from the distributed computing system 500, as desired or required, to consume substantially all electrical power generated by the electrical power generation system. For example, the components of the distributed computing system may be selected, configured, added and/or removed, as necessary to allow the system 500 to consume the maximum practical amount of the power generated by the electrical power generation system (typically in excess of 90% of the available power). This allows for revenue generated from distributed computing tasks to be maximized, while also maximizing consumption of produced natural gas via the electrical power generation system.

[0135] As discussed above, the mobile data centers 510 and the various electronic components contained there (e.g., DCUs 520, monitoring and control system 580, power system 530 and/or backup power system 540) may be connected to a network via wired or wireless connection to a communication system 555. The communication system 555 may comprise one or more modems, network switches, and network management computers to provide connectivity to the network, such as the Internet, via a fiber optic cable, fixed point wireless (laser, millimeter wave towers, microwave towers or the like used to relay high speed internet on a line-of-sight basis), satellite internet, cell-based internet or any other means of internet connection. And the components of the communication system 555 may be distributed throughout the mobile data center 510 as required

to connect all DCUs 520 into the network and to supply sufficient data input and output bandwidth for all connected components.

[0136] It will be appreciated that heat and airflow management are important considerations when operating in an oilfield, as outside air temperatures may vary widely from extreme cold to extreme heat. Moreover, excessive dust and precipitation must also be monitored and controlled during oilfield operation. Accordingly, in one embodiment, the monitoring and control system 580 may be adapted to control various parameters of the mobile data center 510, such as temperature, moisture, oxygen, power and/or others.

[0137] In one embodiment, the mobile data center 510 may be designed with a cold aisle and a hot aisle. For example, the DCUs 520 may be located within vertically stacked, horizontal racks extending along a row within the mobile data center; and all of the DCUs may be positioned within the racks such that their intake fans point towards the cold aisle, while their exhaust fans point in an opposite direction, towards the hot aisle. It will be appreciated that one or more air inlets of the mobile data center 510 may be aligned with the cold aisle and one or more exhausts of the mobile data center be aligned with the hot aisle.

[0138] In one embodiment, the hot and cold aisles may be isolated / separated by employing a faceplate that extends along the row of stacked DCUs 520, adjacent to the exhaust-side thereof. Generally, the faceplate may comprise a metal, plastic, composite, wood or other thin and flat material having a plurality of precut apertures disposed therein. The apertures may be positioned such that each aperture is aligned with an exhaust fan of one of the DCUs. And the apertures may be sized/shaped to complement the size/shape of the DCU exhaust fans, such that each fan substantially fills/covers each aperture and such that each fan may transmit exhaust through one of the apertures. Accordingly, the faceplate forms a physical barrier between gaps in DCU exhaust fans, which helps to ensure that hot air does not recirculate from the hot aisle back to the cold aisle.

[0139] The hot aisle may be naturally vented to an exterior of the mobile data center 510, for example, with direct exhaust via one or more exhaust panels or vents. Alternatively, the mobile data center may include a forced air exhaust system, wherein exhaust fans force air out of the hot aisle and exhaust to the exterior. In such embodiments, the exhaust fans may communicate with the monitoring and control system 580 such that the fans may be automatically activated/deactivated as the temperature within the mobile data center increases/decreases.

[0140] In another embodiment, the mobile data center 510 may comprise various louvers, dampers, filters and/or awnings designed to protect against direct and wind-blown precipitation, as well as excessive dust intake. In such cases, dampers may be connected to the monitoring and control system 580 such that they may be automatically closed to seal and the mobile data center in the event of a power failure.

[0141] It will be appreciated that the mobile data center 510 may be further designed with various safety and security features specific to oilfield operations. For example, the mobile data center 510 may comprise one or more wireless cameras controlled by the monitoring and control system 580 and powered by the power system 530 and/or the backup power system 540. Such cameras may be specified for continuous remote monitoring and/or motion-activated recording. As another example, the mobile data center 510 may comprise motion activated lighting systems that serve as an additional crime deterrent and/or that may provide sufficient light to facilitate work during nighttime operations.

[0142] And as yet another example, the mobile data center 510 may comprise a fire suppression system designed to retard gas and electrical fires. In one embodiment, the monitoring and control system 580 may cause the dampers to automatically seal when extreme temperatures are detected (i.e., to cut off oxygen flow to a fire inside the mobile data center).

Computing Machines

[0143] Referring to FIG. 6, a block diagram is provided illustrating an exemplary computing machine 600 and modules 650 in accordance with one or more embodiments presented herein. The computing machine 600 may represent any of the various computing systems discussed herein, such as but not limited to, the DCUs (FIG. 5 at 520), the MC system (Fig. 1 at 180), the client devices (FIG. 1 at 160) and/or the third-party systems (FIG. 1 at 170). And the modules 650 may comprise one or more hardware or software elements configured to facilitate the computing machine 600 in performing the various methods and processing functions presented herein.

[0144] The computing machine 600 may comprise all kinds of apparatuses, devices, and machines for processing data, including but not limited to, a programmable processor, a computer, and/or multiple processors or computers. As shown, an exemplary computing machine 600 may include various internal and/or attached components, such as a processor 610, system bus 670, system

memory 620, storage media 640, input/output interface 680, and network interface 660 for communicating with a network 630.

[0145] The computing machine 600 may be implemented as a conventional computer system, an embedded controller, a server, a laptop, a mobile device, a smartphone, a wearable device, a set-top box, over-the-top content TV ("OTT TV"), Internet Protocol television ("IPTV"), a kiosk, a vehicular information system, one more processors associated with a television, a customized machine, any other hardware platform and/or combinations thereof. Moreover, a computing machine may be embedded in another device, such as but not limited to, a smartphone, a personal digital assistant ("PDA"), a tablet, a mobile audio or video player, a game console, a Global Positioning System ("GPS") receiver, or a portable storage device (e.g., a universal serial bus ("USB") flash drive). In some embodiments, such as the DCUs, the computing machine 600 may be a distributed system configured to function using multiple computing machines interconnected via a data network or system bus 670.

[0146] The processor 610 may be configured to execute code or instructions to perform the operations and functionality described herein, manage request flow and address mappings, and to perform calculations and generate commands. The processor 610 may be configured to monitor and control the operation of the components in the computing machine 600. The processor 610 may be a general-purpose processor, a processor core, a multiprocessor, a reconfigurable processor, a microcontroller, a digital signal processor ("DSP"), an application specific integrated circuit ("ASIC"), a graphics processing unit ("GPU"), a field programmable gate array ("FPGA"), a programmable logic device ("PLD"), a controller, a state machine, gated logic, discrete hardware components, any other processing unit, or any combination or multiplicity thereof. The processor 610 may be a single processing unit, multiple processing units, a single processing core, multiple processing cores, special purpose processing cores, coprocessors, or any combination thereof. In addition to hardware, exemplary apparatuses may comprise code that creates an execution environment for the computer program (e.g., code that constitutes one or more of: processor firmware, a protocol stack, a database management system, an operating system, and a combination thereof). According to certain embodiments, the processor 610 and/or other components of the computing machine 600 may be a virtualized computing machine executing within one or more other computing machines.

[0147] The system memory 620 may include non-volatile memories such as read-only memory ("ROM"), programmable read-only memory ("PROM"), erasable programmable read-only memory ("EPROM"), flash memory, or any other device capable of storing program instructions or data with or without applied power. The system memory 620 also may include volatile memories, such as random-access memory ("RAM"), static random-access memory ("SRAM"), dynamic random-access memory ("DRAM"), and synchronous dynamic random-access memory ("SDRAM"). Other types of RAM also may be used to implement the system memory. The system memory 620 may be implemented using a single memory module or multiple memory modules. While the system memory is depicted as being part of the computing machine 600, one skilled in the art will recognize that the system memory may be separate from the computing machine without departing from the scope of the subject technology. It should also be appreciated that the system memory may include, or operate in conjunction with, a non-volatile storage device such as the storage media 640.

[0148] The storage media 640 may include a hard disk, a compact disc read only memory ("CD-ROM"), a digital versatile disc ("DVD"), a Blu-ray disc, a magnetic tape, a flash memory, other non-volatile memory device, a solid-state drive ("SSD"), any magnetic storage device, any optical storage device, any electrical storage device, any semiconductor storage device, any physical-based storage device, any other data storage device, or any combination or multiplicity thereof. The storage media 640 may store one or more operating systems, application programs and program modules such as module, data, or any other information. The storage media may be part of, or connected to, the computing machine 600. The storage media may also be part of one or more other computing machines that are in communication with the computing machine such as servers, database servers, cloud storage, network attached storage, and so forth.

[0149] The modules 650 may comprise one or more hardware or software elements configured to facilitate the computing machine 600 with performing the various methods and processing functions presented herein. The modules 650 may include one or more sequences of instructions stored as software or firmware in association with the system memory 620, the storage media 640, or both. The storage media 640 may therefore represent examples of machine or computer readable media on which instructions or code may be stored for execution by the processor. Machine or computer readable media may generally refer to any medium or media used to provide instructions to the processor. Such machine or computer readable media associated with the modules may

comprise a computer software product. It should be appreciated that a computer software product comprising the modules may also be associated with one or more processes or methods for delivering the module to the computing machine 600 via the network, any signal-bearing medium, or any other communication or delivery technology. The modules 650 may also comprise hardware circuits or information for configuring hardware circuits such as microcode or configuration information for an FPGA or other PLD.

[0150] The input/output ("I/O") interface 680 may be configured to couple to one or more external devices, to receive data from the one or more external devices, and to send data to the one or more external devices. Such external devices along with the various internal devices may also be known as peripheral devices. The I/O interface 680 may include both electrical and physical connections for operably coupling the various peripheral devices to the computing machine 600 or the processor 610. The I/O interface 680 may be configured to communicate data, addresses, and control signals between the peripheral devices, the computing machine, or the processor. The I/O interface 680 may be configured to implement any standard interface, such as small computer system interface ("SCSI"), serial-attached SCSI ("SAS"), fiber channel, peripheral component interconnect ("PCI"), PCI express (PCIe), serial bus, parallel bus, advanced technology attachment ("ATA"), serial ATA ("SATA"), universal serial bus ("USB"), Thunderbolt, FireWire, various video buses, and the like. The I/O interface may be configured to implement only one interface or bus technology. Alternatively, the I/O interface may be configured to implement multiple interfaces or bus technologies. The I/O interface may be configured as part of, all of, or to operate in conjunction with, the system bus 670. The I/O interface 680 may include one or more buffers for buffering transmissions between one or more external devices, internal devices, the computing machine 600, or the processor 610.

[0151] The I/O interface 680 may couple the computing machine 600 to various input devices including mice, touch-screens, scanners, biometric readers, electronic digitizers, sensors, receivers, touchpads, trackballs, cameras, microphones, keyboards, any other pointing devices, or any combinations thereof. When coupled to the computing device, such input devices may receive input from a user in any form, including acoustic, speech, visual, or tactile input.

[0152] The I/O interface 680 may couple the computing machine 600 to various output devices such that feedback may be provided to a user via any form of sensory feedback (e.g., visual

feedback, auditory feedback, or tactile feedback). For example, a computing machine can interact with a user by sending documents to and receiving documents from a device that is used by the user (e.g., by sending web pages to a web browser on a user's client device in response to requests received from the web browser). Exemplary output devices may include, but are not limited to, displays, speakers, printers, projectors, tactile feedback devices, automation control, robotic components, actuators, motors, fans, solenoids, valves, pumps, transmitters, signal emitters, lights, and so forth. And exemplary displays include, but are not limited to, one or more of: projectors, cathode ray tube ("CRT") monitors, liquid crystal displays ("LCD"), light-emitting diode ("LED") monitors and/or organic light-emitting diode ("OLED") monitors.

[0153] Embodiments of the subject matter described in this specification can be implemented in a computing machine 600 that includes one or more of the following components: a backend component (e.g., a data server); a middleware component (e.g., an application server); a frontend component (e.g., a client computer having a graphical user interface ("GUI") and/or a web browser through which a user can interact with an implementation of the subject matter described in this specification); and/or combinations thereof. The components of the system can be interconnected by any form or medium of digital data communication, such as but not limited to, a communication network. Accordingly, the computing machine 600 may operate in a networked environment using logical connections through the network interface 660 to one or more other systems or computing machines across a network.

[0154] The processor 610 may be connected to the other elements of the computing machine 600 or the various peripherals discussed herein through the system bus 670. It should be appreciated that the system bus 670 may be within the processor, outside the processor, or both. According to some embodiments, any of the processor 610, the other elements of the computing machine 600, or the various peripherals discussed herein may be integrated into a single device such as a system on chip ("SOC"), system on package ("SOP"), or ASIC device.

Experiments

Experiment 1

[0155] In a first experiment, a flare mitigation system was deployed at a well site within the Bakken Field. The flare mitigation system included an electrical power generation system having

six engine-type power generation modules adapted to receive fuel gas from a fuel gas supply line. Specifically, the system included a first set of power generation modules including two 350 kW engine-type power generation modules and one 225 kW engine-type power generation module; and a second set of power generation modules that also included two 350 kW engine-type power generation modules and one 225 kW engine-type power generation module.

[0156] The first set of power generation modules was connected, via a first parallel panel, to a first electrical transformation module comprising a 1 MVA step down transformer. And the second set of power generation modules was connected, via a second parallel panel, to a second electrical transformation module comprising a 1 MVA step down transformer.

[0157] The first electrical transformation module received a first input electrical flow from the first parallel panel having a voltage of 480 V and transformed the flow into a first output electrical flow having a voltage of 208 V. The first output electrical flow was then distributed, via diesel locomotive ("DLO") cables on a cable tray, to an electrical power system of a first mobile data center. Specifically, the DLO cables were distributed to a plurality of breaker panels (e.g., 4 or 5) associated with the first mobile data center; each of the breaker panels was in electrical communication with 25 to 35 PDUs; and each of the PDUs was in electrical communication with up to 4 DCUs racked within the first mobile data center. Accordingly the first set of power generation modules was able to support from about 400 DCUs to about 700 DCUs (depending on the number of breaker panels and PDUs employed).

[0158] The second electrical transformation module received a second input electrical flow from the second parallel panel having a voltage of 480 V and transformed the flow into a second output electrical flow having a voltage of 208 V. The second output electrical flow was then distributed to up to 700 DCUs contained within a second mobile center, substantially as described above with respect to the first mobile data center.

[0159] Each of the first and second mobile data centers measured approximately 40' by 8' by 9.5' (e.g., the size of a High Cube shipping container). Both mobile data centers employed forced air with cold air entering through louvered, screened and filtered intakes on one long axis, and hot air exhausting through louvered and screened fan exhausts on the other long axis.

[0160] The above system was found to consume fuel gas at a rate of about 300 Mscfd. The system was further found to generate an electrical output of about 2 MW, wherein substantially all of such electrical output was utilized to power the DCUs contained within the mobile data centers.

Experiment 2

[0161] In a second experiment, a flare mitigation system was deployed at a well site within the D-J Basin. The flare mitigation system included an electrical power generation system having three engine-type power generation modules adapted to receive fuel gas from a fuel gas supply line. A first 1.8 MW engine-type power generation module was connected to both a first electrical transformation module and a second electrical transformation module. A second 1.8 MW engine-type power generation module was connected to both a third and a fourth electrical transformation module. And a third 1.8 MW engine-type power generation module was connected to both a fifth and a sixth electrical transformation module.

[0162] Each of the first, second, third, fourth, fifth and sixth electrical transformation modules comprised a 1 MVA step-down transformer adapted to receive a 480 V input electrical flow from a respective, connected power generation module and to transform such flow into an output electrical flow having a voltage of 208 V or 240 V. Each of the six electrical transformation modules was also in electrical communication with a separate mobile data center (substantially as described above with respect to Experiment 1), such that a total of six mobile data centers comprising a total of 2,100 DCUs were powered via the three 1.8 MW power generation modules.

[0163] The above system was found to consume fuel gas at a rate of about 900 Mscfd. The system was further found to generate an electrical output of about 5.4 MW, wherein substantially all of such electrical output was utilized to power the DCUs contained within the mobile data centers.

Experiment 3

[0164] In a third experiment, a flare mitigation system was deployed at a well site within the D-J Basin. The flare mitigation system included an electrical power generation system comprising a 350 kW or 385 kW engine-type power generation module adapted to receive fuel gas from a fuel gas supply line. The power generation module was connected to an electrical transformation

module comprising a 0.5 MVA step-down transformer, which transformed a 480 V electrical flow from the generator to a 208 V or 240 V output electrical flow (as described above).

[0165] The output electrical flow was then distributed to an electrical power system of a single 20' by 8' by 9.5' mobile data center, which employed power channels (rather than PDUs to support 264 DCUs). For ventilation, the mobile data center utilized natural aspiration via direct exhaust of DCUs to the container's exterior. Specifically, the mobile data center included a pair of awnings and protective walls extending from the air intake (a wall of metal gridding and filtration material on one long axis), as well as the air exhaust wall (a metal grid against which DCU exhaust fans were mounted directly on the other long axis).

[0166] The above system was found to consume fuel gas at a rate of about 70 Mscfd to about 80 Mscfd. Moreover, it was found that, in some cases, two paralleled 170 kW engine-type generators could be substituted for a single 350 kW or 385 kW engine-type generator.

* * *

[0167] Various embodiments are described in this specification, with reference to the detailed discussed above, the accompanying drawings, and the claims. Numerous specific details are described to provide a thorough understanding of various embodiments. However, in certain instances, well-known or conventional details are not described in order to provide a concise discussion. The figures are not necessarily to scale, and some features may be exaggerated or minimized to show details of particular components. Therefore, specific structural and functional details disclosed herein are not to be interpreted as limiting, but merely as a basis for the claims and as a representative basis for teaching one skilled in the art to variously employ the embodiments.

[0168] The embodiments described and claimed herein and drawings are illustrative and are not to be construed as limiting the embodiments. The subject matter of this specification is not to be limited in scope by the specific examples, as these examples are intended as illustrations of several aspects of the embodiments. Any equivalent examples are intended to be within the scope of the specification. Indeed, various modifications of the disclosed embodiments in addition to those shown and described herein will become apparent to those skilled in the art, and such modifications are also intended to fall within the scope of the appended claims.

[0169] It will be understood by those skilled in the art that the drawings are diagrammatic and that further items of equipment such as temperature sensors, pressure sensors, pressure relief valves, control valves, flow controllers, level controllers, holding tanks, storage tanks, and the like may be required in a commercial plant.

[0170] While this specification contains many specific implementation details, these should not be construed as limitations on the scope of any invention or of what may be claimed, but rather as descriptions of features that may be specific to particular embodiments of particular inventions. Certain features that are described in this specification in the context of separate embodiments can also be implemented in combination in a single embodiment. Conversely, various features that are described in the context of a single embodiment can also be implemented in multiple embodiments separately or in any suitable subcombination. Moreover, although features may be described above as acting in certain combinations and even initially claimed as such, one or more features from a claimed combination can in some cases be excised from the combination, and the claimed combination may be directed to a subcombination or variation of a subcombination.

[0171] Similarly, while operations are depicted in the drawings in a particular order, this should not be understood as requiring that such operations be performed in the particular order shown or in sequential order, or that all illustrated operations be performed, to achieve desirable results. In certain circumstances, multitasking and parallel processing may be advantageous. Moreover, the separation of various system modules and components in the embodiments described above should not be understood as requiring such separation in all embodiments, and it should be understood that the described program components and systems can generally be integrated together in a single software product or packaged into multiple software products.

[0172] All references including patents, patent applications and publications cited herein are incorporated herein by reference in their entirety and for all purposes to the same extent as if each individual publication or patent or patent application was specifically and individually indicated to be incorporated by reference in its entirety for all purposes.

CLAIMS

[0173] What is claimed is:

1. A flare mitigation system comprising:

an electrical power generation system comprising:

a power generation module adapted to:

receive a fuel gas stream comprising a fuel gas associated with a heat value of at least about 1,000 Btu/scf; and

consume the fuel gas stream to generate a high-voltage electrical output associated with a first voltage; and

an electrical transformation module in electrical communication with the power generation module, the electrical transformation module adapted to:

receive the high-voltage electrical output generated by the power generation module; and

transform the high-voltage electrical output into a low-voltage electrical output associated with a second voltage that is lower than the first voltage; and

a distributed computing system powered by the electrical power generation system, the distributed computing system comprising:

a communications system comprising one or more data satellite antennas, the communications system adapted to provide a network; and

a first mobile data center comprising:

an enclosure defining an interior space;

a plurality of distributed computing units located within the interior space of the enclosure, each of the plurality of distributed computing units in communication with the network; and

a power system located at least partially within the interior space of the enclosure, the power system in electrical communication with the electrical transformation module and the plurality of distributed computing units such

that the power system receives the low-voltage electrical output and powers each of the plurality of distributed computing units.

2. A system according to claim 1, wherein:

the power generation module comprises an engine-type generator;

the high-voltage electrical output is from about 70 kW to about 2 MW; and

the first voltage is from about 480 V to about 4.16 kV.

3. A system according to claim 2, wherein the second voltage is from about 208 V to about 240 V.

4. A system according to claim 3, wherein:

the high-voltage electrical output is from about 300 kW to about 400 kW;

the first voltage is about 480 V;

the enclosure of the first mobile data center comprises:

a length of about 20 feet;

a width of about 8 feet; and

a height of from about 8.5 feet to about 9.5 feet; and

the plurality of distributed computing units comprises at least about 200 distributed computing units.

5. A system according to claim 4, wherein the electrical power generation system is adapted to consume from about 50 Mscf to about 100 Mscf of fuel gas per day.

6. A system according to claim 3, wherein:

the high-voltage electrical output is from about 1 MW to about 2 MW;

the first voltage is about 480 V;

the enclosure of the first mobile data center comprises:

a length of about 40 feet;

a width of about 8 feet; and

a height of from about 8.5 feet to about 9.5 feet; and

the plurality of distributed computing units comprises at least about 400 distributed computing units.

7. A system according to claim 6, wherein the electrical power generation system is adapted to consume from about 100 Mscf to about 500 Mscf of fuel gas per day.

8. A system according to claim 6, wherein the distributed computing system further comprises a second mobile data center comprising:

a second enclosure defining an interior space, the second enclosure having a length, width and height substantially similar to the respective length, width and height of the enclosure of the first mobile data center;

a second plurality of distributed computing units located within the interior space of the second enclosure, each of the second plurality of distributed computing units in communication with the network; and

a second power system located at least partially within the interior space of the second enclosure, the second power system in electrical communication with the electrical transformation module and the second plurality of distributed computing units such that the power system receives the low-voltage electrical output and powers each of the second plurality of distributed computing units.

9. A system according to claim 6, wherein:

the electrical power generation system further comprises:

a second electrical transformation module in electrical communication with the power generation module, the second electrical transformation module adapted to:

receive the high-voltage electrical output generated by the power generation module; and

transform the high-voltage electrical output into a second low-voltage electrical output associated with the second voltage; and

the distributed computing system further comprises:

a second mobile data center comprising:

a second enclosure defining an interior space, the second enclosure having a length, width and height substantially similar to the respective length, width and height of the enclosure of the first mobile data center;

a second plurality of distributed computing units located within the interior space of the second enclosure, each of the second plurality of distributed computing units in communication with the network; and

a second power system located at least partially within the interior space of the second enclosure, the second power system in electrical communication with the electrical transformation module and the second plurality of distributed computing units such that the power system receives the low-voltage electrical output and powers each of the second plurality of distributed computing units.

10. A system according to claim 1, wherein:

the power generation module comprises a turbine-type generator;

the high-voltage electrical output comprises from about 2 MW to about 30 MW; and

the first voltage is from about 4.16 kV to about 12 kV.

11. A system according to claim 10, wherein the distributed computing system further comprises a second mobile data center comprising:

a second enclosure defining an interior space, the second enclosure having a length, width and height substantially similar to the respective length, width and height of the enclosure of the first mobile data center;

a second plurality of distributed computing units located within the interior space of the second enclosure, each of the second plurality of distributed computing units in communication with the network; and

a second power system located at least partially within the interior space of the second enclosure, the second power system in electrical communication with the electrical

transformation module and the second plurality of distributed computing units such that the second power system receives the low-voltage electrical output and powers each of the second plurality of distributed computing units.

12. A system according to claim 10, wherein:

the electrical power generation system further comprises:

a second electrical transformation module in electrical communication with the power generation module, the second electrical transformation module adapted to:

receive the high-voltage electrical output generated by the power generation module; and

transform the high-voltage electrical output into a second low-voltage electrical output associated with the second voltage; and

the distributed computing system further comprises:

a second mobile data center comprising:

a second enclosure defining an interior space, the second enclosure having a length, width and height substantially similar to the respective length, width and height of the enclosure of the first mobile data center;

a second plurality of distributed computing units located within the interior space of the second enclosure, each of the second plurality of distributed computing units in communication with the network; and

a second power system located at least partially within the interior space of the second enclosure, the second power system in electrical communication with the electrical transformation module and the second plurality of distributed computing units such that the second power system receives the low-voltage electrical output and powers each of the second plurality of distributed computing units.

13. A system according to claim 10, wherein the second voltage is from about 208 V to about 240 V.

14. A system according to claim 1, further comprising a monitoring and control system in communication with the distributed computing system via the network.

15. A system according to claim 1, further comprising a natural gas processing system in communication with the electrical power generation system, the natural gas processing system adapted to process raw natural gas into the fuel gas.

16. A system according to claim 1, wherein the plurality of distributed computing units are adapted to mine a cryptocurrency.

17. A flare mitigation system comprising:

an electrical power generation system comprising:

a first power generation module adapted to:

receive a first fuel gas stream comprising a fuel gas associated with a heat value of at least about 1,000 Btu/scf; and

consume the fuel gas stream to generate a first high-voltage electrical output associated with a first voltage;

a second power generation module adapted to:

receive a second fuel gas stream comprising the fuel gas; and

consume the second fuel gas stream to generate a second high-voltage electrical output associated with the first voltage;

a parallel panel in electrical communication with the first power generation module and the second power generation module, the parallel panel adapted to:

receive the first and second high-voltage electrical outputs; and

combine and synchronize the first and second high-voltage electrical outputs into a combined high-voltage electrical output; and

an electrical transformation module in electrical communication with the parallel panel, the electrical transformation module adapted to:

receive the combined high-voltage electrical output; and

transform the combined high-voltage electrical output into a low-voltage electrical output associated with a second voltage that is lower than the first voltage; and

a distributed computing system powered by the electrical power generation system, the distributed computing system comprising:

a communications system comprising one or more data satellite antennas, the communications system adapted to provide a network; and

a first mobile data center comprising:

an enclosure defining an interior space;

a plurality of distributed computing units located within the interior space of the enclosure, each of the plurality of distributed computing units in communication with the network; and

a power system located at least partially within the interior space of the enclosure, the power system in electrical communication with the electrical transformation module and the plurality of distributed computing units such that the power system receives the low-voltage electrical output and powers each of the plurality of distributed computing units.

18. A system according to claim 19, wherein:

the first power generation module comprises an engine-type generator;

the first high-voltage electrical output is from about 70 kW to about 2 MW;

the second power generation module comprises an engine-type generator;

the second high-voltage electrical output is from about 70 kW to about 2 MW; and

the first voltage is from about 480 V to about 4.16 kV.

19. A system according to claim 18, wherein the second voltage is from about 208 V to about 240 V.

20. A system according to claim 19, wherein the distributed computing system further comprises a second mobile data center comprising:

a second enclosure defining an interior space;

a second plurality of distributed computing units located within the interior space of the second enclosure, each of the second plurality of distributed computing units in communication with the network; and

a second power system located at least partially within the interior space of the second enclosure, the second power system in electrical communication with the electrical transformation module and the second plurality of distributed computing units such that the second power system receives the low-voltage electrical output and powers each of the second plurality of distributed computing units.

ABSTRACT

[0174] Systems and methods are provided to mitigate flaring of natural gas. A natural gas processing system may process raw natural gas into a fuel gas stream that may be used to power any number of on-site power generation modules. In turn, the power generation modules may convert the fuel gas stream into an electrical output, which may be employed to power any number of distributed computing units housed within one or more mobile data centers. In certain embodiments, the distributed computing units may be adapted to mine cryptocurrency or perform other distributed computing tasks to generate revenue.

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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
16/529,152	08/01/2019	Charles Cavness	CRUSOE-105002US1	9940

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EXAMINER
AMAYA, CARLOS DAVID

ART UNIT	PAPER NUMBER
2836	

NOTIFICATION DATE	DELIVERY MODE
05/07/2020	ELECTRONIC

Please find below and/or attached an Office communication concerning this application or proceeding.

The time period for reply, if any, is set in the attached communication.

Notice of the Office communication was sent electronically on above-indicated "Notification Date" to the following e-mail address(es):

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Office Action Summary	Application No. 16/529,152	Applicant(s) Cavness et al.	
	Examiner CARLOS AMAYA	Art Unit 2836	AIA (FITF) Status Yes

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTHS FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☑ Responsive to communication(s) filed on 8/1/2019.

☐ A declaration(s)/affidavit(s) under **37 CFR 1.130(b)** was/were filed on _____.

2a)☐ This action is **FINAL.** 2b) ☑ This action is non-final.

3)☐ An election was made by the applicant in response to a restriction requirement set forth during the interview on _____; the restriction requirement and election have been incorporated into this action.

4)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims*

5) ☑ Claim(s) 1-20 is/are pending in the application.

5a) Of the above claim(s) _____ is/are withdrawn from consideration.

6) ☐ Claim(s) _____ is/are allowed.

7) ☑ Claim(s) 1-20 is/are rejected.

8) ☐ Claim(s) _____ is/are objected to.

9) ☐ Claim(s) _____ are subject to restriction and/or election requirement

* If any claims have been determined allowable, you may be eligible to benefit from the **Patent Prosecution Highway** program at a participating intellectual property office for the corresponding application. For more information, please see http://www.uspto.gov/patents/init_events/pph/index.jsp or send an inquiry to **PPHfeedback@uspto.gov.**

Application Papers

10)☑ The specification is objected to by the Examiner.

11)☑ The drawing(s) filed on 8/1/2019 is/are: a)☑ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

Priority under 35 U.S.C. § 119

12)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

Certified copies:

a)☐ All b)☐ Some** c)☐ None of the:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

** See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☑ Notice of References Cited (PTO-892)

2) ☑ Information Disclosure Statement(s) (PTO/SB/08a and/or PTO/SB/08b) Paper No(s)/Mail Date 11/14/2019.

3) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date _____.

4) ☐ Other: _____.

DETAILED ACTION

Notice of Pre-AIA or AIA Status

1. The present application, filed on or after March 16, 2013, is being examined under the first inventor to file provisions of the AIA.

Specification

2. The disclosure is objected to because of the following informalities: Paragraph 0131 line 1 delete “of a”. Paragraph 0141 line 6 delete “may comprise”. Paragraph 0165 line 3 delete “DSUs” and replace it with --DCUs--. Appropriate correction is required.

Claim Objections

3. Claims 9, 12 are objected to because of the following informalities: Claims 9 and 12 lines 19 and 20 recite “the electrical transformation” and “the low-voltage”; however, it appears that it should read the second electrical transformation and the second low-voltage. Appropriate correction is required.

Claim Rejections - 35 USC § 102

4. The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

> A person shall be entitled to a patent unless –
>
> (a)(2) the claimed invention was described in a patent issued under section 151, or in an application for patent published or deemed published under section 122(b), in which the patent or application, as the case may be, names another inventor and was effectively filed before the effective filing date of the claimed invention.

5. Claim(s) 1 is/are rejected under 35 U.S.C. 102(a)(2) as being anticipated by Barbour (US 2020/0051184).

With respect to claim 1, Barbour discloses a flare mitigation system (paragraph 0008) comprising: an electrical power generation system comprising: a power generation module adapted to: receive a fuel gas stream comprising a fuel gas associated with a heat value of at least about 1,000 Btu/scf; and consume the fuel gas stream to generate a high-voltage electrical output associated with a first voltage (figures 1 and 2 discloses power generating modules couple to a generator to produce power. Note that the power generation system receives natural gas); and

an electrical transformation module in electrical communication with the power generation module, the electrical transformation module adapted to: receive the high-voltage electrical output generated by the power generation module; and transform the high-voltage electrical output into a low-voltage electrical output associated with a second voltage that is lower than the first voltage (figure 4 discloses a transforming module 80 to receive a high voltage and step-down the voltage); and

a distributed computing system powered by the electrical power generation system, the distributed computing system comprising:

a communications system comprising one or more data satellite antennas (antennas 96, figure 4 and 6), the communications system adapted to provide a network; and

a first mobile data center comprising:

an enclosure defining an interior space (see figure 6);

a plurality of distributed computing units located within the interior space of the enclosure, each of the plurality of distributed computing units in communication with the network (see mining processors 92, figure 4); and

a power system located at least partially within the interior space of the enclosure, the power system in electrical communication with the electrical transformation module and the plurality of distributed computing units such that the power system receives the low-voltage electrical output and powers each of the plurality of distributed computing units (figure 4 discloses distribution panel and contactor panel for distributing for powering the distributed computing units 92).

Claim Rejections - 35 USC § 103

6. The following is a quotation of 35 U.S.C. 103 which forms the basis for all obviousness rejections set forth in this Office action:

> A patent for a claimed invention may not be obtained, notwithstanding that the claimed invention is not identically disclosed as set forth in section 102, if the differences between the claimed invention and the prior art are such that the claimed invention as a whole would have been obvious before the effective filing date of the claimed invention to a person having ordinary skill in the art to which the claimed invention pertains. Patentability shall not be negated by the manner in which the invention was made.

7. Claims 2-16 is/are rejected under 35 U.S.C. 103 as being unpatentable over Barbour (US 2020/0051184) in view of TORVUND (US 2020/0006938).

With respect to claim 2, Barbour discloses a system according to claim 1; except for, wherein: the power generation module comprises an engine-type generator; the high-voltage electrical output is from about 70 kW to about 2 MW; and the first voltage is from about 480 V to about 4.16 kV.

TORVUND discloses a 25 MW gas turbine 68 and a 5 MW that produce voltages in the ranges of 400V to 11 kV, see figure 2.

It would have been obvious to a person having ordinary skill in the art to have modify Barbour and include a turbine generator that produces a desired wattages and voltage that meet a load, for example. Furthermore, it has been held that discovering

an optimum value of a result effective variable involves only routine skill in the art. In re Boesch, 617 F.2d 272, 205 USPQ 215 (CCPA 1980).

With respect to claims 3, 13, Barbour in view of TORVUND disclose a system according to one of the claims, wherein the second voltage is from about 208 V to about 240 V. Paragraph of Barbour discloses providing voltages of 120V and 208V.

With respect to claims 4, 6, Barbour in view of TORVUND disclose a system according to one of the claims, wherein: the high-voltage electrical output is from about 300 kW to about 400 kW; the first voltage is about 480 V; the enclosure of the first mobile data center comprises: a length of about 20 feet; a width of about 8 feet; and a height of from about 8.5 feet to about 9.5 feet; and the plurality of distributed computing units comprises at least about 200 distributed computing units. Figure 6 discloses a mobile data center the use of ship container of different sizes, paragraph 0065.

With respect to claims 5, 7, Barbour in view of TORVUND disclose a system according to one of the claims, wherein the electrical power generation system is adapted to consume from about 50 Mscf to about 100 Mscf of fuel gas per day; wherein the electrical power generation system is adapted to consume from about 100 Mscf to about 500 Mscf of fuel gas per day. Barbour and TORVUND discloses the use of generators that use natural gas, thus it would have been obvious to have use a generator that consume a desired gas per day.

With respect to claims 8-9, 11-12, Barbour in view of TORVUND disclose a system according to claim 6, wherein the distributed computing system further comprises a second mobile data center comprising: a second enclosure defining an interior space, the second enclosure having a length, width and height substantially

similar to the respective length, width and height of the enclosure of the first mobile data center;

a second plurality of distributed computing units located within the interior space of the second enclosure, each of the second plurality of distributed computing units in communication with the network; and a second power system located at least partially within the interior space of the second enclosure, the second power system in electrical communication with the electrical transformation module and the second plurality of distributed computing units such that the power system receives the low-voltage electrical output and powers each of the second plurality of distributed computing units; wherein: the electrical power generation system further comprises: a second electrical transformation module in electrical communication with the power generation module, the second electrical transformation module adapted to: receive the high-voltage electrical output generated by the power generation module; and transform the high-voltage electrical output into a second low-voltage electrical output associated with the second voltage; and the distributed computing system further comprises: a second mobile data center comprising: a second enclosure defining an interior space, the second enclosure having a length, width and height substantially similar to the respective length, width and height of the enclosure of the first mobile data center; a second plurality of distributed computing units located within the interior space of the second enclosure, each of the second plurality of distributed computing units in communication with the network; and a second power system located at least partially within the interior space of the second enclosure, the second power system in electrical communication with the electrical transformation module and the second plurality of

distributed computing units such that the power system receives the low-voltage electrical output and powers each of the second plurality of distributed computing units. Figure 4 and 6 discloses a computing system providing in a shipping container with its respective transformation modules; thus it would have been obvious to have provided a second shipping container with a second transformation module and a second a second power distribution system, since it has been held that mere duplication of the essential working parts of a device involves only routine skill in the art. St. Regis Paper Co. v. Bemis Co., 193 USPQ 8.

With respect to claim 10, Barbour disclose a system according to claim 1; except for, wherein: the power generation module comprises a turbine-type generator; the high-voltage electrical output comprises from about 2 MW to about 30 MW; and the first voltage is from about 4.16 kV to about 12 kV.

TORVUND discloses a 25 MW gas turbine 68 and a 5 MW that produce voltages in the ranges of 400V to 11 kV, see figure 2.

It would have been obvious to a person having ordinary skill in the art to have modify Barbour and include a turbine generator that produces a desired wattages and voltage that meet a load, for example. Furthermore, it has been held that discovering an optimum value of a result effective variable involves only routine skill in the art. In re Boesch, 617 F.2d 272, 205 USPQ 215 (CCPA 1980).

With respect to claims 14-15, Barbour in view of TORVUND disclose a system according to claim 1, further comprising a monitoring and control system in communication with the distributed computing system via the network; further comprising a natural gas processing system in communication with the electrical power

generation system, the natural gas processing system adapted to process raw natural gas into the fuel gas. Figure 4 discloses a mining components with respective sensor of the system, figures 1-3 disclose processing the natural gas, paragraph 0004.

With respect to claim 16, Barbour in view of TORVUND disclose a system according to claim 1, wherein the plurality of distributed computing units are adapted to mine a cryptocurrency. Barbour discloses providing power to a mine computing system, thus it would have been obvious to have used any known computing systems as the load.

Double Patenting

8. A rejection based on double patenting of the "same invention" type finds its support in the language of 35 U.S.C. 101 which states that "whoever invents or discovers any new and useful process... may obtain a patent therefor..." (Emphasis added). Thus, the term "same invention," in this context, means an invention drawn to identical subject matter. See *Miller v. Eagle Mfg. Co.*, 151 U.S. 186 (1894); *In re Vogel*, 422 F.2d 438, 164 USPQ 619 (CCPA 1970); *In re Ockert*, 245 F.2d 467, 114 USPQ 330 (CCPA 1957).

A statutory type (35 U.S.C. 101) double patenting rejection can be overcome by canceling or amending the claims that are directed to the same invention so they are no longer coextensive in scope. The filing of a terminal disclaimer cannot overcome a double patenting rejection based upon 35 U.S.C. 101.

9. Claims 1-20 are provisionally rejected under 35 U.S.C. 101 as claiming the same invention as that of claims 1-20 of copending Application No. 16/694,883 (reference

application). This is a provisional statutory double patenting rejection since the claims directed to the same invention have not in fact been patented.

Conclusion

10. Any inquiry concerning this communication or earlier communications from the examiner should be directed to CARLOS AMAYA whose telephone number is (571)272-8941. The examiner can normally be reached on M-F 7:00AM-4:00PM.

Examiner interviews are available via telephone, in-person, and video conferencing using a USPTO supplied web-based collaboration tool. To schedule an interview, applicant is encouraged to use the USPTO Automated Interview Request (AIR) at http://www.uspto.gov/interviewpractice.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Jared Fureman can be reached on (571) 272-2399. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see https://ppair-my.uspto.gov/pair/PrivatePair. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free).

If you would like assistance from a USPTO Customer Service Representative or access to the automated information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

/CARLOS AMAYA/
Primary Examiner, Art Unit 2836

Notice of References Cited	Application/Control No. 16/529,152	Applicant(s)/Patent Under Reexamination Cavness et al.	
	Examiner CARLOS AMAYA	Art Unit 2836	Page 1 of 1

U.S. PATENT DOCUMENTS

*		Document Number Country Code-Number-Kind Code	Date MM-YYYY	Name	CPC Classification	US Classification
*	A	US-20200051184-A1	02-2020	Barbour; Stephen	H04L67/104	1/1
*	B	US-20200006938-A1	01-2020	TORVUND; Trond Normann Sivertsen	H02J3/00	1/1
	C					
	D					
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	F					
	G					
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	I					
	J					
	K					
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FOREIGN PATENT DOCUMENTS

*		Document Number Country Code-Number-Kind Code	Date MM-YYYY	Country	Name	CPC Classification
	N					
	O					
	P					
	Q					
	R					
	S					
	T					

NON-PATENT DOCUMENTS

*		Include as applicable: Author, Title Date, Publisher, Edition or Volume, Pertinent Pages)
	U	
	V	
	W	
	X	

*A copy of this reference is not being furnished with this Office action. (See MPEP § 707.05(a).)
Dates in MM-YYYY format are publication dates. Classifications may be US or foreign.

Search Notes	Application/Control No.	Applicant(s)/Patent Under Reexamination
	16/529,152	Cavness et al.
	Examiner	Art Unit
	CARLOS AMAYA	2836

CPC - Searched*		
Symbol	Date	Examiner

CPC Combination Sets - Searched*		
Symbol	Date	Examiner
C10L3/104, E21B43/16, G06Q20/065, G06Q2220/00	05/04/2020	CA

US Classification - Searched*			
Class	Subclass	Date	Examiner

* See search history printout included with this form or the SEARCH NOTES box below to determine the scope of the search.

Search Notes		
Search Notes	Date	Examiner
EAST Search	05/04/2020	CA
PLUS Search	05/04/2020	CA
Inventor Search	05/04/2020	CA

Interference Search			
US Class/CPC Symbol	US Subclass/CPC Group	Date	Examiner

/CARLOS AMAYA/ Primary Examiner, Art Unit 2836	

EAST Search History

EAST Search History (Prior Art)

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	Time Stamp
L1	99	("4911379" "5407647" "4425757" "4865817" "5192517" "5362464" "5727538" "6196056" "4255926" "4333764" "4448751" "4567916" "4821524" "4944496" "5565180" "6009900" "6210464" "6210464" "4273025" "4317540" "4452898" "4509456" "4560042" "4563982" "4583319" "4764085" "4779355" "4919826" "4960708" "4963329" "4978367" "4992301" "5023064" "5326835" "5450899" "5520858" "5662838" "5707424" "5824271" "5950572" "6228146" "6236894" "4265670" RE30935 "4341651" "4350665" "4363443" "4364753" "4381898" "4382908" "4391860" "4409301" "4410041" "4416332" "4445846" "4474612" "4528337" "4548765" "4557816" "4566565" "4582254" "4609541" "4774152" "4808534" "4818640" "4849191" "4871580" "4976685" "4991423" "5017348" "5231991" "5242564" "5259456" "5271725" "5282739" "5395050" "5439509" "5536489" "5542963" "5602435" "5716597" "5723055" "5782080" "5785902" "5791107" "5803938" "5833734" "5834519" "5839271" "5887418" "5904850" "5911336" "5922305" "5958377" "6030603" "6037683" "6066249" "6076517" "6097184" "6123523").pn.	US-PGPUB; USPAT	OR	ON	2020/05/04 17:53
S1	12	("20110115425" | "20140372772" | "20170218843" | "20170271701" | "20180109112" | "20190022580" | "7998227" | "8070863" | "9337704" | "9637433" | "9673632" | "9719024").PN.	US-PGPUB; USPAT	OR	ON	2020/05/01 15:56

S2	41	("20030037567" | "20060076076" | "20070021513" | "20070130991" | "20090031756" | "20090277218" | "20100011663" | "20100281775" | "20110174016" | "20120096895" | "20120192580" | "20120279235" | "20130061632" | "20130186133" | "3110889" | "3254496" | "3354663" | "3763658" | "3786454" | "3996030" | "4016603" | "4404008" | "4456971" | "4857078" | "5992175" | "6105390" | "6182469" | "6250105" | "6553784" | "7017506" | "7041156" | "7594942" | "7713497" | "8156758" | "8293186" | "RE39826").PN. OR ("9719024").URPN.	US-PGPUB; USPAT; USOCR	OR	ON	2020/05/01 16:03
S3	0	gas same flare same (generator turbine dynamo) same (transformer transformat$4) same (rack server network (data adj center) computing)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2020/05/01 16:12
S4	4	gas same flare same (generator turbine dynamo) same (transformer transformat$4) and (rack server network (data adj center) computing)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2020/05/01 16:13
S5	22	("20070095536" | "20080197012" | "20150284811" | "3562115" | "3589313" | "3853498" | "4171017" | "4657290" | "4736111" | "5727903" | "6601543" | "7094388" | "7559367" | "7584789" | "7815713" | "7943014" | "8070863" | "8151880" | "8156662" | "8480789" | "8999036").PN. OR ("9337704").URPN.	US-PGPUB; USPAT; USOCR	OR	ON	2020/05/01 16:28
S6	18	gas same flare same (generator turbine dynamo) same (transformer transformat$4)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2020/05/01 16:32

S7	99	("4911379" "5407647" "4425757" "4865817" "5192517" "5362464" "5727538" "6196056" "4255926" "4333764" "4448751" "4567916" "4821524" "4944496" "5565180" "6009900" "6210464" "6210464" "4273025" "4317540" "4452898" "4509456" "4560042" "4563982" "4583319" "4764085" "4779355" "4919826" "4960708" "4963329" "4978367" "4992301" "5023064" "5326835" "5450899" "5520858" "5662838" "5707424" "5824271" "5950572" "6228146" "6236894" "4265670" RE30935 "4341651" "4350665" "4363443" "4364753" "4381898" "4382908" "4391860" "4409301" "4410041" "4416332" "4445846" "4474612" "4528337" "4548765" "4557816" "4566565" "4582254" "4609541" "4774152" "4808534" "4818640" "4849191" "4871580" "4976685" "4991423" "5017348" "5231991" "5242564" "5259456" "5271725" "5282739" "5395050" "5439509" "5536489" "5542963" "5602435" "5716597" "5723055" "5782080" "5785902" "5791107" "5803938" "5833734" "5834519" "5839271" "5887418" "5904850" "5911336" "5922305" "5958377" "6030603" "6037683" "6066249" "6076517" "6097184" "6123523").pn.	US-PGPUB; USPAT	OR	ON	2020/05/04 09:49
S8	1416	gas same (generator turbine dynamo) same (transformer transformat$4) same (rack server network (data adj center) computing)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2020/05/04 10:29
S9	0	("2020/0051184").URPN.	USPAT	OR	ON	2020/05/04 11:02
S10	0	("2020/0051184").URPN.	USPAT	OR	ON	2020/05/04 11:17

S11	16	S8 and flar$4	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2020/05/04 11:22
S12	2	(cavness-charles).in.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2020/05/04 11:32
S13	2	(lochmiller-chase).in.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2020/05/04 11:33
S14	50	(parker-kenneth).in.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2020/05/04 11:33
S15	33834	C10L3/104, E21B43/16, G06Q20/065, G06Q2220/00.CPC.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2020/05/04 11:36
S16	2	S8 and S15	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2020/05/04 11:37

S17	260	S15 and flar$4	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2020/05/04 11:38
S18	11	("20050189112" | "20120000660" | "20130220605" | "20140124208" | "20150167550" | "3368627" | "4511381").PN. OR ("9725644").URPN.	US-PGPUB; USPAT; USOCR	OR	ON	2020/05/04 11:46
S19	6	(US-20200087591-$ or US-20200040272-$ or US-20200051184-$).did. or (US-9719024-$ or US-9337704-$ or US-9725644-$).did.	US-PGPUB; USPAT	OR	ON	2020/05/04 11:49
S20	6	gas same flar$4 same (generator turbine dynamo) same (transformer transformat$4) same (rack server network (data adj center) computing)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2020/05/04 12:11
S21	53	gas same (generator turbine dynamo) same (transformer transformat$4) same (kw mw) same (v kv)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2020/05/04 12:13
S22	15	gas near (generator turbine dynamo) same (transformer transformat$4) same (kw mw) same (v kv)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2020/05/04 15:30

5/4/2020 6:10:41 PM
C:\Users\camaya\Documents\EAST\Workspaces\16529152.wsp

Bibliographic Data

Application No: 16/529,152

Foreign Priority claimed: ○ Yes ◉ No

35 USC 119 (a-d) conditions met: ☐ Yes ☐ No ☐ Met After Allowance

Verified and Acknowledged: /CARLOS AMAYA/ (Examiner's Signature) ____ (Initials)

Title: Systems and Methods for Generating and Consuming Power from Natural Gas

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FILING or 371(c) DATE	CLASS	GROUP ART UNIT	ATTORNEY DOCKET NO.
08/01/2019	307	2836	CRUSOE-105002US1
RULE			

APPLICANTS

Crusoe Energy Systems Inc., Denver, CO,

INVENTORS

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Chase Lochmiller Castle Rock, CO, UNITED STATES

Kenneth Parker Denver, CO, UNITED STATES

CONTINUING DATA

This application has PRO of 62713368 08/01/2018

FOREIGN APPLICATIONS

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Receipt date: 11/14/2019 16/529,152 - GAU: 2836

Doc code: IDS
Doc description: Information Disclosure Statement (IDS) Filed

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INFORMATION DISCLOSURE STATEMENT BY APPLICANT

(Not for submission under 37 CFR 1.99)

Application Number	16529152
Filing Date	2019-08-01
First Named Inventor	Charles Cavness
Art Unit	1733
Examiner Name	
Attorney Docket Number	CRUSOE-105002US1

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Examiner Initial*	Cite No	Patent Number	Kind Code[1]	Issue Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear
	1	7998227	B2	2011-08-16	Mittricker, Frank F.	Entire Document
	2	8070863	B2	2011-12-06	Tsangaris et al.	Entire Document
	3	9337704	B1	2016-05-10	Leslie et al.	Entire Document
	4	9637433	B2	2017-05-02	Zubrin et al.	Entire Document
	5	9719024	B2	2017-08-01	Young et al.	Entire Document
	6	9673632	B1	2017-06-06	Ramesh et al.	Entire Document

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First Named Inventor	Charles Cavness
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Examiner Name	
Attorney Docket Number	CRUSOE-105002US1

	1	20110115425	A1	2011-05-19	Olsson, Mats	Entire Document	
	2	20140372772	A1	2014-12-18	McKnight et al.	Entire Document	
	3	20170218843	A1	2017-08-03	Oehring et al.	Entire Document	
	4	20170271701	A1	2017-09-21	Berlowitz et al.	Entire Document	
	5	20180109112	A1	2018-04-19	Paine et al.	Entire Document	
	6	20190022580	A1	2019-01-24	Muhsen, Al	Entire Document	

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	1	2013022501	WO	A1	2013-02-14	Gill, Jerrold	Entire Document	

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Attorney Docket Number	CRUSOE-105002US1

	1	BELLUSCI, MICHAEL: Why waste all that cheap Permian gas? Make some bitcoins with it, Apr. 2018, accessed Aug. 16, 2019 at https://www.dallasnews.com/business/energy/2018/04/13/instead-flaring-cheap-permian-natural-gas-could-used-power-bitcoin-mining-rigs
	2	BTU ANALYTICS, Bitcoin to BTUs: Cryptocurrency Impacts On Natural Gas, Jan. 3, 2018, accessed Aug. 16, 2019 at https://btuanalytics.com/cryptocurrency-bitcoin-natural-gas/
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Receipt date: 11/14/2019 16/529,152 - GAU: 2836

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(Not for submission under 37 CFR 1.99)

Application Number	16529152
Filing Date	2019-08-01
First Named Inventor	Charles Cavness
Art Unit	1733
Examiner Name	
Attorney Docket Number	CRUSOE-105002US1

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See attached certification statement.

The fee set forth in 37 CFR 1.17 (p) has been submitted herewith.

☒ A certification statement is not submitted herewith.

SIGNATURE

A signature of the applicant or representative is required in accordance with CFR 1.33, 10.18. Please see CFR 1.4(d) for the form of the signature.

Signature	/Kyle Zeller/	Date (YYYY-MM-DD)	2019-11-14
Name/Print	Kyle Zeller	Registration Number	64748

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APPLICATION NUMBER	FILING OR 371(C) DATE	FIRST NAMED APPLICANT	ATTY. DOCKET NO./TITLE
16/529,152	08/01/2019	Charles Cavness	CRUSOE-105002US1

CONFIRMATION NO. 9940

114903
Zeller IP Group PLLC
155 Water St.
Suite 6-6
Brooklyn, NY 11201

PUBLICATION NOTICE

OC00000014525779

Title: Systems and Methods for Generating and Consuming Power from Natural Gas

Publication No.US-2020-0040272-A1
Publication Date:02/06/2020

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First Named Inventor	Charles Cavness
Art Unit	1733
Examiner Name	
Attorney Docket Number	CRUSOE-105002US1

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	2	8070863	B2	2011-12-06	Tsangaris et al.	Entire Document
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	4	9637433	B2	2017-05-02	Zubrin et al.	Entire Document
	5	9719024	B2	2017-08-01	Young et al.	Entire Document
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	Attorney Docket Number	CRUSOE-105002US1

	1	20110115425	A1	2011-05-19	Olsson, Mats	Entire Document
	2	20140372772	A1	2014-12-18	McKnight et al.	Entire Document
	3	20170218843	A1	2017-08-03	Oehring et al.	Entire Document
	4	20170271701	A1	2017-09-21	Berlowitz et al.	Entire Document
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Examiner Name	
Attorney Docket Number	CRUSOE-105002US1

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INFORMATION DISCLOSURE STATEMENT BY APPLICANT

(Not for submission under 37 CFR 1.99)

Application Number	16529152
Filing Date	2019-08-01
First Named Inventor	Charles Cavness
Art Unit	1733
Examiner Name	
Attorney Docket Number	CRUSOE-105002US1

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Please see 37 CFR 1.97 and 1.98 to make the appropriate selection(s):

That each item of information contained in the information disclosure statement was first cited in any communication from a foreign patent office in a counterpart foreign application not more than three months prior to the filing of the information disclosure statement. See 37 CFR 1.97(e)(1).

OR

☐ That no item of information contained in the information disclosure statement was cited in a communication from a foreign patent office in a counterpart foreign application, and, to the knowledge of the person signing the certification after making reasonable inquiry, no item of information contained in the information disclosure statement was known to any individual designated in 37 CFR 1.56(c) more than three months prior to the filing of the information disclosure statement. See 37 CFR 1.97(e)(2).

See attached certification statement.

The fee set forth in 37 CFR 1.17 (p) has been submitted herewith.

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A signature of the applicant or representative is required in accordance with CFR 1.33, 10.18. Please see CFR 1.4(d) for the form of the signature.

Signature	/Kyle Zeller/	Date (YYYY-MM-DD)	2019-11-14
Name/Print	Kyle Zeller	Registration Number	64748

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Serial No.: 16/529,152
Docket: CRUSOE-105002US1

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant:	Crusoe Energy Systems Inc.	**Art Unit:**	1733
Serial No.:	16/529,152	**Examiner:**	
Filed:	2019-08-01	**Conf. No.:**	9940
Title:	Systems and Methods for Generating and Consuming Power from Natural Gas		

Information Disclosure Statement

Electronically Filed
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Sir:

This Information Disclosure Statement is filed in accordance with 37 C.F.R. §§1.56, 1.97 and 1.98. The items listed on enclosed Form PTO/SB/08a are made of record to assist the Patent and Trademark Office in its examination of this application. The Examiner is respectfully requested to fully consider the items and to independently ascertain their teaching.

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Serial No.: 16/529,152
Docket: CRUSOE-105002US1

Authorization

The Commissioner is hereby authorized to charge any additional fees which may be required for this Information Disclosure Statement, or credit any overpayment to Deposit Account No. 50-6138, Order No. CRUSOE-105002US1.

Respectfully Submitted,
Zeller IP Group, PLLC

Dated: November 14, 2019

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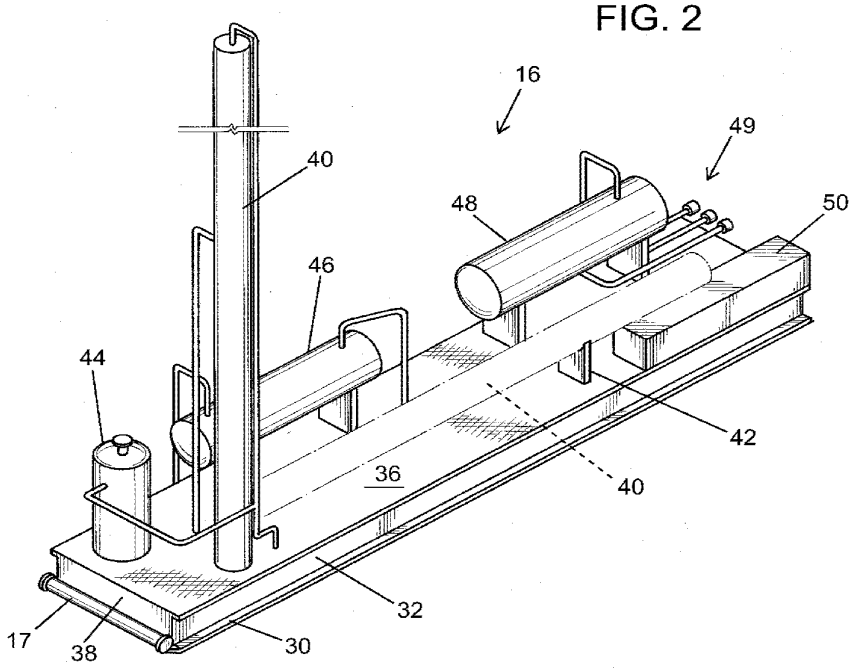
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[Continued on next page]

(54) **Title**: MODULAR GAS PROCESSING SYSTEM

FIG. 2



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(57) Abstract: A gas processing system for use at an oil and/or gas well site. The gas processing system includes a transportable production skid including a first gas- liquid separator, a transportable heater/treater skid including a second gas-liquid separator and at least one raceway skid having piping for connecting said production skid to said heater/treater skid.

MODULAR GAS PROCESSING SYSTEM

BACKGROUND OF THE INVENTION

FIELD OF THE INVENTION

The present invention relates to gas processing systems and more particularly, to transportable, modular gas processing systems for installation at an oil and/or gas well site.

DESCRIPTION OF THE PRIOR ART

In a typical well site gas processing facility, the production stream from the well head is directed to a first separation zone, which can comprise a 2-phase separator (separating liquids and gas), a 3-phase separator (separating oil, water, and gas), or a 4-phase separator (separating oil, water, gas, and solids). The gas passing through the first separation zone is then directed to a compressor or other gathering system. The liquids from the first separation zone can then be sent to a second separation zone or to a heater/treater, wherein additional gas is recovered and the oil and water are further separated. The recovered oil can either be directed to an oil storage tank or to a vapor recovery tower, while the water is sent to a water storage tank or other reclamation zone.

As noted above, prior art on-site gas processing facilities, generally comprise a phase separation system to separate gas, water, oil (liquid hydrocarbons) and solids. In regard to these conventional, prior art gas processing/production systems, each component of the system such as the towers, separators, treaters, pumps, storage tanks, connector piping, auxiliary

equipment, as well as any containment components must be delivered to the well pad which is typically a 200 ft x 300 ft cleared site. Upon arrival at the site, each component must be unloaded, and placed in its designated location using erection equipment, e.g., cranes, which also have to be moved to the site.

As is well known, it requires many workers with various skill sets to position, assemble and connect the equipment and piping necessary to set up these prior art gas processing systems. It will thus be recognized that the procedure is labor intensive, time consuming, poses safety concerns to the workers, and is expensive. Indeed, it is estimated that prior art gas processing facilities of the type under consideration generally require approximately 2500 man hours to install.

These prior art facilities do not infrequently have leaks in the piping, pumps, etc. which leads to spillage of petroleum-like products and/or contaminated water on the ground, posing a problem for any nearby stream, lake, or other body of water as well as possible contamination of underground aquifers.

Further, in these prior art gas processing facilities, because of the potential of spills from bad piping connections, leaking equipment, etc. containment is a must. In this regard, it is not uncommon for any containment set up to have a large footprint since it must surround all the equipment as well as any storage tanks associated therewith.

In this regard, one of the main problems at well sites and treating facilities of the type under consideration is that spills of oil, water-oil mixtures, and the like

can occur causing serious environmental problems. In prior art systems, this problem has been addressed by building berms around the equipment, tanks, etc., the berms forming a pond-like enclosure which is generally lined with a material or substrate preventing the spilled material from migrating into the ground. Building of berms surrounding specifically prepared substrate on which the components of the system are positioned is time consuming, labor intensive and expensive.

SUMMARY OF THE INVENTION

One aspect of the present invention provides a modular gas processing system comprised of self-contained portable skids upon which is mounted the necessary components of the processing system, and necessary piping sufficient to provide a "plug and play" gas processing system.

The modular system of the present invention provides highway transportable skids which can be rapidly deployed to a well site using trucks, trailers, and other such vehicles or carriers which can be legally used on regulated highways leading to the well site.

In one embodiment the invention provides a modular gas processing system comprised of a production skid, a heater treater skid, and at least one raceway skid, preferably two raceway skids, and move preferably three raceway skids which support necessary piping to connect the production skid to the heater treater skid and other necessary conduits, components, facilities or the like, of the processing system.

These and further features and advantages of the present invention will become apparent from the following detailed description, wherein reference is made to the figures in the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 shows an overall, perspective view of a modular system of the present invention installed at a well site.

Fig. 2 is a perspective view of one embodiment of a production skid of the present invention.

Fig. 3 is a perspective view of one embodiment of a heater treater skid of the present invention.

Fig. 4 is a perspective view of one embodiment of two of the raceway skids of the present invention.

Fig. 5 is a perspective view of one embodiment of another raceway skid used in the present invention.

Fig. 6 is an elevational view, partly in section, of a portion of a skid showing the containment of liquids and an apparatus for removing the contained liquids.

Fig. 7 is an elevational view showing the use of a flex connection in one embodiment of the present invention.

Fig. 8 is an elevational view, partly in section, showing one apparatus allowing the VRT to pivot between generally horizontal and generally vertical positions.

Fig. 9 is a top, plan view taken along the lines 9—9 of Fig. 8.

Fig. 10 is a view similar to Fig. 8 but showing the VRT moved from the vertical position shown in Fig. 8 to a generally horizontal position.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

In one of the embodiments of the present invention, one of the main skids, the production skid, comprises a first gas-liquid separator system and can comprise two separators, a flare scrubber, and a vapor recovery tower, while the other main skid, which is physically separated from the first main skid, comprises the heater treater unit, i.e., a second gas-liquid separator system. There are three other physically separate skids which can be used in the modular system of the present invention. Two of these skids are basically pipe racks for piping which connects the two main skids. A fifth skid, which also is basically a pipe rack for piping, connects piping from the other two pipe skids to a facilities station at the well site. Thus, the present invention, in one embodiment, can have five skids albeit that three of the skids are mainly pipe racks. However, for maximum modularity, preferably all five skids are used.

A feature of the present invention is that the need for constructing large berms is greatly reduced. Thus the skids for the two main processing units from which spills most frequently occur comprises trays or pans which collect any spilled material. The trays are provided with pumps connected by suitable piping to both of the main skids, such that if there is a spill, or if there is excessive rainfall which fills the pans or trays, an automatic float system or other automatic level sensing system turns on the pump and pumps the accumulation of liquid in the skid pans or trays to one of the storage/collector tanks in a tank battery.

A further important feature of the present invention is that the connections between the two main skid units and the pipeline skids can be done by flex

connections, meaning that there is no necessity for on-site plumbing requiring accurate measuring, cutting, welding, etc.; i.e., the flex connections allow quick connection between the pipeline racks and the two main skids. One of the advantages of this is that when wells are abandoned, typically the treating facility is disassembled, meaning that piping is cut and much of it lost. Indeed, in some cases, much of the gas processing equipment is left behind. With the system of the present invention, if the well is abandoned, because of these flex connections, the modules can be quickly and easily disassembled, moved from the site, and most if not all of the components, including the piping saved for future use.

Referring first to Fig. 1, there is shown a typical well site 10 at which is a wellhead 12 from which gas as well as liquids e.g. oil, hydrocarbon condensates, and water is being produced, the wellhead 12 being connected by line 14 to a production skid shown generally as 16 and described more fully hereafter. The piping from equipment on production skid 16 is connected, preferably by flex connectors (described hereafter), to the piping on the first raceway skid 18 which in turn in connected, preferably by flex connectors, to the piping on a second raceway skid 20. The piping on the skid 20 is also connected, preferably by flex connectors, to piping on a heater treater skid shown generally as 22. A third raceway skid 22 has piping which connects, preferably via flex connectors, to a facilities station shown generally as 24. Facilities station 24 is typical of those at a gas processing well site and can comprise pumps, compressors, generators

and other equipment normally used in the operation of an on-site gas processing facility.

The well site 10 also includes a tank battery shown generally as 26, having tanks 26A-26D for storage of water, oil and other liquid hydrocarbons. Tank battery 26 is connected via suitable piping indicated in phantom at 28 to necessary piping coming from production skid 16, heater treater skid 22, as well or facilities station 24. Tank battery 26 sits on a prepared pad 27 surrounded by berm 28, the pad 27 being formed of a material or substrate which, to the extent practicable, prevents the migration of any spill of oil and/or contaminated water into the ground beneath the tank battery 26. This points to one of the clear advantages of the present invention. In prior art gas processing facilities, it would have been common to erect a berm virtually around the entire site on which the prior art gas processing system was erected. However, using the modular system of the present invention, it is only necessary to have a prepared pad for and a berm around the tank battery.

Although not shown, but as is well known to those skilled in the art, recovered natural gas and other normally gaseous hydrocarbons emanating from wellhead 12 can be introduced into a pipeline or other gathering facility (not shown) located at site 10 or, in certain cases, can be compressed on site and stored in a suitable pressure vessel.

Referring now to Fig. 2, there is shown one of the main skids, i.e., the production skid 16. Production skid 16 as seen with reference to Figs. 2 and 6 has a bottom wall 30 (see Fig. 6), side walls 32 and 34, and opposite end walls,

one of which is shown in Fig. 2 as 38. The end walls in conjunction with side walls 32 and 34 and bottom wall 30 form a pan or tray-like containment structure. Mounted on the top of skid 16 is a work surface 36 which can be comprised at least partially of metal grate or the like commonly used in industrial facilities such as refineries, chemical plants, etc. The use of metal grate is preferable in that it ensures that any leakage from equipment on skid 16 falls into the pan or tray-like containment structure rather than running off onto the ground surrounding the skid, which would be the case if a solid plate-like support surface were employed.

It will be understood by those skilled in the art that skid 16 as well as skid 22, described more fully hereafter, is a fabricated structure which basically comprises a framework made of steel beams, cross braces, (as described below with respect to raceway skids 18, 20 and 21) and any other necessary structural components as described or readily apparent to those of skill in the art to ensure that the skid(s) 16 and 22 can support the weight of any vessels, equipment and the like placed thereon, but yet be light enough to as to be transported by carriers, e.g., trailers, tractor trailers, etc. which can move over regulated highways.

Typically, the skids 16 and 22, and for that matter, the raceway skids described hereafter, if necessary, will have a pull bar such as bar 17 shown on skid 16 which can be grasped by any number of devices for pulling the skid, if necessary, either on the ground, on a concrete pad, or up a ramp onto a suitable carrier for transportation.

Although not shown, it will be understood that the skids could be provided with retractable wheels, rollers, or the like, which could be used to more easily maneuver the skids into position either during fabrication or at the well site, the wheels or rollers, then being retracted, such that the bottom framework of the skid would sit on the well site.

With reference to Figs. 2 it can be seen that production skid 16 comprises a vapor recovery tower (VRT) 40 well known to those skilled in the art. As depicted in phantom, in one position, the VRT 40 can rest in a generally horizontal position, a portion laying on a cradle 42 affixed to production skid 16 such that the production skid 16 can be transported along regulated highways. As also seen, and described more fully hereafter, the VRT 40 can be moved to a generally vertical position when in operation. Production skid 16 can also comprise a flare scrubber 44, one or more separators, e.g., a high pressure separator 46 and a low pressure separator 48. Skid 16 can also carry a tool box 50 for tools customarily used in connection with any servicing of equipment on production skid 16. As can also be seen in Fig. 2, there is also necessary piping indicated generally at 40, valving, etc., which although not shown is well known to those skilled in the art. The operation of VRT's, separators, flare scrubbers, and associated equipment is well known to those skilled in the art.

Referring now to Figs. 8-10, there is shown one assembly that can be used such that VRT 40 can be secured to skid 16 in such a way that it can be moved from a generally horizontal position for transport to a generally vertical position when in use. Referring first to Fig. 8, it can be seen that there is a frame

shown generally as 79, comprising upper and lower collars 80 and 82, respectively, which encircle VRT 40. Frame 79 further comprises a plurality of circumferentially displaced struts 83 which are secured to collars 80 and 82 whereby a frame is formed in a cage-like structure.

Collars 80 and 82, as seen with particular reference to Fig. 9, but also with reference to Figs. 8 and 10, comprise first and second jaw members 84 and 86 which cooperate to define a circular opening 88 having a diameter substantially the same as the OD of VRT 40. Generally, diameter 88 would be slightly smaller than that of the OD of VRT 40 such that when the jaw members 84 and 86 are securedly connected to one another by means of flange/nut-bolt assemblies 90 and 92, jaws 84 and 86 will be tightly compressed against VRT 40. In like manner, collar 82 is comprised of first and second jaw members 94 and 96. As seen, collar 82 is similar to collar 80 in having jaw members 94 and 96 which can be flanged together or for that matter, hinged. However, collar 82 is also provided with hinge leafs 98 and 100 which are pivotally connected by means of pivot pins 106 and 108 to brackets 102 and 104, respectively, which in turn are secured to a structural cross beam 110 forming part of the frame of skid 16. Additionally, collar 82 is provided with a laterally outwardly extending flange 112 which rests on a support plate 114 which in turn is connected by support member 116 to another crossbeam 118.

In general, it will be seen that production skid 16 comprises an initial gas/liquids separation system. Although as depicted skid 16 includes a VRT as well as a high pressure separator 46 and a low pressure separator 48, a flare

scrubber, etc., it will be understood that in some cases, the VRT may be dispensed with in favor of high and/or low pressure separators. However, it is well known that a VRT serves to insulate the compressors from gas surges and is generally more tolerant to higher and lower pressures. Furthermore, the VRT makes for more stable pressures and allows better operation. In any event, at its minimum, skid 16 can be considered as comprising a gas/liquids separation system.

Referring now to Figs. 3 and 9, there is shown heater treater skid 22 which also comprises a gas-liquid separator system. Heater treater skid 22 carries a heater treater unit 50. A heater treater unit 50, as is well known, is a combination of a heater, a free-water knockout, and an oil and gas separator. The operation and construction of heater treaters is well known to those skilled in the art and need not be described in detail here.

It will be understood in conjunction with the production skid 16 and heater treater skid 22, that the equipment mounted thereon can be permanently or removably affixed thereto, the latter, in many respects, being more desirable for maintenance purposes, replacement, etc.

Referring now to Figs. 4 and 5, the pipe raceway skids are shown in greater detail. As can be seen from Figs. 4 and 5, the raceway skids are comprised of metal beams 60, and cross-pieces 61 welded or otherwise securely affixed to one another to form a generally rectangular base shown generally as 63. Securely mounted on each of the bases 63 and extending upward therefrom are a plurality of spaced pipe supports or racks 62 on which piping shown

generally as 64 rests. It will be appreciated that the supports 62 can be provided with saddles or cradles in which the undivided pipe segments 64 can nest, if desired.

As noted above, skids 16 and 22 generally form pan-like structures which collect spilled liquids from equipment on those skids. Referring now to Fig. 6, it can be seen that spilled liquids including rain water has collected in a pan. To prevent overflowing which would contaminate the ground area around the skids, each of the skids having a pan or tray is also provided with one or more pumps P (see Fig. 6) which is connected to a float 70 or some other automatic, liquid level sensor system which will turn pump P on when the liquid in the skid reaches a certain level. The pump P is connected by suitable piping, e.g., pipe 62, to one of the tanks in the tank battery 26 where pumped liquids can be later processed or disposed of in an environmentally friendly manner.

As noted above, the modular system of the present invention provides decided advantages over prior art on site gas processing facilities. Thus, the modular system of the present invention combines all necessary equipment and hookups to separate the gas, oil, water and solid components produced from land drilled wells. The portable skids used in the modular system have built-in connection piping that can be connected to each other by flex connectors in a plug-and-play method. The flex connections cut installation time and eliminate many plumbing operations that are necessary on prior art well site gas processing facilities. Additionally, and as described above, several of the skids have built in containment to mitigate and even eliminate environmental impact.

As noted above, the piping between the various skids can be connected by means of flex connections which greatly enhance the speed of assembly of the gas processing system, reduces labor and also reduces waste that is typically associated in rigid plumbing operations. Reference is now made to Fig. 7 for a typical flex connection between piping from two different skids. Piping 64 on skid 20 is connected to piping 64 on skid 18 via flex connection 160. In this regard, flex connection 160 and flanges 162 and 164 at opposite ends, flange 162 being mated with flange 166 on piping 64 from skid 20, flange 164 being mated with flange 168 on piping 64 from skid 18. As is typical, the flanges are connected by nut and bolt assemblies. The flex pipe 160 can be of metal and/or composite construction, both of which can be made to withstand high pressures. For example, flex pipe 160 can be made of metal hose and braid or of concentric layers of thermoplastic (in an hour glass) and a core of reinforcing material (steel or fiber). In many systems, the use of composite flex pipe is desirable since it presents a necessary pressure rating because of the steel reinforcement and it often times is more desirable in corrosive environments. Furthermore, composite flex pipe may also avert the need for cathodic protection because of the protective thermoplastic jacket.

As noted above, in a preferred form the modular system of the present invention comprises five different skids, i.e., a production skid, a heater treater skid, and three raceway skids. The production skid can comprise a high pressure separator, a low pressure separator, a vapor recovery tower (VRT), flare scrubber, a fuel pot, and a coalescing filter together with all necessary

connection piping, valving, controllers etc. The heater treater skid can comprise a heater treater, a fuel pot, and a coalescing filter along with all necessary valving, piping, controllers, etc.. To facilitate connection between the various skids, flex connections are used between the various skids.

A significant advantage of the modular system of the present invention is that the VRT mount is hinged such that the skid carrying the VRT can, like the other skids, be transported on regulated highways using conventional trucks, trailers or the like customarily used to transport heavy equipment, i.e., the VRT can be moved to a substantially horizontal position for transport.

Another distinct advantage of the modular system of the present invention is that if a given well is abandoned, virtually all of the processing equipment and most of the piping can be recovered. In prior art systems, when a well was abandoned, the well would be capped, the processing equipment would simply be shut down, and at least the piping cut up on site. In that event, some of the equipment as well as most of the piping was either left at the site or not available for future use. However, with the modular system of the present invention, when the well is abandoned, piping connections can be easily disassembled, the skids can be picked up and moved and either recovered for scrap, and/or if still usable, moved to another well site.

Also, the modular system of the present invention minimizes potential environmental damages from spills which can occur in prior art well site gas processing facilities. Since the skids which contain the processing equipment have collection pans or trays, any spilled liquids or collected rain water can be

pumped to one of the tanks in the tank battery where it can be subsequently removed for processing or disposal.

Although specific embodiments of the invention have been described herein in some detail, this has been done solely for the purposes of explaining the various aspects of the invention, and is not intended to limit the scope of the invention as defined in the claims which follow. Those skilled in the art will understand that the embodiment shown and described is exemplary, and various other substitutions, alterations and modifications, including but not limited to those design alternatives specifically discussed herein, may be made in the practice of the invention without departing from its scope.

WHAT IS CLAIMED IS:

1. A gas processing system for use at an oil and/or gas well site, comprising:

a transportable production skid, said production skid including a first gas-liquid separation system;

a transportable heater/treater skid, said heater/treater skid comprising second gas-liquid separation system; and

at least one raceway skid, said at least one raceway skid comprising piping for connecting said production skid to said heater treater skid.

2. The system of claim 1, wherein said production skid includes a vapor recovery tower (VRT).

3. The system of claim 2, wherein said production skid includes a flare scrubber, a high pressure separator, and a low pressure separator.

4. The system of claim 1, wherein said heater/treater skid includes a heater/treater unit.

5. The system of claim 4, wherein said heater/treater skid comprises a free water knockout.

6. The system of claim 1, comprising a first raceway skid, said first raceway skid comprising piping connectable to said production skid and a second raceway skid, said second raceway skid comprising piping connectable to said piping on said first raceway skid and to said heater/treater skid.

7. The system of claim 6, comprising a third raceway skid, said third raceway skid comprising piping connectable to said piping on said second raceway skid and a facilities station.

8. The system of claim 1, wherein said production skid comprises a frame, an upper support surface and a lower tray.

9. The system of claim 1, wherein said heater/treater skid comprises, a frame, an upper support surface and a lower tray.

10. The system of any one of claims 8 or 9, wherein said upper support surface comprises a grate.

11. The system of any one of claims 8 or 9, wherein at least one of said production skid and said heater/treater skid comprise a liquids removal apparatus disposed in said tray for removing liquids collected in said tray.

12. The system of claim 11, wherein both of said production skid and said heater/treater skid comprise a liquids removal apparatus.

13. The system of claim 11, wherein said liquids removal apparatus comprises a pump and a level sensor operatively connected to said pump.

14. The system of claim 13, wherein said level sensor comprises a float.

15. The system of claim 1, wherein said VRT is movable from a first, generally horizontal position for transportation purposes to a second, generally vertical position for use.

16. The system of claim 15, wherein said production skid comprises a skid body and said VRT comprises a hinged connection to said skid body.

WO 2013/022501

PCT/US2012/033525

SUBSTITUTE SHEET (RULE 26)
1/5

FIG. 1

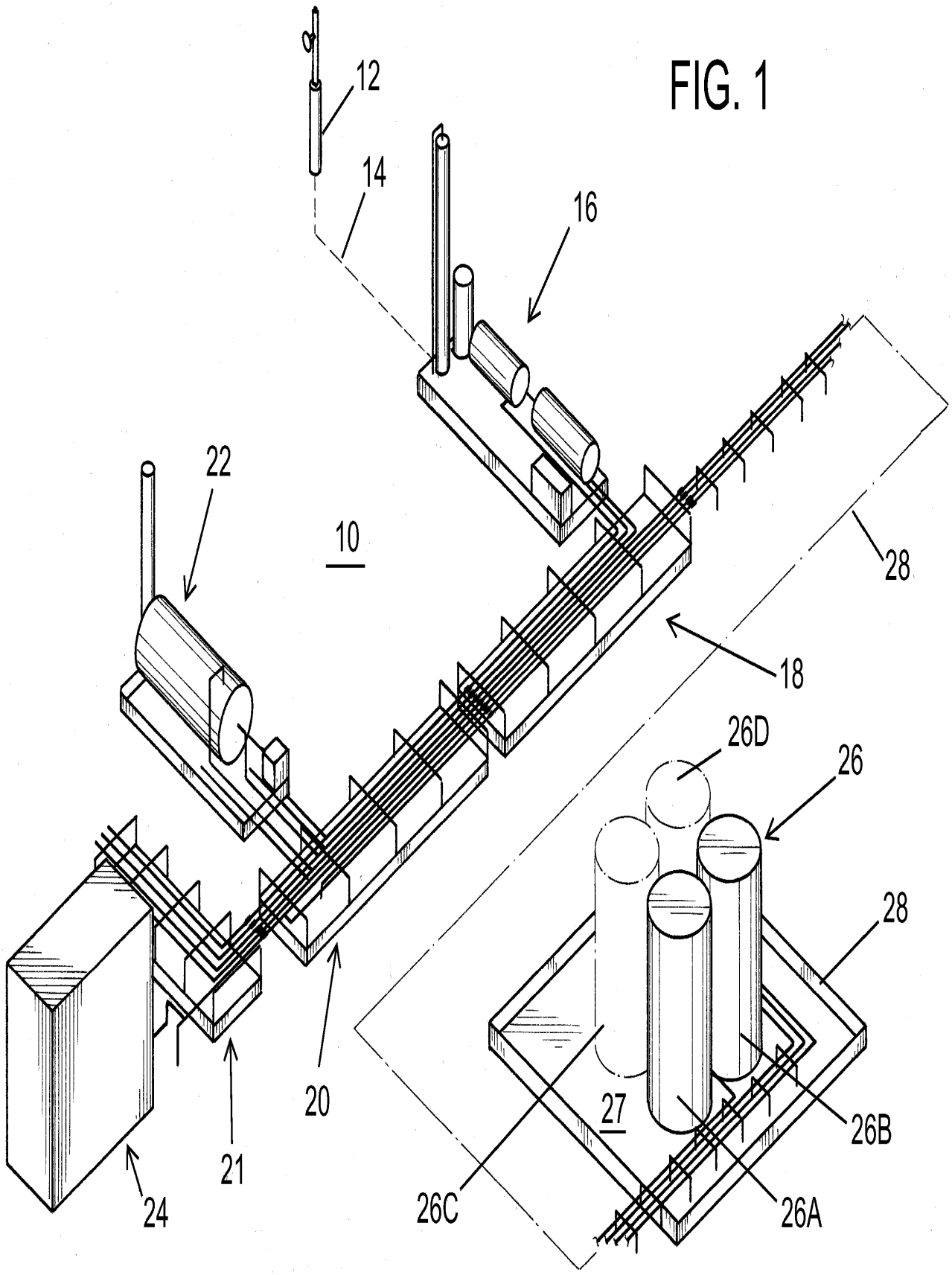


FIG. 2

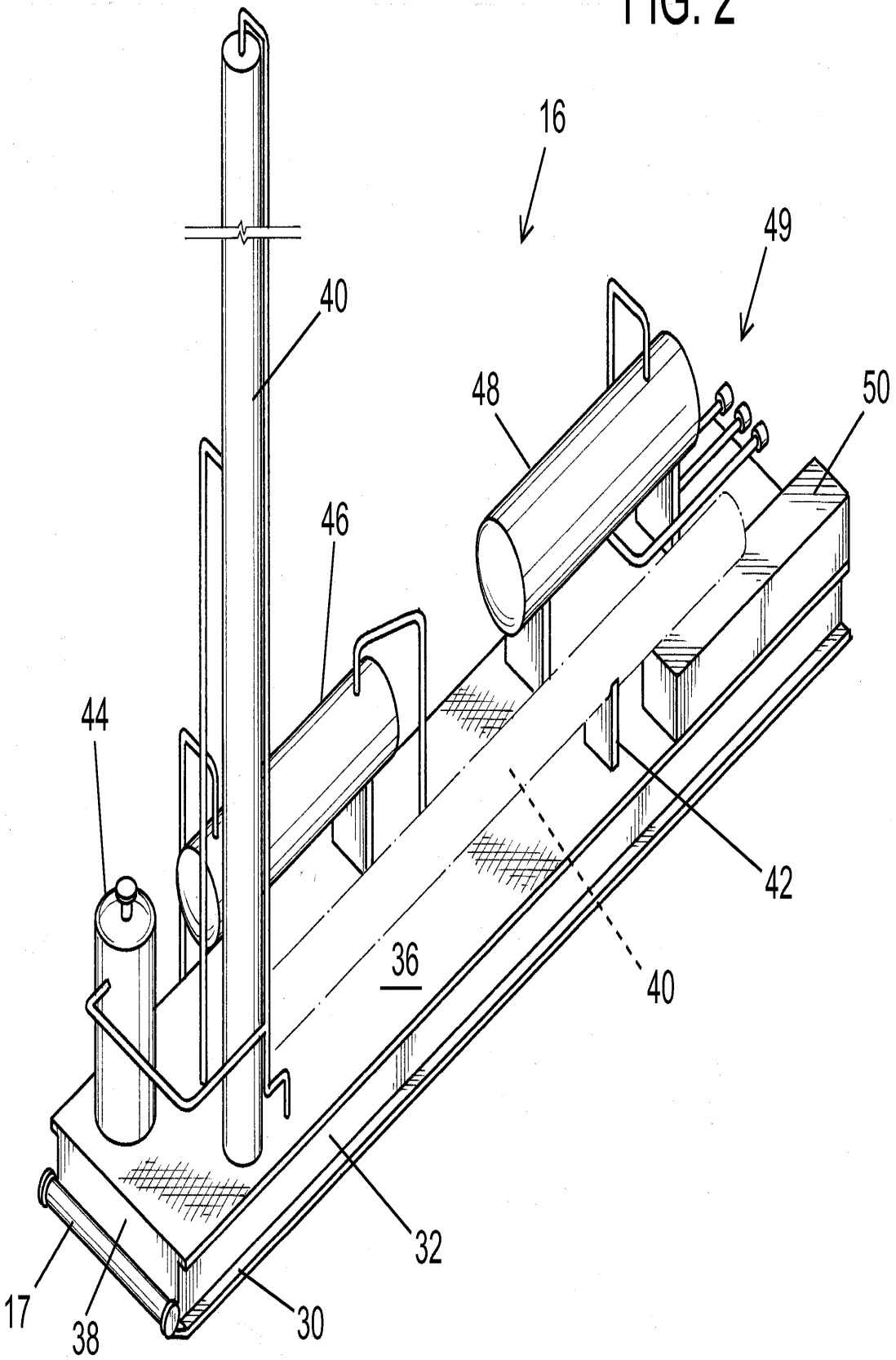


FIG. 3

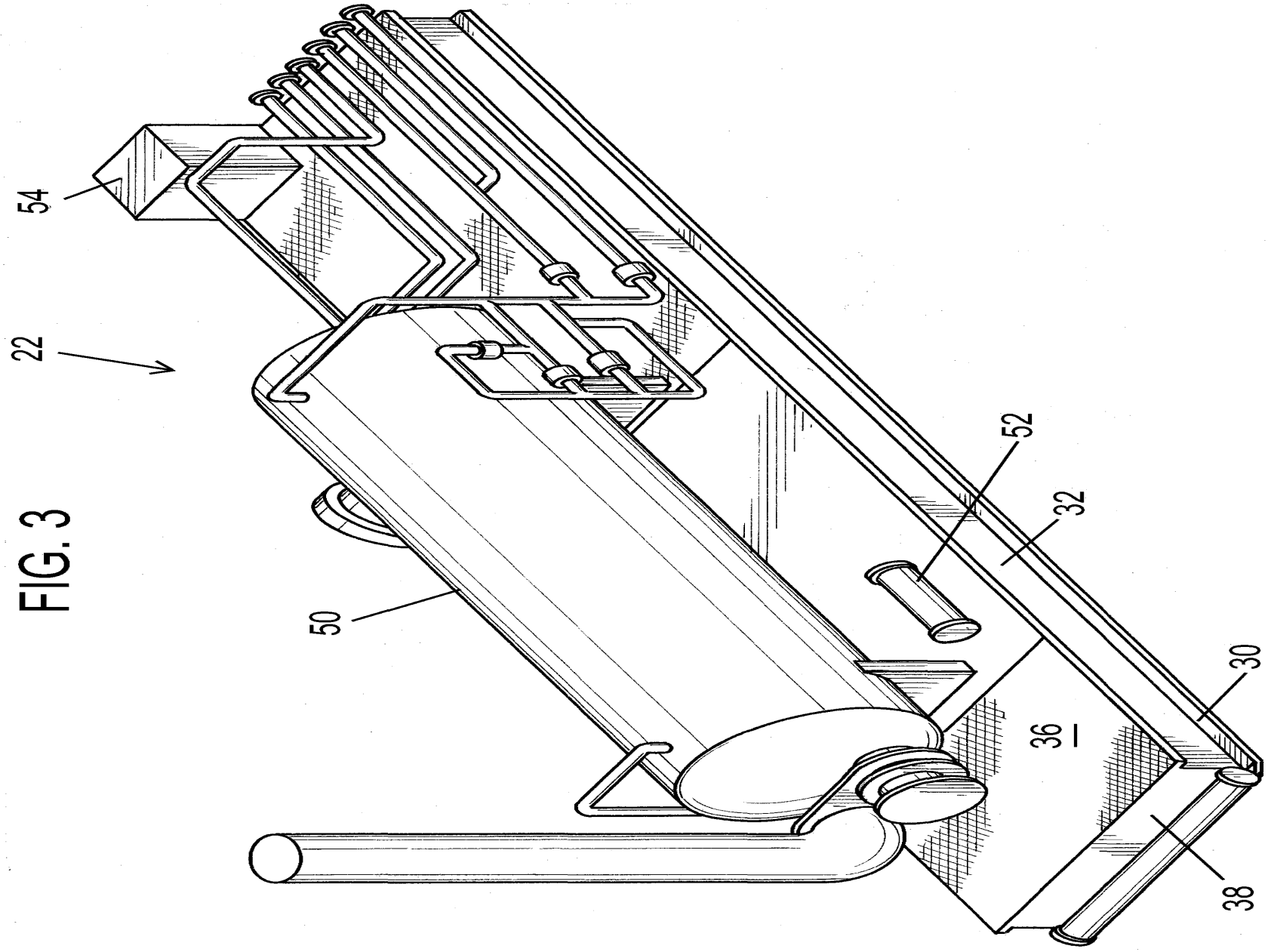


FIG. 7

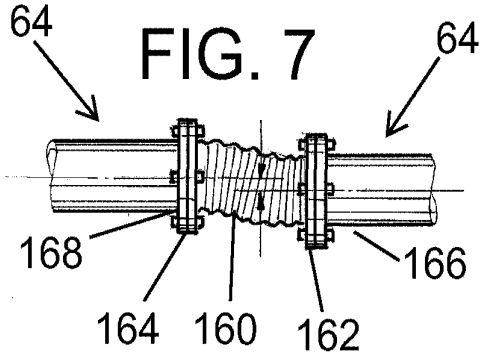


FIG. 4

FIG. 5

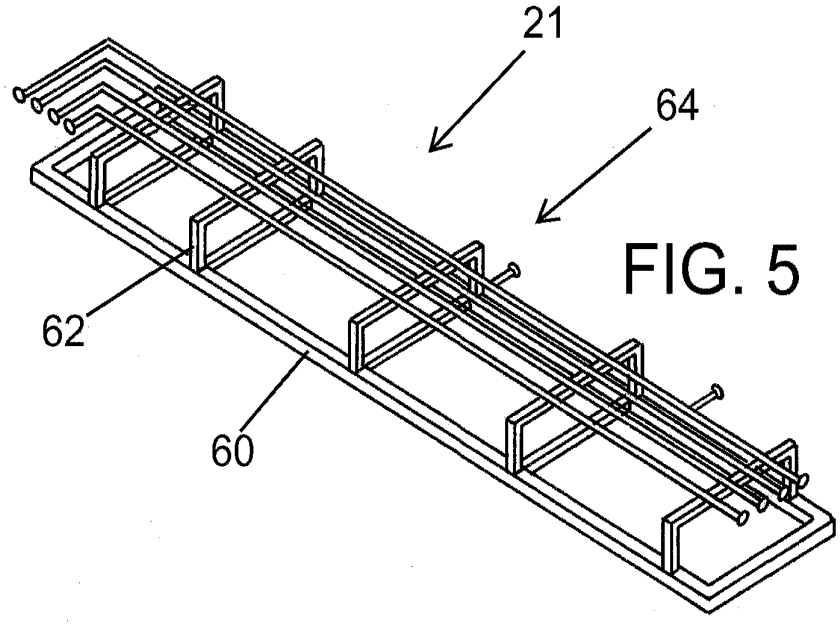


FIG. 6

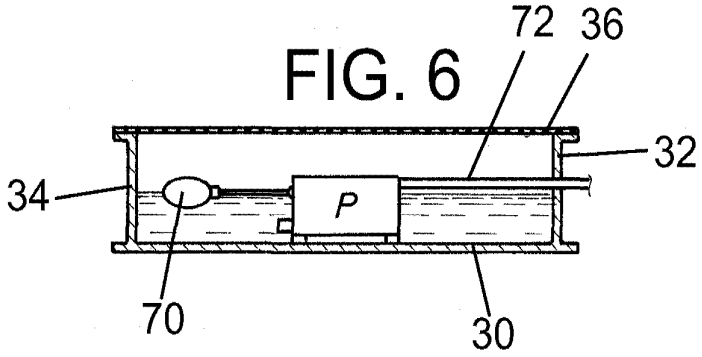


FIG. 8

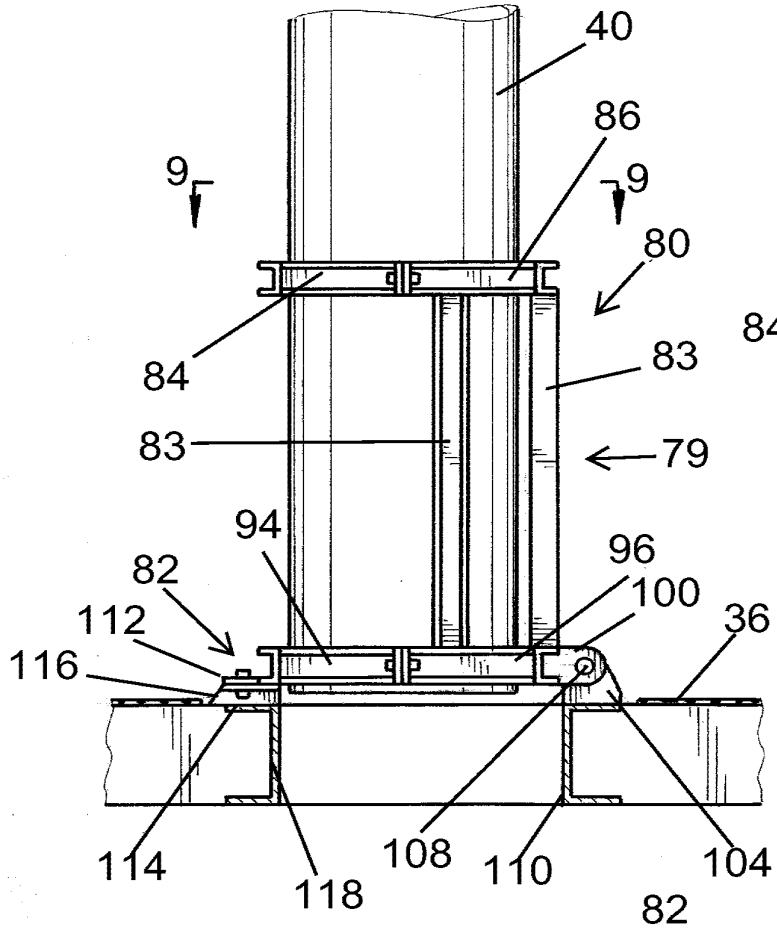


FIG. 9

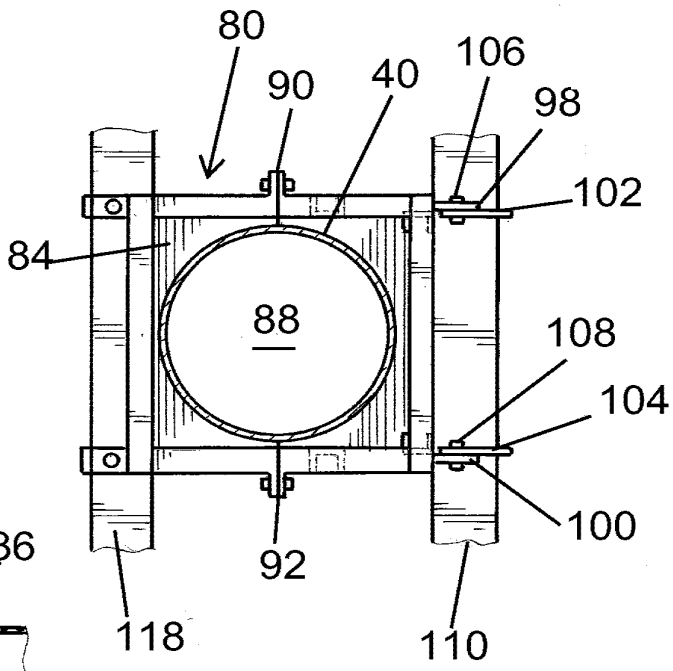
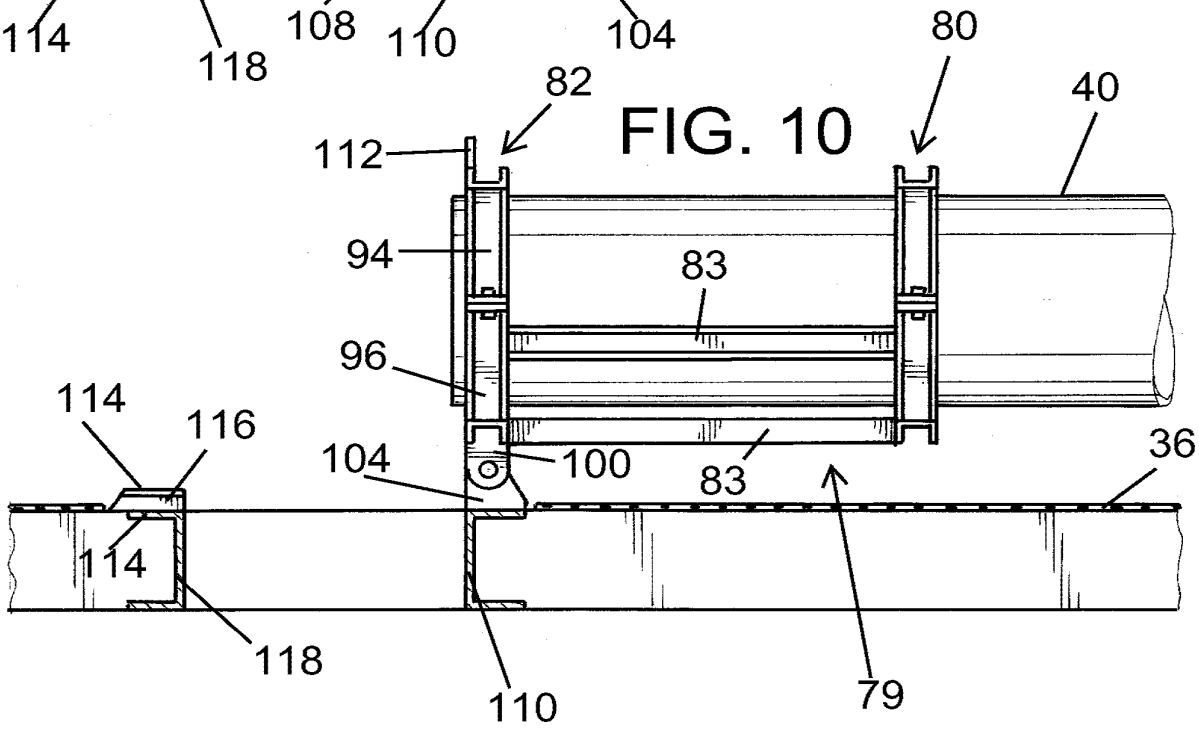


FIG. 10



INTERNATIONAL SEARCH REPORT

International application No.
PCT/US20 12/033525

A. CLASSIFICATION OF SUBJECT MATTER
IPC(8) - E21 B 43/34 (201 2.01)
USPC - 166/267
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC(8) - E21B 15/00, 43/00, 43/34 (201 2.01)
USPC - 166/79.1 , 267; 210/241

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
PatBase, Google Patents, Google.com

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X -- Y	uuss 4,779,677 A (COBB) 2 5 October 1988 (25.10.1988) entire document	1, 4 , 6-10 --- 2, 3, 5, 1 1-16
Y	US 5,287,927 A (PASS et al) 22 February 1994 (22.02.1994) entire document	2, 3, 1 1-16
Y	US 2008/0167390 A1 (ARCHER et al) 10 July 2008 (10.07.2008) entire document	3, 5
A	US 5,082,556 A (REESE) 21 January 1992 (21.01.1992) entire document	1-16
A	US 4,659,460 A (MULLER et al) 21 April 1987 (21.04.1987) entire document	1-16

☐ Further documents are listed in the continuation of Box C. ☐

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"E" earlier application or patent but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
"O" document referring to an oral disclosure, use, exhibition or other means
"p" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search
12 July 2012

Date of mailing of the international search report
26 JUL 201.

Name and mailing address of the ISA/US
Mail Stop PCT, Attn: ISA/US, Commissioner for Patents
P.O. Box 1450, Alexandria, Virginia 22313-1450
Facsimile No. 571-273-3201

Authorized officer:
Blaine R. Copenheaver
PCT Helpdesk: 571-272-4300
PCT OSP: 571-272-7774

Form PCT/ISA/210 (second sheet) (July 2009)

PATENT COOPERATION TREATY

From the INTERNATIONAL SEARCHING AUTHORITY

To: KYLE ZELLER
ZELLER IP GROUP PLLC
155 WATER ST.
SUITE 6-6
BROOKLYN, NY 11201

PCT

NOTIFICATION OF TRANSMITTAL OF THE INTERNATIONAL SEARCH REPORT AND THE WRITTEN OPINION OF THE INTERNATIONAL SEARCHING AUTHORITY, OR THE DECLARATION

(PCT Rule 44.1)

	Date of mailing *(day/month/year)* 11 OCT 2019
Applicant's or agent's file reference CRUSOE-105002PCT	**FOR FURTHER ACTION** See paragraphs 1 and 4 below
International application No. PCT/US2019/044646	International filing date *(day/month/year)* 01 August 2019
Applicant CRUSOE ENERGY SYSTEMS INC.	

1. ☒ The applicant is hereby notified that the international search report and the written opinion of the International Searching Authority have been established and are transmitted herewith.

   Filing of amendments and statement under Article 19:
   The applicant is entitled, if he so wishes, to amend the claims of the international application (see Rule 46):

   When? The time limit for filing such amendments is normally two months from the date of transmittal of the international search report.

   How? Directly to the International Bureau of WIPO preferably through ePCT or on paper to, 34 chemin des Colombettes 1211 Geneva 20, Switzerland, Facsimile No.: +41 22 338 82 70

   For more detailed instructions, see *PCT Applicant's Guide*, International Phase, paragraphs 9.004 – 9.011.

2. ☐ The applicant is hereby notified that no international search report will be established and that the declaration under Article 17(2)(a) to that effect and the written opinion of the International Searching Authority are transmitted herewith.

3. ☐ **With regard to any protest** against payment of (an) additional fee(s) under Rule 40.2, the applicant is notified that:
   ☐ the protest together with the decision thereon has been transmitted to the International Bureau together with any request to forward the texts of both the protest and the decision thereon to the designated Offices.
   ☐ no decision has been made yet on the protest; the applicant will be notified as soon as a decision is made.

4. **Reminders**

   The applicant may **submit comments on an informal basis on the written opinion of the International Searching Authority** to the International Bureau. These comments will be made available to the public after international publication. The International Bureau will send a copy of such comments to all designated Offices unless an international preliminary examination report has been or is to be established.

   Shortly after the expiration of **18 months from the priority date, the international application will be published** by the International Bureau. If the applicant wishes to avoid or postpone publication, a notice of withdrawal of the international application, or of the priority claim, must reach the International Bureau before the completion of the technical preparations for international publication (Rules 90*bis*.1 and 90*bis*.3).

   Within **19 months** from the priority date, but only in respect of some designated Offices, a demand for international preliminary examination must be filed if the applicant wishes to postpone the entry into the national phase **until 30 months** from the priority date (in some Offices even later); otherwise, the applicant must, **within 20 months** from the priority date, perform the prescribed acts for **entry into the national phase** before those designated Offices. In respect of other designated Offices, the time limit of **30 months** (or later) will apply even if no demand is filed within 19 months. For details about the applicable time limits, Office by Office, see www.wipo.int/pct/en/texts/time_limits.html and the *PCT Applicant's Guide*, National Chapters.

   Within **22 months from the priority date, the applicant may request that a supplementary international search be carried out** by a different International Searching Authority that offers this service (Rule 45*bis*.1). The procedure for requesting supplementary international search is described in the *PCT Applicant's Guide*, International Phase, paragraphs 8.006-8.032.

Name and mailing address of the ISA/US Mail Stop PCT, Attn: ISA/US Commissioner for Patents P.O. Box 1450, Alexandria, VA 22313-1450 Facsimile No. 571-273-8300	Authorized officer Blaine R. Copenheaver PCT Helpdesk: 571-272-4300 Telephone No. PCT OSP: 571-272-7774

Form PCT/ISA/220 (July 2017)

PATENT COOPERATION TREATY

PCT

INTERNATIONAL SEARCH REPORT

(PCT Article 18 and Rules 43 and 44)

Applicant's or agent's file reference CRUSOE-105002PCT	FOR FURTHER ACTION	see Form PCT/ISA/220 as well as, where applicable, item 5 below.
International application No. PCT/US2019/044646	International filing date *(day/month/year)* 01 August 2019	(Earliest) Priority Date *(day/month/year)* 01 August 2018
Applicant CRUSOE ENERGY SYSTEMS INC.		

This international search report has been prepared by this International Searching Authority and is transmitted to the applicant according to Article 18. A copy is being transmitted to the International Bureau.

This international search report consists of a total of 2 sheets.

☐ It is also accompanied by a copy of each prior art document cited in this report.

1. **Basis of the report**

a. With regard to the **language**, the international search was carried out on the basis of:

☒ the international application in the language in which it was filed.

☐ a translation of the international application into _____ which is the language of a translation furnished for the purposes of international search (Rules 12.3(a) and 23.1(b)).

b. ☐ This international search report has been established taking into account the **rectification of an obvious mistake** authorized by or notified to this Authority under Rule 91 (Rule 43.6*bis*(a)).

c. ☐ With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, see Box No. I.

2. ☐ **Certain claims were found unsearchable** (see Box No. II).

3. ☐ **Unity of invention is lacking** (see Box No. III).

4. With regard to the **title**,

☒ the text is approved as submitted by the applicant.

☐ the text has been established by this Authority to read as follows:

5. With regard to the **abstract**,

☒ the text is approved as submitted by the applicant.

☐ the text has been established, according to Rule 38.2, by this Authority as it appears in Box No. IV. The applicant may, within one month from the date of mailing of this international search report, submit comments to this Authority.

6. With regard to the **drawings**,

a. the figure of the **drawings** to be published with the abstract is Figure No. 1

☒ as suggested by the applicant.

☐ as selected by this Authority, because the applicant failed to suggest a figure.

☐ as selected by this Authority, because this figure better characterizes the invention.

b. ☐ none of the figures is to be published with the abstract.

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US2019/044646

A. CLASSIFICATION OF SUBJECT MATTER

IPC(8) - H02J 3/38; E21B 36/00; E21B 43/24; G06F 1/32; H01M 8/14; H02J 3/40; H02J 9/00 (2019.01)
CPC - H02J 3/38; F02C 3/20; F02C 9/40; G06F 1/32; H01M 8/14; H02J 3/40; H02J 9/00 (2019.08)

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
See Search History document

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
USPC - 60/39.281; 307/64; 307/69; 307/76; 307/78; 307/85; 700/286; 700/295 (keyword delimited)

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
See Search History document

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 2017/0218843 A1 (US WELL SERVICES LLC) 03 August 2017 (03.08.2017) entire document	1-20
A	US 9,673,632 B1 (GOOGLE INC) 06 June 2017 (06.06.2017) entire document	1-20
A	US 2017/0271701 A1 (EXXONMOBIL RESEARCH AND ENGINEERING COMPANY) 21 September 2017 (21.09.2017) entire document	1-20
A	US 2014/0372772 A1 (MICROSOFT CORPORATION) 18 December 2014 (18.12.2014) entire document	1-20
A	US 2011/0115425 A1 (OLSSON) 19 May 2011 (19.05.2011) entire document	1-20
A	US 2018/0109112 A1 (POWERSECURE, INC.) 19 April 2018 (19.04.2018) entire document	1-20

☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"E" earlier application or patent but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
23 September 2019	11 OCT 2019
Name and mailing address of the ISA/US Mail Stop PCT, Attn: ISA/US, Commissioner for Patents P.O. Box 1450, Alexandria, VA 22313-1450 Facsimile No. 571-273-8300	Authorized officer Blaine R. Copenheaver PCT Helpdesk: 571-272-4300 PCT OSP: 571-272-7774

Form PCT/ISA/210 (second sheet) (January 2015)

PATENT COOPERATION TREATY

From the
INTERNATIONAL SEARCHING AUTHORITY

To: KYLE ZELLER
ZELLER IP GROUP PLLC
155 WATER ST.
SUITE 6-6
BROOKLYN, NY 11201

PCT

WRITTEN OPINION OF THE
INTERNATIONAL SEARCHING AUTHORITY

(PCT Rule 43*bis*.1)

Date of mailing *(day/month/year)* 10 OCT 2019

Applicant's or agent's file reference	FOR FURTHER ACTION
CRUSOE-105002PCT	See paragraph 2 below

International application No.	International filing date *(day month year)*	Priority date *(day month year)*
PCT/US2019/044646	01 August 2019	01 August 2018

International Patent Classification (IPC) or both national classification and IPC
IPC(8) - H02J 3/38; E21B 36/00; E21B 43/24; G06F 1/32; H01M 8/14; H02J 3/40; H02J 9/00 (2019.01)
CPC - H02J 3/38; F02C 3/20; F02C 9/40; G06F 1/32; H01M 8/14; H02J 3/40; H02J 9/00 (2019.08)

Applicant CRUSOE ENERGY SYSTEMS INC.

1. This opinion contains indications relating to the following items:

- [x] Box No. I Basis of the opinion
- [ ] Box No. II Priority
- [ ] Box No. III Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
- [ ] Box No. IV Lack of unity of invention
- [x] Box No. V Reasoned statement under Rule 43*bis*.1(a)(i) with regard to novelty, inventive step and industrial applicability; citations and explanations supporting such statement
- [ ] Box No. VI Certain documents cited
- [ ] Box No. VII Certain defects in the international application
- [x] Box No. VIII Certain observations on the international application

2. **FURTHER ACTION**

If a demand for international preliminary examination is made, this opinion will be considered to be a written opinion of the International Preliminary Examining Authority ("IPEA") except that this does not apply where the applicant chooses an Authority other than this one to be the IPEA and the chosen IPEA has notified the International Bureau under Rule 66.1*bis*(b) that written opinions of this International Searching Authority will not be so considered.

If this opinion is, as provided above, considered to be a written opinion of the IPEA, the applicant is invited to submit to the IPEA a written reply together, where appropriate, with amendments, before the expiration of 3 months from the date of mailing of Form PCT/ISA/220 or before the expiration of 22 months from the priority date, whichever expires later.

For further options, see Form PCT/ISA/220.

Name and mailing address of the ISA/US	Date of completion of this opinion	Authorized officer
Mail Stop PCT, Attn: ISA/US Commissioner for Patents P.O. Box 1450, Alexandria, VA 22313-1450 Facsimile No. 571-273-8300	23 September 2019	Blaine R. Copenheaver PCT Helpdesk: 571-272-4300 PCT OSP: 571-272-7774

WRITTEN OPINION OF THE INTERNATIONAL SEARCHING AUTHORITY

International application No.
PCT/US2019/044646

Box No. I Basis of this opinion

1. With regard to the **language**, this opinion has been established on the basis of:

☒ the international application in the language in which it was filed.

☐ a translation of the international application into _____ which is the language of a translation furnished for the purposes of international search (Rules 12.3(a) and 23.1(b)).

2. ☐ This opinion has been established taking into account the **rectification of an obvious mistake** authorized by or notified to this Authority under Rule 91 (Rule 43*bis*.1(a)).

3. ☐ With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, this opinion has been established on the basis of a sequence listing:

a. ☐ forming part of the international application as filed:

☐ in the form of an Annex C/ST.25 text file.

☐ on paper or in the form of an image file.

b. ☐ furnished together with the international application under PCT Rule 13*ter*.1(a) for the purposes of international search only in the form of an Annex C/ST.25 text file.

c. ☐ furnished subsequent to the international filing date for the purposes of international search only:

☐ in the form of an Annex C/ST.25 text file (Rule 13*ter*.1(a)).

☐ on paper or in the form of an image file (Rule 13*ter*.1(b) and Administrative Instructions, Section 713).

4. ☐ In addition, in the case that more than one version or copy of a sequence listing has been filed or furnished, the required statements that the information in the subsequent or additional copies is identical to that forming part of the application as filed or does not go beyond the application as filed, as appropriate, were furnished.

5. Additional comments:

WRITTEN OPINION OF THE INTERNATIONAL SEARCHING AUTHORITY

International application No.
PCT/US2019/044646

Box No. V **Reasoned statement under Rule 43*bis*.1(a)(i) with regard to novelty, inventive step and industrial applicability; citations and explanations supporting such statement**

1. Statement

Novelty (N)	Claims	1-20	YES
	Claims	None	NO
Inventive step (IS)	Claims	1-20	YES
	Claims	None	NO
Industrial applicability (IA)	Claims	1-20	YES
	Claims	None	NO

2. Citations and explanations:

Claims 1-20 meet the criteria set out in PCT Article 33(2)-(3), because the prior art does not teach or fairly suggest:

Regarding claims 1, 17, the prior art of record does not teach or fairly suggest, "a power generation module adapted to: receive a fuel gas stream comprising a fuel gas associated with a heat value of at least about 1,000 Btu/scf; and consume the fuel gas stream to generate a high-voltage electrical output associated with a first voltage; and a distributed computing system powered by the electrical power generation system, the distributed computing system comprising: a communications system comprising one or more data satellite antennas, the communications system adapted to provide a network; and a first mobile data center comprising: an enclosure defining an interior space; a plurality of distributed computing units located within the interior space of the enclosure, each of the plurality of distributed computing units in communication with the network; and a power system located at least partially within the interior space of the enclosure, the power system in electrical communication with the electrical transformation module and the plurality of distributed computing units such that the power system receives the low-voltage electrical output and powers each of the plurality of distributed computing units" for claim 1; "a first power generation module adapted to: receive a first fuel gas stream comprising a fuel gas associated with a heat value of at least about 1,000 Btu/scf; and consume the fuel gas stream to generate a first high-voltage electrical output associated with a first voltage; a second power generation module adapted to: receive a second fuel gas stream comprising the fuel gas; and consume the second fuel gas stream to generate a second high-voltage electrical output associated with the first voltage; a parallel panel in electrical communication with the first power generation module and the second power generation module, the parallel panel adapted to: receive the first and second high-voltage electrical outputs; and combine and synchronize the first and second high-voltage electrical outputs into a combined high-voltage electrical output; and an electrical transformation module in electrical communication with the parallel panel, and a distributed computing system powered by the electrical power generation system, the distributed computing system comprising: a communications system comprising one or more data satellite antennas, the communications system adapted to provide a network; and a first mobile data center comprising: an enclosure defining an interior space; a plurality of distributed computing units located within the interior space of the enclosure, each of the plurality of distributed computing units in communication with the network; and a power system located at least partially within the interior space of the enclosure, the power system in electrical communication with the electrical transformation module and the plurality of distributed computing units such that the power system receives the low-voltage electrical output and powers each of the plurality of distributed computing units" for claim 17, in combination with the remaining aspects of claims 1, 17, respectively.

Claims 2-16 and 18-20 meet the criteria due to their dependency on novel claims 1 and 17, respectively.

The prior art, as shown below, details some of the aspect of the invention, however, none of the prior art teaches all the missing limitation either alone or in combination as specified.

US Well Services LLC (US 2017/0218843 A1) teaches a power generation system (a power generation system 502, para. 0069) comprising a power generation module adapted to receive a fuel gas stream (the power generation system 502 contains three natural gas powered turbine sets 510-a, 510-b, 510-c that may have one or more turbines apiece. The turbine sets 510-a, 510-b, 510-c may be supplied with natural gas onsite, para. 0069); an electrical transformation module in electrical communication with the power generation module, the electrical transformation module adapted to: receive the high-voltage electrical output generated by the power generation module; and transform the high-voltage electrical output into a low-voltage electrical output associated with a second voltage that is lower than the first voltage (the system can further include a transformer having a high voltage input in electrical communication with aan electrical output of the turbine generator, and a low voltage output, and a step down transformer having an input that is in electrical communication with the low voltage output of the transformer, para. 0012). However, US Well Services does not teach or fairly suggest, "a power generation module adapted to: receive a fuel gas stream comprising a fuel gas associated with a heat value of at least about 1,000 Btu/scf; and consume the fuel gas stream to generate a high-voltage electrical output associated with a first voltage; and a distributed computing system powered by the electrical power generation system, the distributed computing system comprising: a communications system comprising one or more data satellite antennas, the communications system adapted to provide a network; and a first mobile data center comprising: an enclosure defining an interior space; a plurality of distributed computing units located within the interior space of the enclosure, each of the plurality of distributed computing units in communication with the network; and a power system located at least partially within the interior space of the enclosure, the power system in electrical communication with the electrical transformation module and the plurality of distributed computing units such that the power system receives the low-voltage electrical output and powers each of the plurality of distributed computing units" for claim 1; "a first power generation module adapted to: receive a first fuel gas stream comprising a fuel gas associated with a heat value of at least about 1,000 Btu/scf; and consume the fuel gas stream to generate a first high-voltage electrical output associated with a first voltage; a second power generation module adapted to: receive a second fuel gas stream comprising the fuel gas; and consume the second fuel gas stream to generate a second high-voltage electrical output associated

WRITTEN OPINION OF THE INTERNATIONAL SEARCHING AUTHORITY

International application No.
PCT/US2019/044646

Box No. VIII Certain observations on the international application

The following observations on the clarity of the claims, description, and drawings or on the question whether the claims are fully supported by the description, are made:

Claim 18 is objected to under PCT Rule 66.2(a)(iii) as containing the following defect in the form or contents thereof: claim 18 is recited to be depedent from claim 19. For the purpose of the international opinion, claim 18 is interpreted as being dependent from claim 17.

WRITTEN OPINION OF THE INTERNATIONAL SEARCHING AUTHORITY

International application No.
PCT/US2019/044646

Supplemental Box

In case **the space in any of the preceding boxes is not sufficient.**
Continuation of:

with the first voltage; a parallel panel in electrical communication with the first power generation module and the second power generation module, the parallel panel adapted to: receive the first and second high-voltage electrical outputs; and combine and synchronize the first and second high-voltage electrical outputs into a combined high-voltage electrical output; and an electrical transformation module in electrical communication with the parallel panel, and a distributed computing system powered by the electrical power generation system, the distributed computing system comprising: a communications system comprising one or more data satellite antennas, the communications system adapted to provide a network; and a first mobile data center comprising: an enclosure defining an interior space; a plurality of distributed computing units located within the interior space of the enclosure, each of the plurality of distributed computing units in communication with the network; and a power system located at least partially within the interior space of the enclosure, the power system in electrical communication with the electrical transformation module and the plurality of distributed computing units such that the power system receives the low-voltage electrical output and powers each of the plurality of distributed computing units" for claim 17.

Google Inc. (US 9,673,632 B1) teaches a power system (fluid based power systems, col. 1, line 14) comprising a power generation module adapted to: receive a fuel gas stream (The techniques discussed here involve distributing power through a data center via a common power plane that carries a fluid, such as natural gas, col. 1, lines 58-60), generate electric power and distribute the power through the computer data center (The fluid is delivered to a large number of electrical power generation units that are distributed through the data center. These electrical power generation units may then convert the fluid into electrical power and deliver that electrical power-generally at low voltage--to the computer servers and other electrical loads in the data center, col. 1, lines 60-66). However, Ramesh et al. does not teach or fairly suggest, "a power generation module adapted to: receive a fuel gas stream comprising a fuel gas associated with a heat value of at least about 1,000 Btu/scf; and consume the fuel gas stream to generate a high-voltage electrical output associated with a first voltage; and a distributed computing system powered by the electrical power generation system, the distributed computing system comprising: a communications system comprising one or more data satellite antennas, the communications system adapted to provide a network; and a first mobile data center comprising: an enclosure defining an interior space; a plurality of distributed computing units located within the interior space of the enclosure, each of the plurality of distributed computing units in communication with the network; and a power system located at least partially within the interior space of the enclosure, the power system in electrical communication with the electrical transformation module and the plurality of distributed computing units such that the power system receives the low-voltage electrical output and powers each of the plurality of distributed computing units" for claim 1; "a first power generation module adapted to: receive a first fuel gas stream comprising a fuel gas associated with a heat value of at least about 1,000 Btu/scf; and consume the fuel gas stream to generate a first high-voltage electrical output associated with a first voltage; a second power generation module adapted to: receive a second fuel gas stream comprising the fuel gas; and consume the second fuel gas stream to generate a second high-voltage electrical output associated with the first voltage; a parallel panel in electrical communication with the first power generation module and the second power generation module, the parallel panel adapted to: receive the first and second high-voltage electrical outputs; and combine and synchronize the first and second high-voltage electrical outputs into a combined high-voltage electrical output; and an electrical transformation module in electrical communication with the parallel panel, and a distributed computing system powered by the electrical power generation system, the distributed computing system comprising: a communications system comprising one or more data satellite antennas, the communications system adapted to provide a network; and a first mobile data center comprising: an enclosure defining an interior space; a plurality of distributed computing units located within the interior space of the enclosure, each of the plurality of distributed computing units in communication with the network; and a power system located at least partially within the interior space of the enclosure, the power system in electrical communication with the electrical transformation module and the plurality of distributed computing units such that the power system receives the low-voltage electrical output and powers each of the plurality of distributed computing units" for claim 17.

Claims 1-20 meet the criteria set out in PCT Article 33(4), and thus have industrial applicability because the subject matter claimed can be made or used in industry.

Electronic Acknowledgement Receipt

EFS ID:	37755074
Application Number:	16529152
International Application Number:	
Confirmation Number:	9940
Title of Invention:	Systems and Methods for Generating and Consuming Power from Natural Gas
First Named Inventor/Applicant Name:	Charles Cavness
Customer Number:	114903
Filer:	Kyle Montgomery Zeller
Filer Authorized By:	
Attorney Docket Number:	CRUSOE-105002US1
Receipt Date:	14-NOV-2019
Filing Date:	01-AUG-2019
Time Stamp:	16:05:05
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	no

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Information Disclosure Statement (IDS) Form (SB08)	20191114_CRUSOE105002US1.pdf	1054533 a2fd457a4d24b7eb6f93b63cf6b0477271147120	no	5

Warnings:

Information:					
2	Transmittal Letter	Transmittal.pdf	90307 2e591d8479fe20715c154355c07837dd77078692	no	4
Warnings:					
Information:					
3	Foreign Reference	WO2013022501A1.pdf	409418 01a7cab8cc34eae864e11cbba42790e59a37177c	no	27
Warnings:					
Information:					
4	Non Patent Literature	BitcoinstoBTUsCryptocurrencylmpactsonNaturalGasBTUAnalytics.pdf	458328 4602ea680794568208 66cfc53cb9b94da9097d92	no	10
Warnings:					
Information:					
5	Non Patent Literature	CryptocurrencyStrategiesforPowerandEnergyCcompanies.pdf	12903979 0264acc0fcbf632e1a3808bb111a6eb1798a2f36	no	9
Warnings:					
Information:					
6	Non Patent Literature	GeneratorRatingsExplainedbyLarrieYork.pdf	578941 c6413ed3f4d7df8bc925060159ccd8985aa9b24f	no	4
Warnings:					
Information:					
7	Non Patent Literature	PipeDreamAnalystsMullNaturalGasPoweredBitcoinMiningOperation.pdf	289898 7844afea315f6e1c7637aa7966925c6bef57b688	no	7
Warnings:					
Information:					
8	Non Patent Literature	TexasOilProducersCouldChannelExcessGasintoBitcoinMiningOperations.pdf	328104 466a39b599a76343c35d8db9ab581172495f76ec	no	4
Warnings:					
Information:					

9	Non Patent Literature	WhyWasteAllThatCheapPermianGas.pdf	2895406 9738d41b19df2075b790fb5369ceb2ea0a01f4ee	no	9
Warnings:					
Information:					
10	Other Reference-Patent/App/Search documents	ISRWO_final.pdf	1277858 e23d0c9bd53760c4df71a14fb24bb7cdd84c2600	no	8
Warnings:					
Information:					
			Total Files Size (in bytes):	20286772	

This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.

New Applications Under 35 U.S.C. 111

If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

National Stage of an International Application under 35 U.S.C. 371

If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office

If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

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APPLICATION NUMBER	FILING or 371(c) DATE	GRP ART UNIT	FIL FEE REC'D	ATTY.DOCKET.NO	TOT CLAIMS	IND CLAIMS
16/529,152	08/01/2019	1733	785	CRUSOE-105002US1	20	2

CONFIRMATION NO. 9940

FILING RECEIPT

OC000000110372660

114903
Zeller IP Group PLLC
155 Water St.
Suite 6/6
Brooklyn, NY 11201

Date Mailed: 08/15/2019

Receipt is acknowledged of this non-provisional utility patent application. The application will be taken up for examination in due course. Applicant will be notified as to the results of the examination. Any correspondence concerning the application must include the following identification information: the U.S. APPLICATION NUMBER, FILING DATE, NAME OF FIRST INVENTOR, and TITLE OF INVENTION. Fees transmitted by check or draft are subject to collection.

Please verify the accuracy of the data presented on this receipt. If an error is noted on this Filing Receipt, please submit a written request for a corrected Filing Receipt, including a properly marked-up ADS showing the changes with strike-through for deletions and underlining for additions. If you received a "Notice to File Missing Parts" or other Notice requiring a response for this application, please submit any request for correction to this Filing Receipt with your reply to the Notice. When the USPTO processes the reply to the Notice, the USPTO will generate another Filing Receipt incorporating the requested corrections provided that the request is grantable.

Inventor(s)

Charles Cavness, Denver, CO;
Chase Lochmiller, Castle Rock, CO;
Kenneth Parker, Denver, CO;

Applicant(s)

Crusoe Energy Systems Inc., Denver, CO;

Assignment For Published Patent Application

Crusoe Energy Systems Inc., Denver, CO

Power of Attorney: The patent practitioners associated with Customer Number 114903

Domestic Priority data as claimed by applicant

This appln claims benefit of 62/713,368 08/01/2018

Foreign Applications for which priority is claimed (You may be eligible to benefit from the **Patent Prosecution Highway** program at the USPTO. Please see http://www.uspto.gov for more information.) - None.
Foreign application information must be provided in an Application Data Sheet in order to constitute a claim to foreign priority. See 37 CFR 1.55 and 1.76.

Permission to Access Application via Priority Document Exchange: Yes

Permission to Access Search Results: Yes

Applicant may provide or rescind an authorization for access using Form PTO/SB/39 or Form PTO/SB/69 as appropriate.

If Required, Foreign Filing License Granted: 08/13/2019

The country code and number of your priority application, to be used for filing abroad under the Paris Convention, is **US 16/529,152**

Projected Publication Date: 02/06/2020

Non-Publication Request: No

Early Publication Request: No

** **SMALL ENTITY** **

Title

Systems and Methods for Generating and Consuming Power from Natural Gas

Preliminary Class

075

Statement under 37 CFR 1.55 or 1.78 for AIA (First Inventor to File) Transition Applications: No

PROTECTING YOUR INVENTION OUTSIDE THE UNITED STATES

Since the rights granted by a U.S. patent extend only throughout the territory of the United States and have no effect in a foreign country, an inventor who wishes patent protection in another country must apply for a patent in a specific country or in regional patent offices. Applicants may wish to consider the filing of an international application under the Patent Cooperation Treaty (PCT). An international (PCT) application generally has the same effect as a regular national patent application in each PCT-member country. The PCT process **simplifies** the filing of patent applications on the same invention in member countries, but **does not result** in a grant of "an international patent" and does not eliminate the need of applicants to file additional documents and fees in countries where patent protection is desired.

Almost every country has its own patent law, and a person desiring a patent in a particular country must make an application for patent in that country in accordance with its particular laws. Since the laws of many countries differ in various respects from the patent law of the United States, applicants are advised to seek guidance from specific foreign countries to ensure that patent rights are not lost prematurely.

Applicants also are advised that in the case of inventions made in the United States, the Director of the USPTO must issue a license before applicants can apply for a patent in a foreign country. The filing of a U.S. patent application serves as a request for a foreign filing license. The application's filing receipt contains further information and guidance as to the status of applicant's license for foreign filing.

Applicants may wish to consult the USPTO booklet, "General Information Concerning Patents" (specifically, the section entitled "Treaties and Foreign Patents") for more information on timeframes and deadlines for filing foreign patent applications. The guide is available either by contacting the USPTO Contact Center at 800-786-9199, or it can be viewed on the USPTO website at http://www.uspto.gov/web/offices/pac/doc/general/index.html.

For information on preventing theft of your intellectual property (patents, trademarks and copyrights), you may wish to consult the U.S. Government website, http://www.stopfakes.gov. Part of a Department of Commerce initiative, this website includes self-help "toolkits" giving innovators guidance on how to protect intellectual property in specific

countries such as China, Korea and Mexico. For questions regarding patent enforcement issues, applicants may call the U.S. Government hotline at 1-866-999-HALT (1-866-999-4258).

LICENSE FOR FOREIGN FILING UNDER

Title 35, United States Code, Section 184

Title 37, Code of Federal Regulations, 5.11 & 5.15

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This license is to be retained by the licensee and may be used at any time on or after the effective date thereof unless it is revoked. This license is automatically transferred to any related applications(s) filed under 37 CFR 1.53(d). This license is not retroactive.

The grant of a license does not in any way lessen the responsibility of a licensee for the security of the subject matter as imposed by any Government contract or the provisions of existing laws relating to espionage and the national security or the export of technical data. Licensees should apprise themselves of current regulations especially with respect to certain countries, of other agencies, particularly the Office of Defense Trade Controls, Department of State (with respect to Arms, Munitions and Implements of War (22 CFR 121-128)); the Bureau of Industry and Security, Department of Commerce (15 CFR parts 730-774); the Office of Foreign AssetsControl, Department of Treasury (31 CFR Parts 500+) and the Department of Energy.

NOT GRANTED

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PATENT APPLICATION FEE DETERMINATION RECORD

Substitute for Form PTO-875

Application or Docket Number: 16/529,152

APPLICATION AS FILED - PART I

FOR	(Column 1) NUMBER FILED	(Column 2) NUMBER EXTRA	SMALL ENTITY RATE($)	SMALL ENTITY FEE($)	OR	OTHER THAN SMALL ENTITY RATE($)	OTHER THAN SMALL ENTITY FEE($)
BASIC FEE (37 CFR 1.16(a), (b), or (c))	N/A	N/A	N/A	75		N/A	
SEARCH FEE (37 CFR 1.16(k), (i), or (m))	N/A	N/A	N/A	330		N/A	
EXAMINATION FEE (37 CFR 1.16(o), (p), or (q))	N/A	N/A	N/A	380		N/A	
TOTAL CLAIMS (37 CFR 1.16(i))	20 minus 20 =	*	x 50 =	0.00	OR		
INDEPENDENT CLAIMS (37 CFR 1.16(h))	2 minus 3 =	*	x 230 =	0.00			
APPLICATION SIZE FEE (37 CFR 1.16(s))	If the specification and drawings exceed 100 sheets of paper, the application size fee due is $310 ($155 for small entity) for each additional 50 sheets or fraction thereof. See 35 U.S.C. 41(a)(1)(G) and 37 CFR 1.16(s).			0.00			
MULTIPLE DEPENDENT CLAIM PRESENT (37 CFR 1.16(j))				0.00			
* If the difference in column 1 is less than zero, enter "0" in column 2.			TOTAL	785		TOTAL	

APPLICATION AS AMENDED - PART II

AMENDMENT A

	(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA	SMALL ENTITY RATE($)	SMALL ENTITY ADDITIONAL FEE($)	OR	OTHER THAN SMALL ENTITY RATE($)	OTHER THAN SMALL ENTITY ADDITIONAL FEE($)
Total (37 CFR 1.16(i))	*	Minus	**	=	x =		OR	x =	
Independent (37 CFR 1.16(h))	*	Minus	***	=	x =		OR	x =	
Application Size Fee (37 CFR 1.16(s))									
FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))							OR		
					TOTAL ADD'L FEE		OR	TOTAL ADD'L FEE	

AMENDMENT B

	(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA	RATE($)	ADDITIONAL FEE($)	OR	RATE($)	ADDITIONAL FEE($)
Total (37 CFR 1.16(i))	*	Minus	**	=	x =		OR	x =	
Independent (37 CFR 1.16(h))	*	Minus	***	=	x =		OR	x =	
Application Size Fee (37 CFR 1.16(s))									
FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))							OR		
					TOTAL ADD'L FEE		OR	TOTAL ADD'L FEE	

* If the entry in column 1 is less than the entry in column 2, write "0" in column 3.
** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 20, enter "20".
*** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 3, enter "3".
The "Highest Number Previously Paid For" (Total or Independent) is the highest found in the appropriate box in column 1.

PTO/AIA/15 (10-17)
Approved for use through 11/30/2020. OMB 0651-0032
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
Under the Paperwork Reduction Act of 1995 no persons are required to respond to a collection of information unless it displays a valid OMB control number.

UTILITY PATENT APPLICATION TRANSMITTAL

(Only for new nonprovisional applications under 37 CFR 1.53(b))

Attorney Docket No.	CRUSOE-105002US1
First Named Inventor	Charles Cavness
Title	Systems and Methods for Generating and Consuming Power from Natural Gas
Priority Mail Express® Label No.	

APPLICATION ELEMENTS

See MPEP chapter 600 concerning utility patent application contents.

1. [✔] **Fee Transmittal Form** (PTO/SB/17 or equivalent)
2. [✔] **Applicant asserts small entity status.** See 37 CFR 1.27
3. [ ] **Applicant certifies micro entity status.** See 37 CFR 1.29. Applicant must attach form PTO/SB/15A or B or equivalent.
4. [✔] **Specification** [*Total Pages* 48] Both the claims and abstract must start on a new page. *(See MPEP § 608.01(a) for information on the preferred arrangement)*
5. [✔] **Drawing(s)** (35 U.S.C. 113) [*Total Sheets* 6]
6. **Inventor's Oath or Declaration** [*Total Pages* 3] *(including substitute statements under 37 CFR 1.64 and assignments serving as an oath or declaration under 37 CFR 1.63(e))*
   a. [✔] Newly executed (original or copy)
   b. [ ] A copy from a prior application (37 CFR 1.63(d))
7. [✔] **Application Data Sheet** ** See note below.* See 37 CFR 1.76 (PTO/AIA/14 or equivalent)
8. **CD-ROM or CD-R** in duplicate, large table, or Computer Program (*Appendix*)
   [ ] Landscape Table on CD
9. **Nucleotide and/or Amino Acid Sequence Submission** (*if applicable, items a. – c. are required*)
   a. [ ] Computer Readable Form (CRF)
   b. [ ] Specification Sequence Listing on:
      i. [ ] CD-ROM or CD-R (2 copies); or
      ii. [ ] Paper
   c. [ ] Statements verifying identity of above copies

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ACCOMPANYING APPLICATION PAPERS

10. [✔] **Assignment Papers** (cover sheet & document(s)) Name of Assignee Crusoe Energy Systems Inc.
11. [✔] **37 CFR 3.73(c) Statement** (*when there is an assignee*) [✔] **Power of Attorney**
12. [ ] **English Translation Document** (*if applicable*)
13. [ ] **Information Disclosure Statement** (PTO/SB/08 or PTO-1449)
    [ ] Copies of citations attached
14. [ ] **Preliminary Amendment**
15. [ ] **Return Receipt Postcard** (*MPEP § 503*) (*Should be specifically itemized*)
16. [ ] **Certified Copy of Priority Document(s)** (*if foreign priority is claimed*)
17. [ ] **Nonpublication Request** Under 35 U.S.C. 122(b)(2)(B)(i). Applicant must attach form PTO/SB/35 or equivalent.
18. [ ] **Other:**

*Note: (1) Benefit claims under 37 CFR 1.78 and foreign priority claims under 1.55 **must** be included in an Application Data Sheet (ADS).
(2) For applications filed under 35 U.S.C. 111, the application must contain an ADS specifying the applicant if the applicant is an assignee, person to whom the inventor is under an obligation to assign, or person who otherwise shows sufficient proprietary interest in the matter. See 37 CFR 1.46(b).

19. CORRESPONDENCE ADDRESS

[✔] The address associated with Customer Number: 114903 **OR** [ ] Correspondence address below

Name					
Address					
City		State		Zip Code	
Country		Telephone		Email	

Signature	/Kyle Zeller/	Date	2019-08-01
Name (Print/Type)	Kyle Zeller	Registration No. (Attorney/Agent)	64748

This collection of information is required by 37 CFR 1.53(b). The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.11 and 1.14. This collection is estimated to take 12 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

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Privacy Act Statement

The **Privacy Act of 1974 (P.L. 93-579)** requires that you be given certain information in connection with your submission of the attached form related to a patent application or patent. Accordingly, pursuant to the requirements of the Act, please be advised that: (1) the general authority for the collection of this information is 35 U.S.C. 2(b)(2); (2) furnishing of the information solicited is voluntary; and (3) the principal purpose for which the information is used by the U.S. Patent and Trademark Office is to process and/or examine your submission related to a patent application or patent. If you do not furnish the requested information, the U.S. Patent and Trademark Office may not be able to process and/or examine your submission, which may result in termination of proceedings or abandonment of the application or expiration of the patent.

The information provided by you in this form will be subject to the following routine uses:

1. The information on this form will be treated confidentially to the extent allowed under the Freedom of Information Act (5 U.S.C. 552) and the Privacy Act (5 U.S.C 552a). Records from this system of records may be disclosed to the Department of Justice to determine whether disclosure of these records is required by the Freedom of Information Act.
2. A record from this system of records may be disclosed, as a routine use, in the course of presenting evidence to a court, magistrate, or administrative tribunal, including disclosures to opposing counsel in the course of settlement negotiations.
3. A record in this system of records may be disclosed, as a routine use, to a Member of Congress submitting a request involving an individual, to whom the record pertains, when the individual has requested assistance from the Member with respect to the subject matter of the record.
4. A record in this system of records may be disclosed, as a routine use, to a contractor of the Agency having need for the information in order to perform a contract. Recipients of information shall be required to comply with the requirements of the Privacy Act of 1974, as amended, pursuant to 5 U.S.C. 552a(m).
5. A record related to an International Application filed under the Patent Cooperation Treaty in this system of records may be disclosed, as a routine use, to the International Bureau of the World Intellectual Property Organization, pursuant to the Patent Cooperation Treaty.
6. A record in this system of records may be disclosed, as a routine use, to another federal agency for purposes of National Security review (35 U.S.C. 181) and for review pursuant to the Atomic Energy Act (42 U.S.C. 218(c)).
7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (*i.e.*, GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.
8. A record from this system of records may be disclosed, as a routine use, to the public after either publication of the application pursuant to 35 U.S.C. 122(b) or issuance of a patent pursuant to 35 U.S.C. 151. Further, a record may be disclosed, subject to the limitations of 37 CFR 1.14, as a routine use, to the public if the record was filed in an application which became abandoned or in which the proceedings were terminated and which application is referenced by either a published application, an application open to public inspection or an issued patent.
9. A record from this system of records may be disclosed, as a routine use, to a Federal, State, or local law enforcement agency, if the USPTO becomes aware of a violation or potential violation of law or regulation.

Doc Code: PA..
Document Description: Power of Attorney

PTO/AIA/82A (07-13)
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TRANSMITTAL FOR POWER OF ATTORNEY TO ONE OR MORE REGISTERED PRACTITIONERS

NOTE: This form is to be submitted with the Power of Attorney by Applicant form (PTO/AIA/82B) to identify the application to which the Power of Attorney is directed, in accordance with 37 CFR 1.5, unless the application number and filing date are identified in the Power of Attorney by Applicant form. If neither form PTO/AIA/82A nor form PTO/AIA82B identifies the application to which the Power of Attorney is directed, the Power of Attorney will not be recognized in the application.

Application Number	
Filing Date	2019-08-01
First Named Inventor	Charles Cavness
Title	Systems and Methods for Generating and Consuming Power from Natural Gas
Art Unit	
Examiner Name	
Attorney Docket Number	CRUSOE-105002US1

SIGNATURE of Applicant or Patent Practitioner

Signature	/Kyle Zeller/	Date (Optional)	
Name	Kyle Zeller	Registration Number	64748
Title (if Applicant is a juristic entity)			
Applicant Name (if Applicant is a juristic entity)			

NOTE: This form must be signed in accordance with 37 CFR 1.33. See 37 CFR 1.4(d) for signature requirements and certifications. If more than one applicant, use multiple forms.

☐ *Total of _____ forms are submitted.

This collection of information is required by 37 CFR 1.131, 1.32, and 1.33. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.11 and 1.14. This collection is estimated to take 3 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

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Doc Code: PA..
Document Description: Power of Attorney

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POWER OF ATTORNEY BY APPLICANT

I hereby revoke all previous powers of attorney given in the application identified in either the attached transmittal letter or the boxes below.

Application Number	Filing Date

(Note: The boxes above may be left blank if information is provided on form PTO/AIA/82A.)

☑ I hereby appoint the Patent Practitioner(s) associated with the following Customer Number as my/our attorney(s) or agent(s), and to transact all business in the United States Patent and Trademark Office connected therewith for the application referenced in the attached transmittal letter (form PTO/AIA/82A) or identified above: 114903

OR

☐ I hereby appoint Practitioner(s) named in the attached list (form PTO/AIA/82C) as my/our attorney(s) or agent(s), and to transact all business in the United States Patent and Trademark Office connected therewith for the patent application referenced in the attached transmittal letter (form PTO/AIA/82A) or identified above. (Note: Complete form PTO/AIA/82C.)

Please recognize or change the correspondence address for the application identified in the attached transmittal letter or the boxes above to:

☑ The address associated with the above-mentioned Customer Number

OR

☐ The address associated with Customer Number:

OR

☐ Firm or Individual Name					
Address					
City		State		Zip	
Country					
Telephone		Email			

I am the Applicant (if the Applicant is a juristic entity, list the Applicant name in the box):

Crusoe Energy Systems Inc.

☐ Inventor or Joint Inventor (title not required below)
☐ Legal Representative of a Deceased or Legally Incapacitated Inventor (title not required below)
☑ Assignee or Person to Whom the Inventor is Under an Obligation to Assign (provide signer's title if applicant is a juristic entity)
☐ Person Who Otherwise Shows Sufficient Proprietary Interest (e.g., a petition under 37 CFR 1.46(b)(2) was granted in the application or is concurrently being filed with this document) (provide signer's title if applicant is a juristic entity)

SIGNATURE of Applicant for Patent

The undersigned (whose title is supplied below) is authorized to act on behalf of the applicant (e.g., where the applicant is a juristic entity).

Signature	/ Charles Cavness /	Date (Optional)	
Name	Charles Cavness		
Title	President, Crusoe Energy Systems Inc.		

NOTE: Signature - This form must be signed by the applicant in accordance with 37 CFR 1.33. See 37 CFR 1.4 for signature requirements and certifications. If more than one applicant, use multiple forms.

☐ Total of forms are submitted.

This collection of information is required by 37 CFR 1.131, 1.32, and 1.33. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.11 and 1.14. This collection is estimated to take 3 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

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STATEMENT UNDER 37 CFR 3.73(c)

Applicant/Patent Owner: Crusoe Energy Systems Inc.

Application No./Patent No.: _____ Filed/Issue Date: 2019-08-01

Titled: Systems and Methods for Generating and Consuming Power from Natural Gas

Crusoe Energy Systems Inc., a corporation

(Name of Assignee) (Type of Assignee, e.g., corporation, partnership, university, government agency, etc.)

states that, for the patent application/patent identified above, it is (choose **one** of options 1, 2, 3 or 4 below):

1. ☑ The assignee of the entire right, title, and interest.

2. ☐ An assignee of less than the entire right, title, and interest (check applicable box):

   ☐ The extent (by percentage) of its ownership interest is _____%. Additional Statement(s) by the owners holding the balance of the interest must be submitted to account for 100% of the ownership interest.

   ☐ There are unspecified percentages of ownership. The other parties, including inventors, who together own the entire right, title and interest are:

   Additional Statement(s) by the owner(s) holding the balance of the interest must be submitted to account for the entire right, title, and interest.

3. ☐ The assignee of an undivided interest in the entirety (a complete assignment from one of the joint inventors was made). The other parties, including inventors, who together own the entire right, title, and interest are:

   Additional Statement(s) by the owner(s) holding the balance of the interest must be submitted to account for the entire right, title, and interest.

4. ☐ The recipient, via a court proceeding or the like (*e.g.*, bankruptcy, probate), of an undivided interest in the entirety (a complete transfer of ownership interest was made). The certified document(s) showing the transfer is attached.

The interest identified in option 1, 2 or 3 above (not option 4) is evidenced by either (choose **one** of options A or B below):

A. ☑ An assignment from the inventor(s) of the patent application/patent identified above. The assignment was recorded in the United States Patent and Trademark Office at Reel _____, Frame _____, or for which a copy thereof is attached.

B. ☐ A chain of title from the inventor(s), of the patent application/patent identified above, to the current assignee as follows:

1. From: _____ To: _____

   The document was recorded in the United States Patent and Trademark Office at

   Reel _____, Frame _____, or for which a copy thereof is attached.

2. From: _____ To: _____

   The document was recorded in the United States Patent and Trademark Office at

   Reel _____, Frame _____, or for which a copy thereof is attached.

This collection of information is required by 37 CFR 3.73(b). The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.11 and 1.14. This collection is estimated to take 12 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

If you need assistance in completing the form, call 1-800-PTO-9199 and select option 2.

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Approved for use through 01/31/2013. OMB 0651-0031
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STATEMENT UNDER 37 CFR 3.73(c)

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The document was recorded in the United States Patent and Trademark Office at

Reel _____, Frame _____, or for which a copy thereof is attached.

4. From: _____ To: _____

The document was recorded in the United States Patent and Trademark Office at

Reel _____, Frame _____, or for which a copy thereof is attached.

5. From: _____ To: _____

The document was recorded in the United States Patent and Trademark Office at

Reel _____, Frame _____, or for which a copy thereof is attached.

6. From: _____ To: _____

The document was recorded in the United States Patent and Trademark Office at

Reel _____, Frame _____, or for which a copy thereof is attached.

☐ Additional documents in the chain of title are listed on a supplemental sheet(s).

☑ As required by 37 CFR 3.73(c)(1)(i), the documentary evidence of the chain of title from the original owner to the assignee was, or concurrently is being, submitted for recordation pursuant to 37 CFR 3.11.

[NOTE: A separate copy (i.e., a true copy of the original assignment document(s)) must be submitted to Assignment Division in accordance with 37 CFR Part 3, to record the assignment in the records of the USPTO. See MPEP 302.08]

The undersigned (whose title is supplied below) is authorized to act on behalf of the assignee.

/Kyle Zeller/	2019-08-01
Signature	Date
Kyle Zeller	64748
Printed or Typed Name	Title or Registration Number

ASSIGNMENT

WHEREAS, **Charles Cavness**, a citizen of the United States of America, residing at 164 S. Humboldt St., Denver, CO 80209, **Chase Lochmiller**, a citizen of the United States of America, residing at 609 Cliffgate Ln., Castle Rock, CO 80108, and **Kenneth Parker**, a citizen of the United States of America, residing at 100 S. Clermont St., Denver, CO 80246 (referred to as "**ASSIGNORS**"), have invented certain new and useful inventions and discoveries described in the application for patent titled, "Systems and Methods for Generating and Consuming Power from Natural Gas," for which a patent application is being submitted to the United States Patent and Trademark Office (USPTO) herewith; and

WHEREAS, **Crusoe Energy Systems Inc.**, a corporation doing business at 1660 17th St., Suite 350, Denver, CO 80202 (hereinafter referred to as the "**ASSIGNEE**"), is desirous of acquiring the entire right, title and interest in and to said inventions and discoveries, and in and to said application and any Letters Patent that may issue thereon;

NOW, THEREFORE, for good and valuable consideration, the receipt of which is hereby acknowledged, **ASSIGNORS** hereby sell, assign and transfer to said **ASSIGNEE**, and to **ASSIGNEE's** successors and assigns, **ASSIGNORS'** entire right, title and interest in and to said inventions and discoveries in the United States and its territorial possessions and in all foreign countries and to all Letters Patent or similar legal protection in the United States and its territorial possessions and in any and all foreign countries to be obtained for said inventions and discoveries by said application or any patent application claiming priority to the application, or any continuation, division, continuation-in-part, reexamination, renewal, substitute, extension or reissue thereof or any legal equivalent thereof in a foreign country for the full term of terms for which the same may be granted; and authorize and request the Commissioner of Patents of the United States and any official of any foreign country whose duty it is to issue patents or legal equivalents thereto, to issue same for this inventions and discoveries to **ASSIGNEE**, its lawful successors and assigns.

ASSIGNORS further covenant that **ASSIGNEE** will, upon its request, be provided promptly with all pertinent facts and documents relating to said application, said inventions and discoveries and said Letters Patent and legal equivalents in foreign countries as may be known and accessible to **ASSIGNORS** and will testify as to the same in any interference or litigation related thereto and will promptly execute and deliver to **ASSIGNEE** or its legal representative any and all papers, instruments or affidavits required to apply for, obtain, maintain, issue and enforce said application, said inventions and discoveries and said Letters Patent and said equivalents thereof in any foreign country which may be necessary or desirable to carry out the purposes thereof.

IN WITNESS WHEREOF, we have hereunto set hand and signed on the date indicated below:

ASSIGNORS

Charles Cavness

Charles Cavness

07 / 31 / 2019

Date

Chase Lochmiller

07 / 31 / 2019

Date

Kenneth Parker

Kenneth Parker

07 / 31 / 2019

Date

Doc ID: a30187f8444243ca63f2191cea534bff302b7f05

HELLOSIGN

Audit Trail

TITLE	Assignment - Crusoe Energy Systems Inc.
FILE NAME	Assignment - Crusoe Energy Systems LLC
DOCUMENT ID	a30187f8444243ca63f2191cea534bff302b7f05
STATUS	Completed

This document was requested from script.google.com

Document History

SENT	**07/31/2019** 14:42:43 UTC-5	Sent for signature to Charles Cavness (cully@crusoeenergy.com), Chase Lochmiller (chase@crusoeenergy.com) and Kenneth Parker (ken@crusoeenergy.com) from kyle@zellerip.com IP: 64.78.254.131
VIEWED	**07/31/2019** 14:45:34 UTC-5	Viewed by Kenneth Parker (ken@crusoeenergy.com) IP: 107.77.208.40
SIGNED	**07/31/2019** 14:46:43 UTC-5	Signed by Kenneth Parker (ken@crusoeenergy.com) IP: 107.77.208.40
VIEWED	**07/31/2019** 15:15:14 UTC-5	Viewed by Charles Cavness (cully@crusoeenergy.com) IP: 174.209.23.145
SIGNED	**07/31/2019** 15:15:39 UTC-5	Signed by Charles Cavness (cully@crusoeenergy.com) IP: 174.209.23.145

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Audit Trail

TITLE	Assignment - Crusoe Energy Systems Inc.
FILE NAME	Assignment - Crusoe Energy Systems LLC
DOCUMENT ID	a30187f8444243ca63f2191cea534bff302b7f05
STATUS	Completed

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Document History

VIEWED	**07/31/2019** 15:50:25 UTC-5	Viewed by Chase Lochmiller (chase@crusoeenergy.com) IP: 174.202.14.112
SIGNED	**07/31/2019** 15:50:45 UTC-5	Signed by Chase Lochmiller (chase@crusoeenergy.com) IP: 174.202.14.112
COMPLETED	**07/31/2019** 15:50:45 UTC-5	The document has been completed.

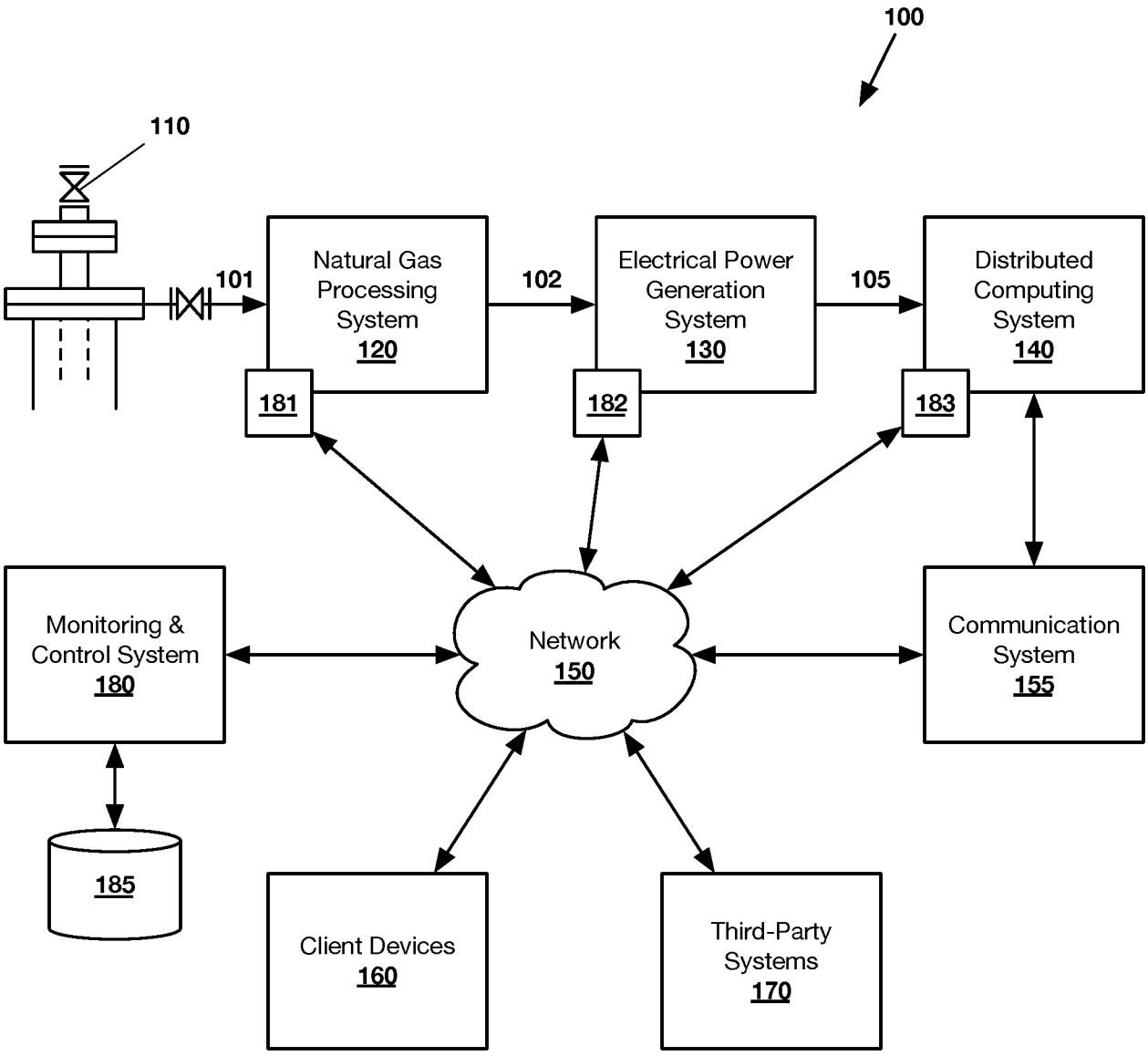

100
110
101
Natural Gas Processing System 120
102
Electrical Power Generation System 130
105
Distributed Computing System 140
181
182
183
Monitoring & Control System 180
Network 150
Communication System 155
185
Client Devices 160
Third-Party Systems 170

FIG. 1

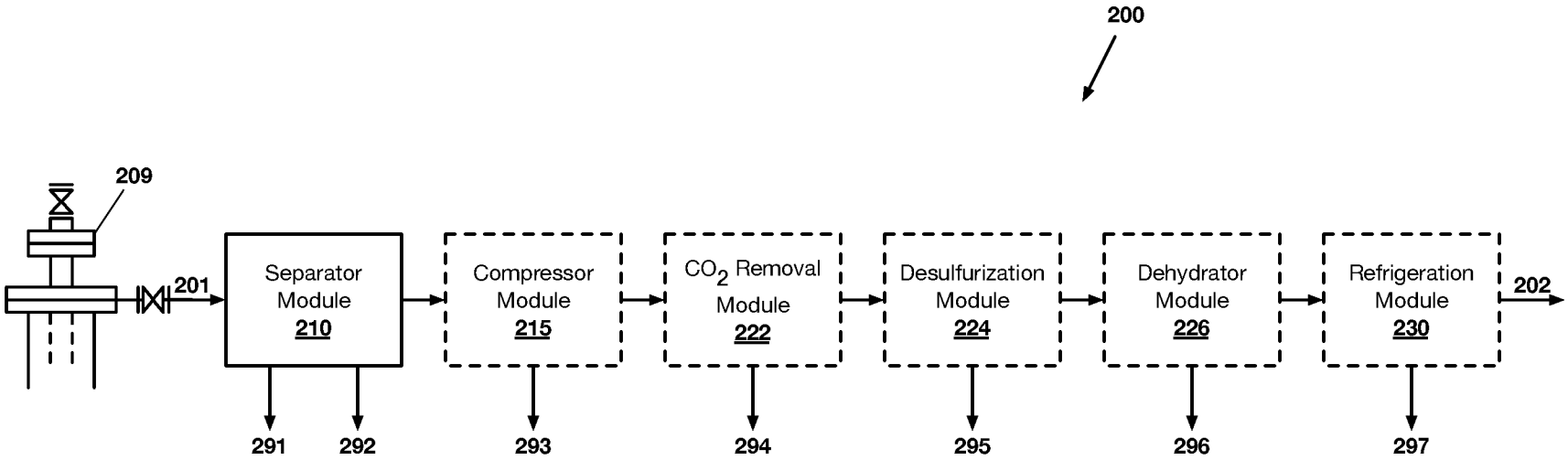

200
209
201
Separator Module 210
Compressor Module 215
CO_2 Removal Module 222
Desulfurization Module 224
Dehydrator Module 226
Refrigeration Module 230
202
291
292
293
294
295
296
297

FIG. 2

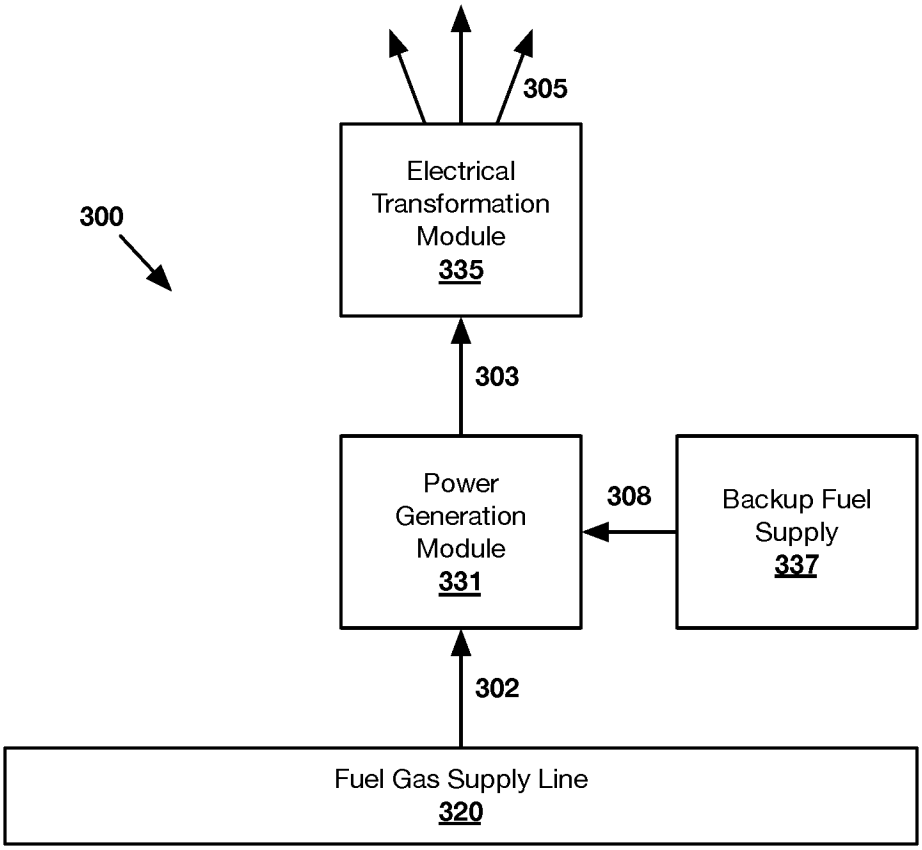

300
305
Electrical Transformation Module
335
303
Power Generation Module
331
308
Backup Fuel Supply
337
302
Fuel Gas Supply Line
320

FIG. 3

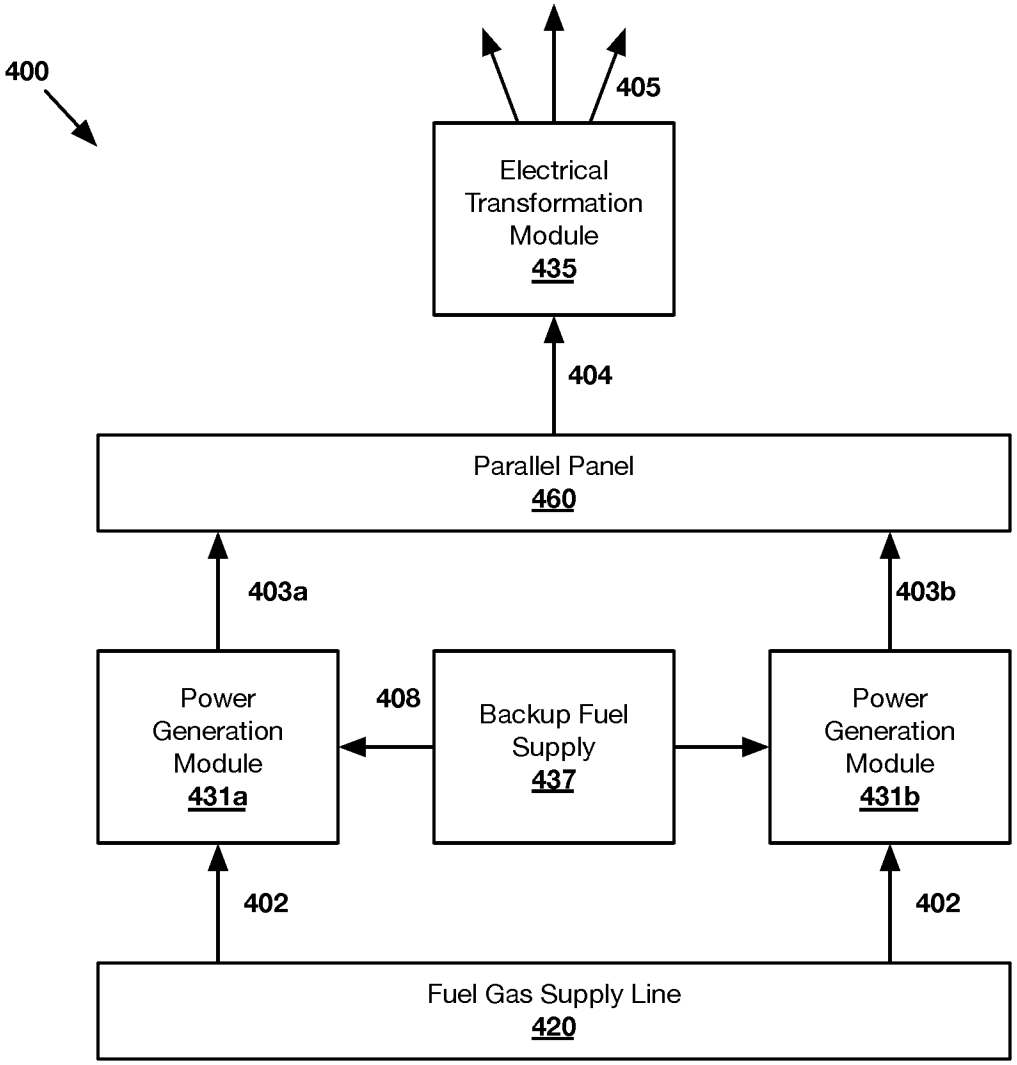

400
405
Electrical Transformation Module 435
404
Parallel Panel 460
403a
403b
Power Generation Module 431a
408
Backup Fuel Supply 437
Power Generation Module 431b
402
402
Fuel Gas Supply Line 420

FIG. 4

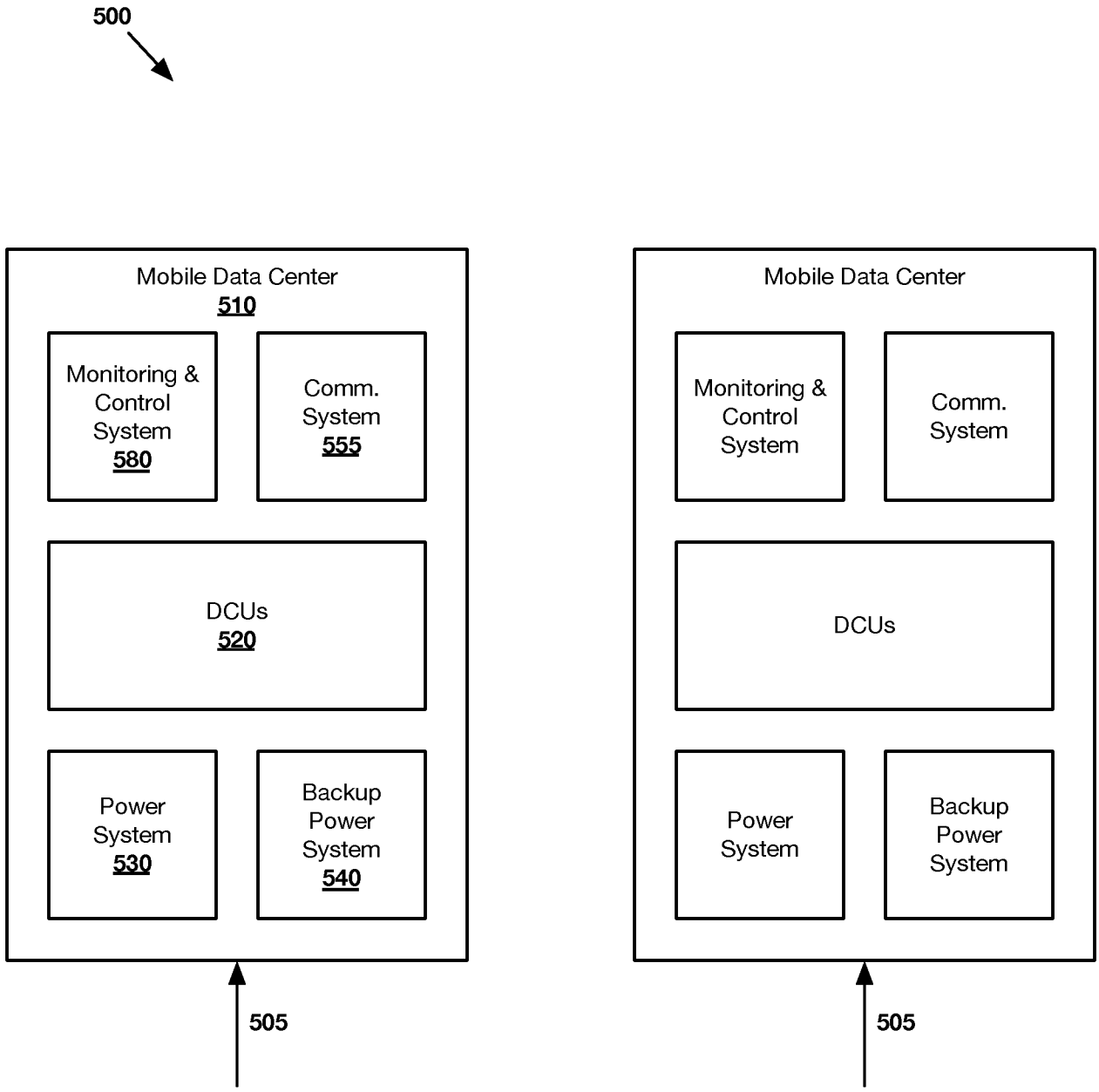

500
Mobile Data Center
510
Monitoring & Control System
580
Comm. System
555
DCUs
520
Power System
530
Backup Power System
540
505
Mobile Data Center
Monitoring & Control System
Comm. System
DCUs
Power System
Backup Power System
505

FIG. 5

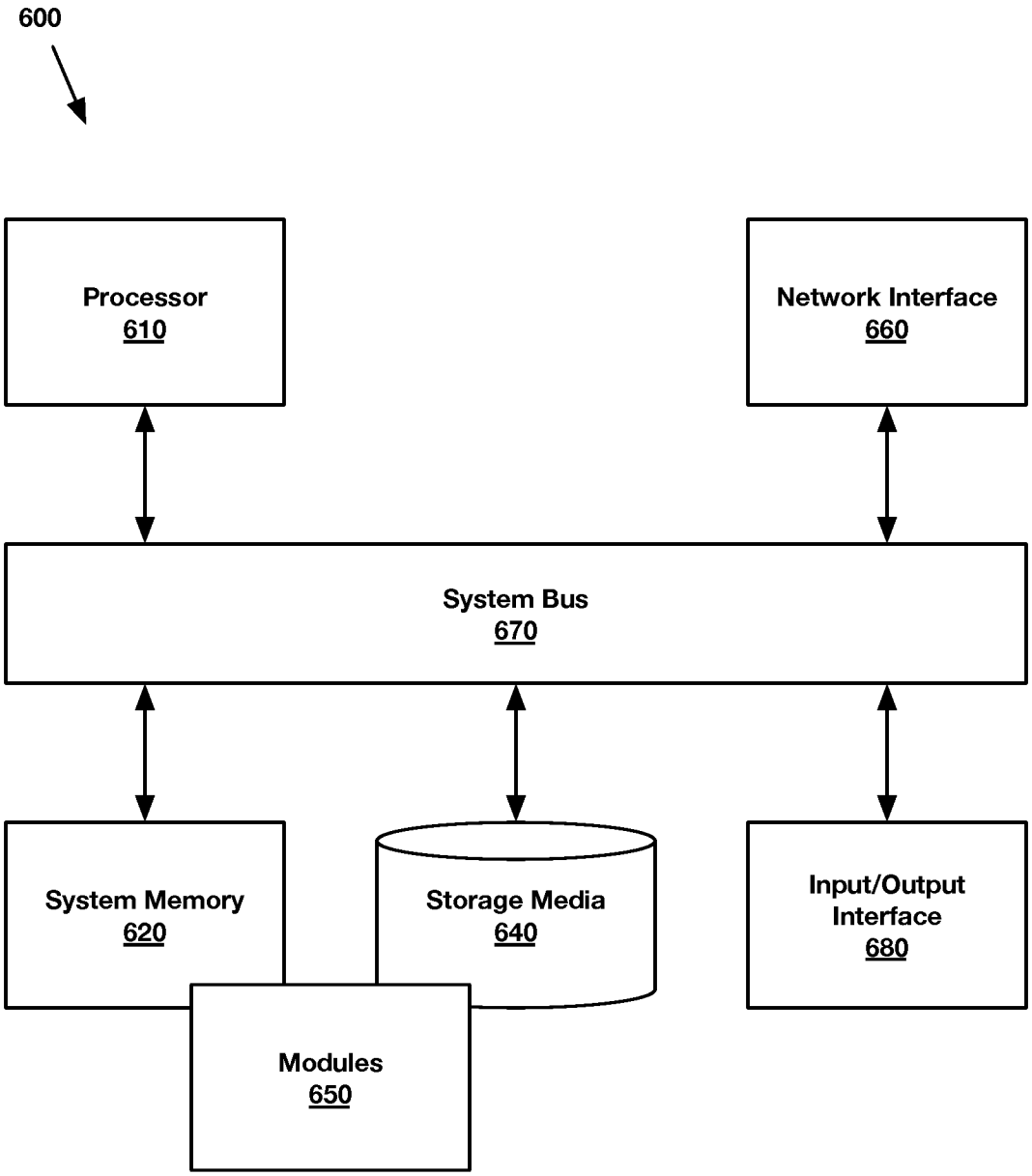

600
Processor
610
Network Interface
660
System Bus
670
System Memory
620
Storage Media
640
Input/Output
Interface
680
Modules
650

FIG. 6

Electronic Patent Application Fee Transmittal

Application Number:	
Filing Date:	
Title of Invention:	Systems and Methods for Generating and Consuming Power from Natural Gas
First Named Inventor/Applicant Name:	Charles Cavness
Filer:	Kyle Montgomery Zeller
Attorney Docket Number:	CRUSOE-105002US1

Filed as Small Entity

Filing Fees for Utility under 35 USC 111(a)

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Basic Filing:				
UTILITY FILING FEE (ELECTRONIC FILING)	4011	1	75	75
UTILITY SEARCH FEE	2111	1	330	330
UTILITY EXAMINATION FEE	2311	1	380	380
Pages:				
Claims:				
Miscellaneous-Filing:				
Petition:				
Patent-Appeals-and-Interference:				

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Post-Allowance-and-Post-Issuance:				
Extension-of-Time:				
Miscellaneous:				
			Total in USD ($)	**785**

Electronic Acknowledgement Receipt

EFS ID:	36749682
Application Number:	16529152
International Application Number:	
Confirmation Number:	9940
Title of Invention:	Systems and Methods for Generating and Consuming Power from Natural Gas
First Named Inventor/Applicant Name:	Charles Cavness
Customer Number:	114903
Filer:	Kyle Montgomery Zeller
Filer Authorized By:	
Attorney Docket Number:	CRUSOE-105002US1
Receipt Date:	01-AUG-2019
Filing Date:	
Time Stamp:	15:08:24
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	yes
Payment Type	CARD
Payment was successfully received in RAM	$785
RAM confirmation Number	E201981F08477811
Deposit Account	506138
Authorized User	Kyle Zeller

The Director of the USPTO is hereby authorized to charge indicated fees and credit any overpayment as follows:

37 CFR 1.16 (National application filing, search, and examination fees)

37 CFR 1.17 (Patent application and reexamination processing fees)

37 CFR 1.19 (Document supply fees)

37 CFR 1.20 (Post Issuance fees)

37 CFR 1.21 (Miscellaneous fees and charges)

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Oath or Declaration filed	aia0001_Chase.pdf	137112 1f68c7f87e0a3fb236df11192f1f0295b84c926c	no	2
Warnings:					
Information:					
2	Oath or Declaration filed	aia0001_Cully.pdf	171404 9fe73b333a193b06cc678599b5b9b205e40819f1	no	2
Warnings:					
Information:					
3	Oath or Declaration filed	aia0001_Ken.pdf	126597 71aac0498cc4969dfad005240dcb7b7c83aa2f1c	no	2
Warnings:					
Information:					
4	Application Data Sheet	aia0014.pdf	1256160 ba41b6b12dfd5eefc442964011c8dbb024af6f4c	no	9
Warnings:					
Information:					
5	Transmittal of New Application	aia0015.pdf	292947 6e7dc59fc30787c1c2d75f16836863f48118b605	no	2
Warnings:					
Information:					
6	Power of Attorney	aia0082.pdf	191620 3c36bc55c1e6fc57da00e8165a3500c7e4d54d20	no	2
Warnings:					
Information:					

7	Assignee showing of ownership per 37 CFR 3.73	aia0096.pdf	253720 b18e81e08320b3d4e0f450c4090a5be39f978855	no	6
Warnings:					
Information:					
8	Specification	Specification.pdf	295399 ec68f7944e967db156cddce65ad5c651d8d4b11b	no	48
Warnings:					
Information:					
9	Drawings-only black and white line drawings	Drawings.pdf	78489 e4bd4334107fd311b86d00177dca69ea040a421b	no	6
Warnings:					
Information:					
10	Fee Worksheet (SB06)	fee-info.pdf	35003 a597541c6b2a913380d14a6813213062d228ea8b	no	2
Warnings:					
Information:					
		Total Files Size (in bytes):	2838451		

This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.

New Applications Under 35 U.S.C. 111

If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

National Stage of an International Application under 35 U.S.C. 371

If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office

If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

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DECLARATION (37 CFR 1.63) FOR UTILITY OR DESIGN APPLICATION USING AN APPLICATION DATA SHEET (37 CFR 1.76)

Title of Invention	Systems and Methods for Generating and Consuming Power from Natural Gas

As the below named inventor, I hereby declare that:

This declaration is directed to:

- [■] The attached application, or
- [ ] United States application or PCT international application number _____

filed on _____.

The above-identified application was made or authorized to be made by me.

I believe that I am the original inventor or an original joint inventor of a claimed invention in the application.

I hereby acknowledge that any willful false statement made in this declaration is punishable under 18 U.S.C. 1001 by fine or imprisonment of not more than five (5) years, or both.

WARNING:

Petitioner/applicant is cautioned to avoid submitting personal information in documents filed in a patent application that may contribute to identity theft. Personal information such as social security numbers, bank account numbers, or credit card numbers (other than a check or credit card authorization form PTO-2038 submitted for payment purposes) is never required by the USPTO to support a petition or an application. If this type of personal information is included in documents submitted to the USPTO, petitioners/applicants should consider redacting such personal information from the documents before submitting them to the USPTO. Petitioner/applicant is advised that the record of a patent application is available to the public after publication of the application (unless a non-publication request in compliance with 37 CFR 1.213(a) is made in the application) or issuance of a patent. Furthermore, the record from an abandoned application may also be available to the public if the application is referenced in a published application or an issued patent (see 37 CFR 1.14). Checks and credit card authorization forms PTO-2038 submitted for payment purposes are not retained in the application file and therefore are not publicly available.

LEGAL NAME OF INVENTOR

Inventor: Chase Lochmiller Date (Optional) :_____

Signature: /Chase Lochmiller/

Note: An application data sheet (PTO/SB/14 or equivalent), including naming the entire inventive entity, must accompany this form or must have been previously filed. Use an additional PTO/AIA/01 form for each additional inventor.

This collection of information is required by 35 U.S.C. 115 and 37 CFR 1.63. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.11 and 1.14. This collection is estimated to take 1 minute to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

If you need assistance in completing the form, call 1-800-PTO-9199 and select option 2.

Privacy Act Statement

The **Privacy Act of 1974 (P.L. 93-579)** requires that you be given certain information in connection with your submission of the attached form related to a patent application or patent. Accordingly, pursuant to the requirements of the Act, please be advised that: (1) the general authority for the collection of this information is 35 U.S.C. 2(b)(2); (2) furnishing of the information solicited is voluntary; and (3) the principal purpose for which the information is used by the U.S. Patent and Trademark Office is to process and/or examine your submission related to a patent application or patent. If you do not furnish the requested information, the U.S. Patent and Trademark Office may not be able to process and/or examine your submission, which may result in termination of proceedings or abandonment of the application or expiration of the patent.

The information provided by you in this form will be subject to the following routine uses:

1. The information on this form will be treated confidentially to the extent allowed under the Freedom of Information Act (5 U.S.C. 552) and the Privacy Act (5 U.S.C 552a). Records from this system of records may be disclosed to the Department of Justice to determine whether disclosure of these records is required by the Freedom of Information Act.
2. A record from this system of records may be disclosed, as a routine use, in the course of presenting evidence to a court, magistrate, or administrative tribunal, including disclosures to opposing counsel in the course of settlement negotiations.
3. A record in this system of records may be disclosed, as a routine use, to a Member of Congress submitting a request involving an individual, to whom the record pertains, when the individual has requested assistance from the Member with respect to the subject matter of the record.
4. A record in this system of records may be disclosed, as a routine use, to a contractor of the Agency having need for the information in order to perform a contract. Recipients of information shall be required to comply with the requirements of the Privacy Act of 1974, as amended, pursuant to 5 U.S.C. 552a(m).
5. A record related to an International Application filed under the Patent Cooperation Treaty in this system of records may be disclosed, as a routine use, to the International Bureau of the World Intellectual Property Organization, pursuant to the Patent Cooperation Treaty.
6. A record in this system of records may be disclosed, as a routine use, to another federal agency for purposes of National Security review (35 U.S.C. 181) and for review pursuant to the Atomic Energy Act (42 U.S.C. 218(c)).
7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (*i.e.*, GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.
8. A record from this system of records may be disclosed, as a routine use, to the public after either publication of the application pursuant to 35 U.S.C. 122(b) or issuance of a patent pursuant to 35 U.S.C. 151. Further, a record may be disclosed, subject to the limitations of 37 CFR 1.14, as a routine use, to the public if the record was filed in an application which became abandoned or in which the proceedings were terminated and which application is referenced by either a published application, an application open to public inspection or an issued patent.
9. A record from this system of records may be disclosed, as a routine use, to a Federal, State, or local law enforcement agency, if the USPTO becomes aware of a violation or potential violation of law or regulation.

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DECLARATION (37 CFR 1.63) FOR UTILITY OR DESIGN APPLICATION USING AN APPLICATION DATA SHEET (37 CFR 1.76)

Title of Invention	Systems and Methods for Generating and Consuming Power from Natural Gas

As the below named inventor, I hereby declare that:

This declaration is directed to:

- [x] The attached application, or
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filed on _____.

The above-identified application was made or authorized to be made by me.

I believe that I am the original inventor or an original joint inventor of a claimed invention in the application.

I hereby acknowledge that any willful false statement made in this declaration is punishable under 18 U.S.C. 1001 by fine or imprisonment of not more than five (5) years, or both.

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LEGAL NAME OF INVENTOR

Inventor: Charles Cavness Date (Optional): July 31, 2019

Signature: / Charles Cavness /

Note: An application data sheet (PTO/SB/14 or equivalent), including naming the entire inventive entity, must accompany this form or must have been previously filed. Use an additional PTO/AIA/01 form for each additional inventor.

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This declaration is directed to:

- [■] The attached application, or
- [ ] United States application or PCT international application number _____

filed on _____.

The above-identified application was made or authorized to be made by me.

I believe that I am the original inventor or an original joint inventor of a claimed invention in the application.

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LEGAL NAME OF INVENTOR

Inventor: Kenneth Parker Date (Optional) :_____

Signature: /Kenneth Parker/

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Application Data Sheet 37 CFR 1.76	Attorney Docket Number	CRUSOE-105002US1
	Application Number	
Title of Invention	Systems and Methods for Generating and Consuming Power from Natural Gas	

The application data sheet is part of the provisional or nonprovisional application for which it is being submitted. The following form contains the bibliographic data arranged in a format specified by the United States Patent and Trademark Office as outlined in 37 CFR 1.76.
This document may be completed electronically and submitted to the Office in electronic format using the Electronic Filing System (EFS) or the document may be printed and included in a paper filed application.

Secrecy Order 37 CFR 5.2:

☐ Portions or all of the application associated with this Application Data Sheet may fall under a Secrecy Order pursuant to 37 CFR 5.2 (Paper filers only. Applications that fall under Secrecy Order may not be filed electronically.)

Inventor Information:

Inventor 1 Remove

Legal Name

Prefix	Given Name	Middle Name	Family Name	Suffix
	Charles		Cavness	

Residence Information (Select One) ● US Residency Non US Residency Active US Military Service

City	State/Province	Country of Residence
Denver	CO	US

Mailing Address of Inventor:

Address 1	164 S. Humboldt St.
Address 2	
City	Denver
State/Province	CO
Postal Code	80209
Country	US

Inventor 2 Remove

Legal Name

Prefix	Given Name	Middle Name	Family Name	Suffix
	Chase		Lochmiller	

Residence Information (Select One) ◉ US Residency Non US Residency Active US Military Service

City	State/Province	Country of Residence
Castle Rock	CO	US

Mailing Address of Inventor:

Address 1	609 Cliffgate Ln.
Address 2	
City	Castle Rock
State/Province	CO
Postal Code	80108
Country	US

Inventor 3 Remove

Legal Name

Prefix	Given Name	Middle Name	Family Name	Suffix
	Kenneth		Parker	

Residence Information (Select One) ◉ US Residency Non US Residency Active US Military Service

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Application Data Sheet 37 CFR 1.76	Attorney Docket Number	CRUSOE-105002US1
	Application Number	
Title of Invention	Systems and Methods for Generating and Consuming Power from Natural Gas	

City	Denver	**State/Province**	CO	**Country of Residence**	US

Mailing Address of Inventor:

Address 1	100 S. Clermont St.		
Address 2			
City	Denver	**State/Province**	CO
Postal Code	80246	**Country**	US

All Inventors Must Be Listed - Additional Inventor Information blocks may be generated within this form by selecting the **Add** button. Add

Correspondence Information:

Enter either Customer Number or complete the Correspondence Information section below.
For further information see 37 CFR 1.33(a).

☐ **An Address is being provided for the correspondence Information of this application.**

Customer Number	114903		
Email Address	uspto@zellerip.com	Add Email	Remove Email

Application Information:

Title of the Invention	Systems and Methods for Generating and Consuming Power from Natural Gas		
Attorney Docket Number	CRUSOE-105002US1	**Small Entity Status Claimed**	☒
Application Type	Nonprovisional		
Subject Matter	Utility		
Total Number of Drawing Sheets (if any)	6	**Suggested Figure for Publication (if any)**	1

Filing By Reference:

Only complete this section when filing an application by reference under 35 U.S.C. 111(c) and 37 CFR 1.57(a). Do not complete this section if application papers including a specification and any drawings are being filed. Any domestic benefit or foreign priority information must be provided in the appropriate section(s) below (i.e., "Domestic Benefit/National Stage Information" and "Foreign Priority Information").

For the purposes of a filing date under 37 CFR 1.53(b), the description and any drawings of the present application are replaced by this reference to the previously filed application, subject to conditions and requirements of 37 CFR 1.57(a).

Application number of the previously filed application	Filing date (YYYY-MM-DD)	Intellectual Property Authority or Country

Publication Information:

☐ Request Early Publication (Fee required at time of Request 37 CFR 1.219)

☐ **Request Not to Publish.** I hereby request that the attached application not be published under 35 U.S.C. 122(b) and certify that the invention disclosed in the attached application **has not and will not** be the subject of an application filed in another country, or under a multilateral international agreement, that requires publication at eighteen months after filing.

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Application Data Sheet 37 CFR 1.76	Attorney Docket Number	CRUSOE-105002US1
	Application Number	
Title of Invention	Systems and Methods for Generating and Consuming Power from Natural Gas	

Representative Information:

Representative information should be provided for all practitioners having a power of attorney in the application. Providing this information in the Application Data Sheet does not constitute a power of attorney in the application (see 37 CFR 1.32).
Either enter Customer Number or complete the Representative Name section below. If both sections are completed the customer Number will be used for the Representative Information during processing.

Please Select One:	● Customer Number	US Patent Practitioner	○ Limited Recognition (37 CFR 11.9)
Customer Number	114903		

Domestic Benefit/National Stage Information:

This section allows for the applicant to either claim benefit under 35 U.S.C. 119(e), 120, 121, 365(c), or 386(c) or indicate National Stage entry from a PCT application. Providing benefit claim information in the Application Data Sheet constitutes the specific reference required by 35 U.S.C. 119(e) or 120, and 37 CFR 1.78.
When referring to the current application, please leave the "Application Number" field blank.

Prior Application Status	Pending		Remove
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
	Claims benefit of provisional	62713368	2018-08-01

Additional Domestic Benefit/National Stage Data may be generated within this form by selecting the **Add** button. Add

Foreign Priority Information:

This section allows for the applicant to claim priority to a foreign application. Providing this information in the application data sheet constitutes the claim for priority as required by 35 U.S.C. 119(b) and 37 CFR 1.55. When priority is claimed to a foreign application that is eligible for retrieval under the priority document exchange program (PDX)[i] the information will be used by the Office to automatically attempt retrieval pursuant to 37 CFR 1.55(i)(1) and (2). Under the PDX program, applicant bears the ultimate responsibility for ensuring that a copy of the foreign application is received by the Office from the participating foreign intellectual property office, or a certified copy of the foreign priority application is filed, within the time period specified in 37 CFR 1.55(g)(1).

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Application Data Sheet 37 CFR 1.76	Attorney Docket Number	CRUSOE-105002US1
	Application Number	
Title of Invention	Systems and Methods for Generating and Consuming Power from Natural Gas	

Statement under 37 CFR 1.55 or 1.78 for AIA (First Inventor to File) Transition Applications

☐ This application (1) claims priority to or the benefit of an application filed before March 16, 2013 and (2) also contains, or contained at any time, a claim to a claimed invention that has an effective filing date on or after March 16, 2013.
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Should applicant choose not to provide an authorization identified in subsection 1 below, applicant **must opt-out** of the authorization by checking the corresponding box A or B or both in subsection 2 below.

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Application Data Sheet 37 CFR 1.76	Attorney Docket Number	CRUSOE-105002US1
	Application Number	
Title of Invention	Systems and Methods for Generating and Consuming Power from Natural Gas	

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Applicant 1 — Remove

If the applicant is the inventor (or the remaining joint inventor or inventors under 37 CFR 1.45), this section should not be completed. The information to be provided in this section is the name and address of the legal representative who is the applicant under 37 CFR 1.43; or the name and address of the assignee, person to whom the inventor is under an obligation to assign the invention, or person who otherwise shows sufficient proprietary interest in the matter who is the applicant under 37 CFR 1.46. If the applicant is an applicant under 37 CFR 1.46 (assignee, person to whom the inventor is obligated to assign, or person who otherwise shows sufficient proprietary interest) together with one or more joint inventors, then the joint inventor or inventors who are also the applicant should be identified in this section.

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● Assignee	Legal Representative under 35 U.S.C. 117	Joint Inventor
Person to whom the inventor is obligated to assign.	Person who shows sufficient proprietary interest	

If applicant is the legal representative, indicate the authority to file the patent application, the inventor is:

Name of the Deceased or Legally Incapacitated Inventor:

If the Applicant is an Organization check here. ☒

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Email Address			

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Assignee Information including Non-Applicant Assignee Information:

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Application Data Sheet 37 CFR 1.76	Attorney Docket Number	CRUSOE-105002US1
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Assignee 1

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If the Assignee or Non-Applicant Assignee is an Organization check here. ☒

Organization Name	Crusoe Energy Systems Inc.

Mailing Address Information For Assignee including Non-Applicant Assignee:

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Phone Number		Fax Number	
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See 37 CFR 1.4(d) for the manner of making signatures and certifications.

Signature	/Kyle Zeller/			Date (YYYY-MM-DD)	2019-08-01
First Name	Kyle	Last Name	Zeller	Registration Number	64748

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Application Data Sheet 37 CFR 1.76	Attorney Docket Number	CRUSOE-105002US1
	Application Number	
Title of Invention	Systems and Methods for Generating and Consuming Power from Natural Gas	

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Systems and Methods for Generating and Consuming Power from Natural Gas

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] The present application claims benefit of U.S. provisional patent application no. 62/713,368, titled "Systems and Methods for Generating and Consuming Power from Natural Gas," filed August 1, 2018, which is incorporated by reference herein in its entirety.

BACKGROUND

[0002] This specification relates to enabling the utilization of raw natural gas, such as flare gas, stranded gas, and associated gas for power generation. More specifically, the specification relates to on-site generation of electricity from natural gas to power modular processing units adapted to perform distributed computing tasks.

[0003] Extracting oil from unconventional resources, such as shale gas formations, through the combination of horizontal drilling and hydraulic fracturing has increased at a rapid pace in recent years. The Bakken, Powder River Basin, Denver Julesburg ("D-J") Basin, North Park Basin, and Permian Basin are just some of the important "plays" in the United States. A "play" is the geographic area underlain by a gas- or oil-containing geologic formation.

[0004] Development of these gas plays and other unconventional resources presents significant potential for economic development and energy independence, but also presents the potential for environmental impacts on land, water and air. For example, although oil production represents the most important source of revenue for a given well, most wells also produce natural gas as a low-value byproduct. Unfortunately, the liquids-rich natural gas byproduct often cannot be economically transported by trucks or trains from remote well locations. Although such natural gases could be transported via pipelines, many oil and natural gas wells are located beyond the reach of such infrastructure. Absent gas pipeline infrastructure, oil well operators must either "vent" or "flare" produced gasses for safety reasons. Venting is the controlled release of natural gases into the atmosphere in the course of oil and gas production operations, however natural gas accumulations around the wellbore create significant safety hazards. Flaring is the controlled burning of natural gas produced in association with oil in the course of routine oil and gas

production operations, and is designed to minimize the safety and environmental risks associated with venting uncombusted natural gas.

[0005] As of April 2016, the NOAA estimates that there are over 6,200 individual flares in the United States, which burn about 35 billion ft3 of natural gas annually—enough to supply about 6 million homes. Such large-scale flaring of natural gas has raised serious environmental and health concerns and various state and federal regulators have begun to take action by implementing strict regulations and enforcement policies. For example, Colorado generally limits flaring to 60 days and many new well permits require producers to have a natural gas offtake solution prior to production; North Dakota has recently implemented a requirement that 90% of associated gas be captured by 2020; and Texas only allows new wells to flare for 10 days before an additional 45-day permit must be obtained. The EPA has also implemented flaring regulations where sites that exceed 100 tons per year of VOC, CO or NOX trigger Title V "Major Source Emitter" rules. Violations of state or federal rules can result in oil wells being "shut in," rejected permits and/or significant cash fines.

[0006] Stranded natural gas, particularly in the case where liquids-weighted wells are shut in due to gas takeaway constraints, represents a very low-cost power generation opportunity. Stranded gas exists across most prominent shale fields today including in the D-J Basin, Permian Basin, Bakken, SCOOP/STACK, etc. Many oil and gas operators in pipeline-constrained environments readily offer their natural gas for low cost—even at a loss to the operator in some cases—so that they can produce oil, which often represents the vast majority of a well's lifetime economics.

[0007] One potential solution to the natural gas problem lies in distributed computing. Cryptocurrency is a booming asset class with the combined market capitalization of digital currencies surpassing $380 billion in July 2018. Cryptocurrencies operate on a distributed system of computers "mining" the currencies – essentially processing the underlying algorithms to continuously verify transactions and account balances. The crypto mining process is a significant industry in its own right, projected to reach a value of $39 billion by 2025 with a projected CAGR of 29.7%.

[0008] This high-growth industry requires innovative and inexpensive electricity sources as it requires enormous amounts of power—approximately 29 TWh of electricity per year on a global basis. For perspective, cryptocurrency mining consumes more power annually than 159 countries,

including Hungary, Ireland, Nigeria or Slovakia. Indeed, electricity is typically the single largest lifetime cost to a cryptocurrency mining operation, with power costs offsetting approximately 30% of total mining revenues in the US.

[0009] Accordingly, there remains a need for systems and methods for generating electricity from natural gas produced from oil wells. It would be beneficial if such electricity could be produced and consumed on-site, for example, by using it to operate power-intensive, modular processing units. It would be further beneficial if such processing units could be employed to mine cryptocurrency or perform other distributed computing tasks to generate additional revenue.

SUMMARY

[0010] In accordance with the foregoing objectives and others, exemplary systems and methods are disclosed herein to convert raw natural gas into a fuel gas stream that may be used to power any number of on-site power generation modules. In turn, the power generation modules may convert the fuel gas stream into electricity, which may be employed to power any number of modular distributed computing units. In certain embodiments, the distributed computing units may be adapted to mine cryptocurrency or perform other distributed computing tasks to generate revenue.

[0011] In one embodiment, a flare mitigation system is provided. Such system may include an electrical power generation system, which may include a power generation module adapted to: receive a fuel gas stream, such as a fuel gas associated with a heat value of at least about 1,000 Btu/scf; and consume the fuel gas stream to generate a high-voltage electrical output associated with a first voltage. The electrical power generation system may also include an electrical transformation module in electrical communication with the power generation module, the electrical transformation module adapted to: receive the high-voltage electrical output generated by the power generation module; and transform the high-voltage electrical output into a low-voltage electrical output associated with a second voltage that is lower than the first voltage.

[0012] The flare mitigation system may also include a distributed computing system powered by the electrical power generation system. The distributed computing system may include a communications system with one or more data satellite antennas in order to provide a network; and a first mobile data center. The mobile data center may include an enclosure defining an interior

space; a plurality of distributed computing units located within the interior space of the enclosure, each of the plurality of distributed computing units in communication with the network; and a power system located at least partially within the interior space of the enclosure, the power system in electrical communication with the electrical transformation module and the plurality of distributed computing units such that the power system receives the low-voltage electrical output and powers each of the plurality of distributed computing units.

[0013] In some cases, the power generation module may be an engine-type generator that generates a high-voltage electrical output of from about 70 kW to about 2 MW (e.g., from about 70 kW to about 300 kW, from about 300 kW to about 400 kW, 400 kW to about 1 MW, or from about 1 MW to about 2 MW). The first voltage of the high-voltage electrical output may be from about 480 V to about 4.16 kV. And the second voltage of the low-voltage electrical output may be from about 208 V to about 240 V.

[0014] In other cases, the power generation module may be a turbine-type generator that generates a high-voltage electrical output of from about 2 MW to about 30 MW. In such cases, the first voltage of the high-voltage electrical output may be from about 4.16 kV to about 12 kV. And the second voltage of the low-voltage electrical output may be from about 208 V to about 240 V.

[0015] In another embodiment, a flare mitigation system is provided. The system may include an electrical power generation system having a first power generation module and a second power generation module. The first power generation module may be adapted to receive a first fuel gas stream, such as a fuel gas associated with a heat value of at least about 1,000 Btu/scf, and to consume the fuel gas stream to generate a first high-voltage electrical output associated with a first voltage. The second power generation module may be adapted to receive a second fuel gas stream including the fuel gas, and to consume the second fuel gas stream to generate a second high-voltage electrical output associated with the first voltage.

[0016] The electrical power generation system may also include a parallel panel in electrical communication with the first power generation module and the second power generation module. The parallel panel may be adapted to receive the first and second high-voltage electrical outputs; and combine and/or synchronize the first and second high-voltage electrical outputs into a combined high-voltage electrical output.

[0017] The electrical power generation system may also include an electrical transformation module in electrical communication with the parallel panel. The electrical transformation module may be adapted to receive the combined high-voltage electrical output; and transform the combined high-voltage electrical output into a low-voltage electrical output associated with a second voltage that is lower than the first voltage.

[0018] The flare mitigation system may further include a distributed computing system powered by the electrical power generation system. The distributed computing system may include a communications system having one or more data satellite antennas in order to provide a network. Moreover, the distributed computing system may include a first mobile data center having an enclosure defining an interior space; a plurality of distributed computing units located within the interior space of the enclosure, each of the plurality of distributed computing units in communication with the network; and a power system located at least partially within the interior space of the enclosure, the power system in electrical communication with the electrical transformation module and the plurality of distributed computing units such that the power system receives the low-voltage electrical output and powers each of the plurality of distributed computing units.

[0019] The details of one or more embodiments of the subject matter of this specification are set forth in the accompanying drawings and the description below. Other features, aspects, and advantages of the subject matter will become apparent from the description, the drawings, and the claims.

BRIEF DESCRIPTION OF THE DRAWINGS

[0020] FIG. 1 shows an exemplary flare mitigation system 100 according to an embodiment.

[0021] FIG. 2 shows an exemplary natural gas processing system 200 according to an embodiment.

[0022] FIG. 3 shows an exemplary electrical power generation system 300 comprising a power generation module 331 in electrical communication with an electrical transformation module 335.

[0023] FIG. 4 shows another exemplary electrical power generation system 400 comprising a plurality of power generation modules (431a, 431b) in electrical communication with an electrical transformation module 435 via a parallel panel 460.

[0024] FIG. 5 shows an exemplary distributed computing system 500 according to an embodiment.

[0025] FIG. 6 shows an exemplary computing machine 600 and modules 650 according to an embodiment.

DETAILED DESCRIPTION

System Overview

[0026] Referring to FIG. 1, an exemplary flare mitigation system 100 according to an embodiment is illustrated. As shown, the system 100 may comprise a natural gas processing system 120, an electrical power generation system 130, a distributed computing system 140, a communication system 155 and a monitoring and control system 180.

[0027] In one embodiment, the flare mitigation system 100 may comprise a natural gas processing system 120 adapted to receive a raw natural gas stream 101 from one or more wellheads 110 in an oil and/or gas reservoir. The natural gas processing system 120 is generally adapted to convert the received raw natural gas 101 into a fuel gas stream 102 that may be introduced to an electrical power generation system 130. As discussed in detail below with respect to FIG. 2, the natural gas processing system 120 may employ a separator module and, optionally, any number of additional modules (e.g., a compressor module, a carbon dioxide removal module, a desulfurization module and/or a refrigeration module) to produce a fuel gas stream 102 meeting the specific requirements of the electrical power generation system 130 and any number of secondary streams.

[0028] The electrical power generation system 130 generally comprises any number of power generation modules adapted to consume the fuel gas 102 and convert the same into electrical power. As discussed in detail below with respect to FIGs. 3-4, each power generation module may be in electrical communication with an electrical transformation module adapted to receive the electrical output of the power generation module(s) and convert the same into an electrical flow 105 that may be employed to power the electrical components of a distributed computing system 140.

[0029] In one embodiment, the distributed computing system 140 may comprise any number distributed computing units ("DCUs") in electrical communication with the electrical power

generation system 130, such that the DCUs are powered via the electrical flow 105 output by the system. The DCUs may comprise a modular computing installation, for example, a data center, cryptocurrency mine or graphics computing cell. And the DCUs are generally adapted to conduct any number of processing-intensive tasks. For example, the DCUs may be employed to execute graphics-intensive distributed computing processes, artificial intelligence ("AI") research, machine learning model training, data analysis, server functions, storage, virtual reality and/or augmented reality applications, tasks relating to the Golem Project, non-currency blockchain applications and/or cryptocurrency mining operations.

[0030] In certain embodiments, the DCUs may be employed to execute mathematical operations in relation to the mining of cryptocurrencies including computing the following hashing algorithms: SHA-256, ETHash, scrypt, CryptoNight, RIPEMD160, BLAKE256, X11, Dagger-Hashimoto, Equihash, LBRY, X13, NXT, Lyra2RE, Qubit, Skein, Groestl, BOINC, X11gost, Scrypt-jane, Quark, Keccak, Scrypt-OG, X14, Axiom, Momentum, SHA-512, Yescrypt, Scrypt-N, Cunningham, NIST5, Fresh, AES, 2Skein, Equilhash, KSHAKE320, Sidechain, Lyra2RE, HybridScryptHash256, Momentum, HEFTY1, Skein-SHA2, Qubit, SpreadX11, Pluck, and/or Fugue256. Additionally or alternatively, the DCUs may be adapted to execute mathematical operations in relation to training computationally intensive machine learning, artificial intelligence, statistical or deep learning models, such as neural networks, recurrent neural networks, convolutional neural networks, generative adversarial networks, gradient boosting machines, random forests, classification and regression trees, linear, polynomial, exponential and generalized linear regressions, logistic regression, reinforcement learning, deep reinforcement learning, hyperparameter optimization, cross validation, support vector machines, principal component analysis, singular value decomposition, convex optimization, and/or independent component analysis.

[0031] As discussed in detail below with respect to FIG. 5, the distributed computing system 140 may comprise one or more mobile data centers, wherein each mobile data center houses a plurality of DCUs therein. In addition to the DCUs, each mobile data center may further house an electrical power system, one or more backup power systems, an environment control system, and/or various monitoring and control equipment 183.

[0032] In certain embodiments, the mobile data center (and any electronic components contained therein) may be in communication with a communication system 155. For example, the mobile data center may be in direct communication with the communication system 155 via a wired connection. As another example, the DCUs may be in indirect communication with the communication system 155 via a network 150.

[0033] In one embodiment, the communication system 155 may comprise one or more data satellite antennas in communication with one or more high-orbit and/or low-orbit satellites. The antennas may be roof-mounted to one or more mobile data centers and/or may be pole-mounted into the ground nearby such mobile data centers. A typical configuration is for two antennas to serve a single mobile data center in order to provide reliability and redundancy; however, a single antenna may be sufficient depending on bandwidth requirements and total DCU count. Alternatively, many (e.g., three or more) antennas may be mounted to a roof of a single mobile data center, and communications cables may extend from the mobile data center to other nearby mobile data centers to provide a centralized communications solution.

[0034] The one or more data satellite antennas of the communication system 155 may be specified for continuous outdoor use, and may be installed using robust mounting hardware to ensure alignment even during heavy wind or other storms common in the oilfield. Antenna modems may be housed inside a mobile data center for warmth, security and weatherproofing, and such modems may be connected to the power system of the mobile data center.

[0035] In one embodiment, the communication system 155 may provide an internal network that includes automatic load-balancing functionality such that bandwidth is allocated proportionately among all active antennas. In such embodiment, if a single antenna fails, the lost bandwidth is automatically redistributed among all functioning antennas. This is an important reliability feature for oilfield operations, where equipment failures due to storms are possible.

[0036] In another embodiment, the antennas and satellite internet systems of the communication system 155 may be specified based on the needs of the distributed computing system 140, with specific attention paid to bandwidth and latency requirements. For lower bandwidth applications such as certain blockchain processing, cryptocurrency mining and/or long-term bulk data processing jobs, high-orbit satellite connectivity ranging from 10 MB/s to 100 MB/s may be specified. For higher bandwidth or low latency requirements such as artificial intelligence model

training, iterative dataset download and boundary spamming projects, visual processing such as images or videos, natural language processing, iterative protein folding simulation jobs, videogaming, or any other high capacity data streaming or rapid communication jobs, low-orbit satellites may be specified to provide significantly increased speeds and reduced latency.

[0037] In any event, the communication system 155 may provide a network 150 to which various components of the flare mitigation system 100 may be connected. The network 150 may include wide area networks ("WAN"), local area networks ("LAN"), intranets, the Internet, wireless access networks, wired networks, mobile networks, telephone networks, optical networks, or combinations thereof. The network 150 may be packet switched, circuit switched, of any topology, and may use any communication protocol. Communication links within the network 150 may involve various digital or an analog communication media such as fiber optic cables, free-space optics, waveguides, electrical conductors, wireless links, antennas, radio-frequency communications, and so forth.

[0038] As shown, the flare mitigation system further 100 comprises a MC system 180, which is generally adapted to maintain processing conditions within acceptable operational constraints throughout the system. Such constraints may be determined by economic, practical, and/or safety requirements. The MC system 180 may handle high-level operational control goals, low-level PID loops, communication with both local and remote operators, and communication with both local and remote systems. The MC system 180 may also be in communication with ancillary systems, such as storage systems, backup systems and/or power generation systems.

[0039] In one embodiment, the MC system 180 may be in communication with various monitoring and control equipment (181-183), such as sensors and/or controllers, via the network 150. Such monitoring and control equipment (181-183) may be in further communication with various components of the natural gas processing system 120, the electrical power generation system 130 and/or the distributed computing system 140, such that the MC system 180 may remotely monitor and control operating parameters throughout the flare mitigation system 100. Exemplary operating parameters may include, but are not limited to, profile of the raw natural gas supply, gas flow rate at various locations, gas pressure at various locations, temperature at various locations, electrical output at one or more locations, electrical load at one or more locations, and/or others.

[0040] As an example, the MC system 180 may determine a change in the profile, flow rate and/or pressure of the raw natural gas 101 and then automatically modulate electrical load of a mobile data center accordingly. And as another example, the MC system 180 may automatically reduce a processing rate of one or more DCUs in response to receiving an indication that supply gas pressure has decreased.

[0041] In one embodiment, any number of users may access the MC system 180 and/or the distributed computing system 140 via a client device 160 in communication with the network 150. Generally, a client device 160 may be any device capable of accessing such systems (e.g., via a native application or via a web browser). Exemplary client devices 160 may include general purpose desktop computers, laptop computers, smartphones, and/or tablets. In other embodiments, client devices 160 may comprise virtual reality ("VR") and/or augmented reality ("AR") hardware and software, which allow users to provide input via physical gestures.

[0042] The relationship of the client device 160 to such systems arises by virtue of computer programs running on the respective computers and having a client-server relationship to each other. Accordingly, each of the client devices 160 may have a client application running thereon, where the client application may be adapted to communicate with a MC application running on a MC system 180 and/or a distributed computing application running on a distributed computing system 140, for example, over a network 150. Thus, the client application may be remote from the MC system 180 and/or the distributed computing system 140. Such a configuration may allow users of client applications to interact with one or both of such systems from any location. Moreover, because the MC system 180 is capable of transceiving information to/from the various other systems (e.g., natural gas processing system 120, electrical power generation system 130, distributed computing system 140, and communication system 155), a user may interact with such systems via the MC system.

[0043] As discussed in detail below, one or more MC system applications and/or distributed computing system applications may be adapted to present various user interfaces to users. Such user interfaces may be based on information stored on the client device 160 and/or received from the respective systems. Accordingly, the application(s) may be written in any form of programming language, including compiled or interpreted languages, or declarative or procedural languages, and it can be deployed in any form, including as a standalone program or as a module,

component, subroutine, or other unit suitable for use in a computing environment. Such software may correspond to a file in a file system. A program can be stored in a portion of a file that holds other programs or data. For example, a program may include one or more scripts stored in a markup language document; in a single file dedicated to the program in question; or in multiple coordinated files (e.g., files that store one or more modules, sub programs, or portions of code).

[0044] Each of the MC system application(s) and/or distributed computing system application(s) can be deployed and/or executed on one or more computing machines that are located at one site or distributed across multiple sites and interconnected by a communication network. In one embodiment, an application may be installed on (or accessed by) one or more client devices 160.

[0045] In certain embodiments, the MC system 180 and/or the client device 160 may be adapted to receive, determine, record and/or transmit application information relating to one or more components of the flare mitigation system 100. The application information may be received from and/or transmitted to the natural gas processing system 120, the electrical power generation system 130 and/or the distributed computing system 140 via, for example, monitoring and/or control equipment (181, 182, 183, respectively) in communication with one or more components of such systems and in further communication with the network 150. Moreover, any of such application information may be stored in and/or retrieved from one or more local or remote databases (e.g., database 185).

[0046] In one embodiment, the MC system 180 may be connected to one or more third-party systems 170 via the network 150. Third-party systems 170 may store information in one or more databases that may be accessed by the MC system 180. The MC system 180 may be capable of retrieving and/or storing information from third-party systems 170, with or without user interaction. Moreover, the MC system may be capable of transmitting stored/received information to such third-party systems.

[0047] It will be appreciated that various components of the flare mitigation system 100 may be modular such that they may be combined to form a modular system. For example, the modular components that make up the natural gas processing system 120, the electrical power generation system 130, the distributed computing system, and/or the communication system 155 may be transported to an oil filed and assembled into the respective subsystems of the flare mitigation system 100.

[0048] In one embodiment, the natural gas processing system 120, electrical power generation system 130, distributed computing system 140 and the communication system 155 may be designed to allow all components of such systems to fit inside the height and width of a portable container, such as a shipping container or similar prefabricated enclosure that is transportable using a standard drop-deck semi-trailer. It will be appreciated that such configuration allows for enhanced mobility of the flare mitigation system 100 to various field sites.

[0049] Moreover, some or all of the aforementioned systems / components may be pre-mounted to a fixed skid, wheeled trailer or other form of mounting brackets in order to simplify and expedite transportation. Key benefits of this approach include reduced assembly time and expense in the field, where oilfield contract labor is often more expensive than shop labor, and where contractor availability (such as electricians) may be constrained. Wheel-mounted solutions may also qualify for special treatment as "temporary equipment," facilitating expedited or reduced regulatory processing in the oilfield environment. Pre-mounting equipment also allows for an operator to quickly re-mobilize the system 100 to a new site if the original gas flow associated with the original well declines or a new area experiences a greatly increased demand for flare mitigation.

[0050] It will be further appreciated that, the natural gas processing system 120, electrical power generation system 130, distributed computing system 140 and/or the communication system 155 may be designed to allow for individual components of such subsystems to be added or removed, as necessary, to provide a flare mitigation system 100 that aims to consume substantially all raw natural gas 101 produced at the wellhead 110. This configuration is important, as each well's gas flow rate, pressure and composition will be unique and may change over time.

[0051] For example, the electrical power generation system 130 may be modified to include additional power generation modules and/or electrical transformation modules and the distributed computing system 140 may be modified to include additional mobile data centers to mitigate increasingly larger volumes of gas during initial flow back and peak production phases of a well's life. Conversely, modules may be removed to accommodate declining flow rates. As another example, individual DCUs within a mobile data center of the distributed computing system 140 can also be remotely "turned down" or turned off to fit gas demand with gas production at each individual wellhead 110.

[0052] Using the above-described system 100, inexpensive and abundant stranded gas 101 can be used to power multi-megawatt-scale power generation equipment to produce power 105 for on-site or adjacent cryptocurrency mining operations. For example, the system may consume raw natural gas having a heat value of at least 1,000 Btu/scf at a rate of 1.3 MMscfd to power approximately 3,300 DCUs having a 14 TH/s mining hash rate (e.g., ANTMINER S9 mining rigs), which is equivalent to a moderate scale commercial mining operation. The cost to power this same mining operation would be about $2.6 million annually under a commercial power purchase agreement ($0.06/kwh).

Natural Gas Processing System

[0053] Referring to FIG. 2, an exemplary natural gas processing system 200 according to an embodiment is illustrated. As shown, the system 200 may comprise a separator module 210 and various optional components, such as a compressor module 215, a CO_2 removal module 222, a desulfurization module 224, a dehydrator module 226 and/or a refrigerator module 230.

[0054] Generally, the natural gas processing system 200 is adapted to convert a raw natural gas stream 201 received from one or more oil and/or gas wellheads 209 into a fuel gas stream 202 and, optionally, various secondary streams. As used herein, the term "raw natural gas" or "raw gas" means unprocessed natural gas released during oil and/or gas production. Raw natural gas 201 may also be referred to as "associated gas," "flare gas," "produced gas," and/or "stranded gas."

[0055] Raw natural gas 201 at a wellhead 209 is commonly a mixture of hydrocarbons, including methane (CH_4), ethane (C_2H_6), propane (C_3H_8), butane (C_4H_{10}), pentane (C_5H_{12}), hexane (C_6H_{14}) and higher hydrocarbons. The raw natural gas 201 also contains other compounds such as water vapor (H_2O), hydrogen sulfide (H_2S), carbon dioxide (CO_2), oxygen (O_2), and nitrogen (N_2). Table 1, below, shows properties of exemplary raw gas from wellheads in the Bakken Formation.

Table 1: Exemplary Raw Natural Gas Properties

Component	Value
Methane	48 - 85 mol %
Ethane	12- 20 mol %
Propane	5 - 15 mol %

Butane+ (C4+)	4 - 17 mol %
$CO_2 + N_2$	1.5 - 3.5 mol %
H_2S	0 - 2.0 mol %
Heat Value	1,200 - 1,715 Btu/scf
Wobbe Index	43 - 57
H_2O	10 - 50 lbs/MMscf

[0056] As used herein, the term "fuel gas" 202 refers to a natural gas stream that has been processed by a natural gas processing system 200 such that it may be used by an electrical power generation system (e.g., FIG. 1 at 130) to generate electrical power for a distributed computing system (FIG. 1 at 140). It will be appreciated that the properties of the fuel gas 202 produced by the natural gas processing system 200 may vary depending on the raw natural gas and requirements of the employed electrical power generation system.

[0057] Nevertheless, the fuel gas 202 will typically comprise a heat value of at least about 1,000 Btu/scf and a methane content of at least about 80%. In some embodiments, the fuel gas 202 may be processed to contain less than about 1% pentane and higher hydrocarbons (C5+) components. Moreover, such fuel gas 202 may be optionally be processed to contain less than about 5% propane and higher hydrocarbons (C3+) components.

[0058] In some embodiments, the produced fuel gas 202 may be substantially free of particulate solids and liquid water to prevent erosion, corrosion or other damage to equipment. Moreover, the fuel gas may be dehydrated of water vapor sufficiently to prevent the formation of hydrates during downstream processing. And, in certain embodiments, the produced fuel gas 202 may contain no more than trace amounts of components such as H_2S, CO_2, and N_2.

[0059] As shown, the raw natural gas 201 received from the wellhead 209 may first be introduced to a separator module 210 such that liquids (e.g., oil 291 and/or water 292) may be separated and removed therefrom. Generally, the separator module 210 may comprise at least one multi-phase separator, such as a 2-phase separator (separating liquids and gas), or a 3-phase separator (separating oil, water, and gas),

[0060] In one particular embodiment, the separator module 210 comprises a 3-phase separator. An exemplary 3-phase separator may comprise a vessel having an inlet to receive the raw natural gas 201, an outlet through which free gas exits the vessel, an outlet through which water exits the vessel, and an outlet through which oil exits the vessel. Upon entering the vessel, the raw gas 201 may encounter an inlet deflector, which causes initial separation of gas from a liquid mixture of oil and water. The free gas may then rise within the vessel, while the heavier liquid mixture descends therewithin. And, optionally, a divertor may be employed within the vessel to redirect flow of the liquid mixture and to allow it to settle more readily within the vessel.

[0061] Once separated from the liquid, the free gas may flow through a mist extractor that removes any entrained liquids remaining in the gas. The resulting gas stream then flows out of the top of the separator vessel, through the gas outlet.

[0062] As the liquid mixture settles within the separator vessel, the oil separates from the water and rises out of solution. In one embodiment, a weir plate may be employed to allow the oil to pour into an oil chamber or bucket, while preventing the water from entering the chamber. Additionally, the separator may include a metal protector plate to block any splashing liquid from entering the gas outlet.

[0063] Generally, the recovered oil 291 can be directed to an oil storage tank or may be transported for sale via truck, rail or pipe. And the water 292 may be sent to a water storage tank, treated on-site, disposed of, and/or transported to a wastewater treatment facility or other reclamation zone.

[0064] In one embodiment, the separator module 210 may comprise, or otherwise be placed in communication with, various monitoring and/or control equipment. Such equipment may be adapted to measure, determine and/or control various operating parameters at any number of locations throughout the separator module 210. As discussed above, such equipment may be in communication with a remote MC system (e.g., via a network) to allow for both (1) remote monitoring and control of the separator module 210 by any number of operators and (2) automatic control thereof.

[0065] As an example, the separator module 210 may comprise any number of pressure monitors, flow meters, regulators and/or control valves to monitor/control gas and/or liquid processing parameters (e.g., inlet/outlet pressure, inlet/outlet flow, level, etc.). Such equipment may be located

within one or more vessels, on one or more inlets and/or on one or more outlets of the separator module 210.

[0066] It will be appreciated that the separator module 210 may further comprise any number of safety valves adapted to direct flow to a safe and contained area upon overpressurization of the vessel. In one embodiment, the separator module may comply with ASME VIII, Division 1 and NACE MR-0175 for H2S environments. Additionally or alternatively, the separator module may comprise a skid designed to SEPCO OPS055 and/or API RP2A standards.

[0067] In certain embodiments, the separator module 210 may further comprise a heater-treater component located upstream of the multi-phase separator or integral therewith. Generally, the heater-treater may comprises a pressurized vessel, or a series of pressurized vessels, in which a bottom-mounted, heat source is operated. During operation, the heater-treater heats the raw natural gas 201 received from the wellhead 209 by means of direct contact with the heat source and the ensuing temperature increase reduces molecular attraction between oil and water molecules contained therein. Accordingly, when the heated raw natural gas is passed to the multi-phase separator, water droplets may settle out of the liquid more rapidly.

[0068] In one embodiment, the gas stream produced by the separator module 210 may be of a sufficient quality to be directly utilized as fuel gas 202 for a power generation module of the electrical power generation system. In such cases, the resulting gas stream 202 may not be introduced to any of the optional processing modules shown in FIG. 2; rather, it may be transferred directly to an electrical power generation module. It will be appreciated that, although the illustrated optional processing modules are not employed in this embodiment, the fuel gas 202 may be aggregated (e.g., in a field gathering pipeline) before being introduced to the electrical power generation module. Additionally or alternatively, conventional valves and/or compressors may be employed upstream of the electrical power generation module to regulate the pressure of the fuel gas 202.

[0069] In other embodiments, the gas stream produced by the separator module 210 may require additional processing upstream of the power generation module. In such cases, the natural gas processing system 200 may comprise one or more of: a compressor module 215, a CO_2 removal module 222, a desulfurization module 224, a dehydrator module 226 and/or a refrigeration module 230.

[0070] Generally, a compressor module 215 may be employed to increase the pressure of the gas stream from an initial pressure of from about 15 psi to about 50 psi, to a final pressure of from about 150 psi to about 350 psi. Such pressure increase may be desired or required when a refrigeration module 230 is employed (discussed below) and/or in cases where the fuel gas 202 is to be introduced to a power generation module comprising a turbine.

[0071] As a result of the pressure increase, the compressor module 215 may also remove heavy natural gas liquids ("NGLs") stream 293 comprising pentane and higher hydrocarbons (C5+) from the natural gas. To that end, the compressor module 215 may comprise any number of individual compressor units operating to raise and lower the pressure of the received gas stream, during any number of compression stages, such that the NGLs 293 contained therein may be liquified and removed. The resulting NGLs stream 293 may exit the compressor module 215 and may be stored in a storage tank and/or transported for sale via truck, rail or pipe.

[0072] Accordingly, the compressor module 215 may produce a resulting gas stream comprising methane, ethane, propane, and butane, wherein the gas stream is substantially free of pentane and higher hydrocarbons (C5+). That is, the resulting compressed gas stream will typically comprise less than about 1% C5+ hydrocarbons, such that the stream comprises a heat content of from about 1,200 Btu/scf to about 1,500 Btu/scf.

[0073] In one embodiment, the compressor module 215 may comprise any number of individual compressor units. The compressor units may be driven by either conventional piston engines or natural gas turbines, and such units are typically fueled by a portion of the natural gas (although some or all of the units may be electrically powered if required). The compressor units typically operate in parallel, although some or all of the compressor units may be operated in stages (serially) as desired or required.

[0074] As the gas is compressed, heat is generated and must be dissipated to cool the gas stream before leaving the compressor module. Accordingly, the compressor module 215 may comprise an aerial cooler system to dissipate excess heat (e.g., an "after cooler"). Additionally, the heat generated by operation of the individual compressor units may be dissipated via a sealed coolant system.

[0075] The compressor module 215 may comprise, or otherwise be placed in communication with, various monitoring and/or control equipment adapted to monitor and/or control operating

parameters (e.g., gas flow and/or pressure) across all compressor units. Such equipment may be in communication with the remote MC system (e.g., via a network) to allow for remote monitoring and control of the compressor module 215 by any number of operators and/or for automatic control thereof.

[0076] In certain embodiments, the natural gas processing system 200 may include a CO_2 removal module 222 to remove CO_2 294 from the gas stream. Generally, the CO_2 removal module 222 will be employed, as required, to meet pipeline specifications. For example, the CO_2 removal module 222 may be employed to reduce CO_2 content in the gas stream to less than about 1% CO_2.

[0077] In one embodiment, the CO_2 removal module 222 may comprise one or more membranes, such as a spiral-wound cellulose acetate membrane. Generally, the membrane operates on the principle of selective permeation, where components with higher permeation rates (e.g., CO_2) permeate through a membrane faster than those with lower permeation rates (e.g., methane, ethane and heavier hydrocarbons). Accordingly, the gas feed stream may be separated into a hydrocarbon-rich (residual) stream on the exterior of the membrane fiber and a CO_2-rich (permeate) stream on the interior of the membrane fiber.

[0078] It will be appreciated that the CO_2 removal module 222 may be adaptable to various gas volumes, CO_2 concentrations, and/or fuel gas specifications. Moreover, operational parameters of the CO_2 removal module, such as pressure difference between the feed gas and permeate gas and/or concentration of the permeating component, may be monitored and/or controlled via various equipment in communication with the remote MC system.

[0079] In another embodiment, the CO_2 removal module 222 may comprise an amine sorbent system. As known in the art, such systems are adapted to absorb CO_2 and then desorb the CO_2 to atmosphere.

[0080] In one embodiment, the natural gas processing system 200 may include a desulfurization module 224 adapted to remove sulfur 295 from the gas stream. Generally, sulfur exists in natural gas as hydrogen sulfide (H_2S), and the natural gas will typically require desulfurization when its H_2S content exceeds about 0.01 lbs/Mscf. It will be appreciated that gas containing high levels of H_2S (i.e., “sour gas”) is undesirable because it is both corrosive to equipment and dangerous to breathe.

[0081] The desulfurization module 224 may employ various technologies to "sweeten," or remove sulfur from, sour gas. In one embodiment, the desulfurization module 224 may employ dry sorbents to capture sulfur gases in solid form (e.g., as sulfates or sulfites). In one such embodiment, a fine sorbent may be injected into the feed gas and the resulting sulfur-containing solids 295 may be collected. Exemplary dry sorbents that may be employed include, but are not limited to, calcium oxide, magnesium oxide, and sodium carbonate.

[0082] In an alternative embodiment, the desulfurization module 224 may comprise a wet scrubber subsystem, such as venturi, packed-column, or tray-type systems. In this embodiment, the feed gas may be contacted with a scrubbing solution or slurry to absorb the H_2S and convert it to mercaptans, which are then drained from the spent bed in liquid form.

[0083] In yet another embodiment, the desulfurization module 224 may employ amine solutions to remove H_2S. During this process, the feed gas is run through a tower containing an amine solution that absorbs sulfur. Exemplary amine solutions may include, but are not limited to, monoethanolamine ("MEA") and diethanolamine ("DEA"). In one such embodiment, the amine solution may be regenerated (i.e., the absorbed sulfur may be removed) and reused.

[0084] In certain embodiments, the sulfur-containing discharge 295 may be discarded. However, in other embodiments, the sulfur may be reduced to its elemental form via further processing and then sold. One exemplary process employed to recover sulfur is known as the "Claus process" and involves using thermal and catalytic reactions to extract the elemental sulfur from the hydrogen sulfide solution.

[0085] It will be appreciated that, no matter which of the above technologies is employed by the desulfurization module 224, a resulting gas stream may be produced that is virtually free of sulfur compounds. That is, the resulting gas stream may comprise a sulfur content of less than about about 0.01 lbs/Mscf.

[0086] The natural gas processing system 200 may additionally or alternatively comprise a dehydrator module 226 adapted to remove water 296 from the gas stream. Generally, the dehydrator module 226 may be employed to reduce the moisture content of the gas stream to about 7 lbs/Mscf or less. This mitigates the risk of damage to pipes and process equipment from blocked flow and corrosion.

[0087] In one embodiment, the dehydrator module 226 may comprise any number of dryer beds including one or more desiccants. Exemplary desiccants include, but are not limited to: activated charcoal/carbon, alumina, calcium oxide, calcium chloride, calcium sulfate, silica, silica alumina, molecular sieves (e.g., zeolites), and/or montmorillonite clay. In one particular embodiment, desiccant materials may be present in a packed-bed configuration.

[0088] It will be appreciated that most desiccants have a limited adsorption capacity and must be replaced or regenerated at given service intervals. Accordingly, for continuous dehydration service, a multi-bed system may be employed where one or more beds are utilized while the others are being replaced/regenerated. The active bed(s) can then be switched in and out of service as required or desired.

[0089] In another embodiment, the dehydrator module 226 may comprise a Triethylene Glycol ("TEG") system. This system contacts the wet gas with TEG, which absorbs the water from the wet gas stream to produce a rich TEG stream. The rich TEG stream is heated with a gas-fired heater and the water is driven off in the form of water vapor to atmosphere. The lean TEG stream may then be cooled and pumped back to contact the gas stream.

[0090] In other embodiments, the dehydrator module 226 may remove water through the use of additives, such as methanol or ethylene glycol, which may be sprayed into the natural gas stream to suppress the freezing point of liquid water. In yet other embodiments, dehydration may comprise a number of steps, including active dehydration, depressurization, regeneration, and repressurization.

[0091] In certain embodiments, the natural gas processing system 200 may include a refrigeration module 230 comprising one or more mechanical refrigeration units ("MRU"). Generally, the refrigeration module may be employed to cool natural gas in an effort to reduce the hydrocarbon dew point of the gas (e.g., to meet pipeline quality specifications) and/or to maximize NGLs recovery (e.g., to improve the overall monetary return of a natural gas stream).

[0092] In one embodiment, the refrigeration module 230 may be adapted to lower the temperature of the received gas stream to a target temperature, such that NGLs comprising propane and higher hydrocarbons (C3+) 297 may be separated therefrom. The target temperature may be selected to allow the NGLs stream 297 to be condensed (e.g., in a single column), without condensing substantial amounts of methane or ethane. Accordingly, the condensed NGLs stream 297 may be

separated and transported for sale via truck, rail or pipe; and the resulting fuel gas stream 202, which comprises mostly methane and ethane, may be transferred to the electrical power generation module.

[0093] In certain embodiments, the refrigeration module 230 may lower the temperature of the received gas stream via heat exchange with a low temperature fluid (i.e., a refrigerant). Exemplary refrigerants include, but are not limited to, propane, propylene (C_3H_6), n-butane, and/or ethylene (C_2H_4). It will be appreciated that other hydrocarbon and non-hydrocarbon refrigerants may additionally or alternatively be employed.

[0094] Generally, the refrigeration module 230 may cool the received gas stream to a target temperature of from about -10 °F to about -32 °F, depending on the composition of the received gas stream. During cooling, the pressure may be adjusted to, or maintained at, from about 70 psi to about 510 psi.

[0095] In one particular embodiment, the refrigeration module 230 may comprise a cascade refrigerator that employs two or more refrigeration stages in series to achieve a lower temperature than is otherwise achievable in a single stage. For example, the refrigerator may cool the gas to a first temperature during a first stage (i.e., a "high stage"), and then cool the gas to a second temperature that is lower than the first temperature during a second stage (i.e., a "low stage").

[0096] It will be appreciated that operational parameters of the refrigeration module 230 may be monitored and/or controlled across any number of refrigeration units via various equipment in communication with the remote MC system. Such operational parameters may include, but are not limited to, temperature and/or coolant recirculation rate.

[0097] It will be appreciated that many aspects of the system 200 depicted in FIG. 2 may be modified or altered to produce fuel gas 202 from raw natural gas 201 received from one or more wellheads 209 in an oil and gas reservoir. The illustrated system 200 is exemplary, and is intended to show broadly the relationship between the various aspects of the system.

Electrical Power Generation System

[0098] FIGs. 3-4 show exemplary electrical power generation systems (300, 400) according to various embodiments. FIG. 3 shows an exemplary electrical power generation system 300 comprising a power generation module 331 in electrical communication with an electrical

transformation module 335. And FIG. 4 shows an exemplary electrical power generation system 500 comprising a plurality of power generation modules (431a, 431b) in a parallel configuration, wherein such modules are in electrical communication with a single electrical transformation module 435.

[0099] Referring to FIG. 3, an exemplary electrical power generation system 300 is illustrated. As shown, the system 300 comprises a power generation module 331 in communication with a gas supply line 320 such that it may receive fuel gas 302 therefrom. The power generation module 331 is further shown to be in electrical communication with an electrical transformation module 335 such that an electrical output 303 may be transmitted from the power generation module to the electrical transformation module.

[0100] Generally, the power generation modules 331 may comprise a generator component adapted to convert fuel gas 302 into electrical energy 303, various equipment for monitoring and controlling the generator component, and ancillary equipment to support the generator component. As discussed below, each of these components may be contained within a protective housing such that the entire power generation module 331 is transportable.

[0101] In one embodiment, the power generation module 331 may comprise a generator component adapted to generate an electrical output 303 via combustion of the fuel gas 302. Generally, the generator component may employ either a fuel-gas-driven reciprocating engine or a fuel-gas-driven rotating turbine to combust the fuel gas 302 and drive an electrical generator.

[0102] The generator component may be associated with various properties, such as various input fuel requirements, a fuel gas consumption rate and an electrical output. The input fuel requirements of a given generator component specify the required properties of fuel received by the generator. As discussed above, the employed power generation modules 331 may be specified to operate with fuel gas 302 having a wide variety of properties. For example, certain modules may include a generator components adapted to utilize rich gas, delivered directly downstream of a separator module. Additionally or alternatively, the power generation module 331 may comprise a generator adapted to utilize fuel gas that has been processed to such that it is substantially free of propane and higher hydrocarbons (C3+) components.

[0103] The fuel gas consumption rate of a given generator refers to the volume of fuel gas consumed by the generator within a given time period. The fuel gas consumption rate may be

determined for continuous operation of the generator at standard ambient conditions. Generally, the fuel gas consumption rate of engine-type generators may range from about 40 Mscfd to about 500 Mscfd. And the fuel gas consumption rate of turbine-type generators may range from about 1 MMscfd to about 6 MMscfd.

[0104] Electrical output refers to the electrical energy output by a given generator after efficiency losses within the generator. This property is often referred to as "real power" or "kWe." The electrical output may be provided as "continuous power," which refers to the real power obtained from the generator when the module is operating continuously at standard ambient conditions.

[0105] Although nearly any generator may be employed in the power generation modules 331, it has been found that generators that produce an electrical output of from about 70 kW to about 30 MW are preferred because these sizes correlate with the quantities of fuel available in a typical application.

[0106] Generally, engine-type generators may produce an electrical output ranging from about 70 kW to about 2 MW, with an associated voltage ranging from about 480 V to about 4.16 kV. And turbine-type generators may produce an electrical output ranging from about 2 MW to 30 MW, with an associated voltage ranging from about 4.16 kV to about 12 kV.

[0107] It will be appreciated that the various generator components employed in the power generation module 331 may be adapted to operate reliably in harsh oilfield conditions, and with variability in gas rates, composition and heating values. Moreover, it will be appreciated that the specific generator employed in a power generation module 331 may be selected and configured based on the specifications of the raw natural gas and the amount of such raw natural gas that is produced at the wellhead.

[0108] As shown, the power generation module 331 may be in further communication with a backup fuel supply 337 containing a backup fuel 308. In one embodiment, the backup fuel supply 337 may comprise a natural gas storage tank containing pressurised natural gas (e.g., received from the natural gas processing system). In another embodiment, the backup fuel supply 337 may comprise an on-site reserve of propane. At times of low wellhead gas pressure, the backup fuel 308 may be piped directly to the generator of the power generation module 331, from the backup fuel supply 337.

[0109] In one embodiment, the power generation module 331 may be adapted to automatically switch between the fuel gas 302 and the backup fuel 308. In such embodiments, the generator may utilize fuel gas 302 as long as the pressure and/or flow rate of the fuel gas is greater than or equal to a predetermined value (e.g., from about 20 psig to about 25 psig); and the generator may switch to the backup fuel 308 when the pressure and/or flow rate drops below the predetermined value. It will be appreciated that the fuel switching process may be seamless, resulting in uninterrupted electrical power generation regardless of instantaneous natural gas supply rates.

[0110] In one embodiment, the power generation module 331 may comprise various monitoring and control equipment in direct communication with the generator component and in remote communication with the MC system (e.g., via a network). Such equipment may allow for automatic monitoring of operational parameters, including but not limited to, fuel gas supply pressure, fuel gas flow rate, fuel gas characteristics, electrical output (e.g., frequency, voltage, amperage, etc.) and/or emissions. And this configuration may further allow for automatic and/or manual control of the generator, which enables greater reliability and efficiency in remote oilfield locations where human operators are not always present.

[0111] Typically, the power generation module 331 will further comprise various ancillary components (commonly referred to as the "balance of plant"). Such components may include, but are not limited to, compressors, lubrication systems, emissions control systems, catalysts, and exhaust systems.

[0112] As an example, the power generation module 331 may comprise integrated emissions reduction technologies, such as but not limited to, a non-selective catalytic reduction ("NSCR") system or a selective catalytic reduction ("SCR") system. However, even without employing such emissions technology, the internal combustion process employed by the disclosed embodiments, may significantly reduce emissions of NOx, CO and volatile organic compounds ("VOCs") relative to flaring. For example, an exemplary electrical power generation system 300 that does not include an NSCR or SCR may reduce emissions of such compounds by about 95% or more, as compared to flaring (e.g., at least 95%, at least 96%, at least 97%, at least 98%, or at least 99%).

[0113] It will be appreciated that emissions monitoring and control are key permitting requirements in the oilfield. By reducing emissions, the disclosed embodiments help oil and gas

operators achieve environmental and regulatory benefits as well as improved community relationships.

[0114] In one embodiment, the power generation module 331 may comprise a housing designed to contain and protect the above-described components of the module. Such housing may provide features such as, but not limited to, weatherproofing, skid or trailer mounting for portability, and sound attenuation.

[0115] In certain embodiments, the power generation module 331 may be supported by a transportable chassis, trailer, or railcar to facilitate positioning and/or repositioning of the module. More particularly, the transportable chassis, trailers, or railcars may be coupled to vehicles, such as trucks or trains, and transported over a geographic area. The generator skids can range in size from an enclosed trailer hauled behind a pickup truck, to a plurality of semi-trailer loads for the generator and its required ancillary equipment.

[0116] As shown, the electrical power generation system 300 further comprises an electrical transformation module 335 in electrical communication with the power generation module 331. Generally, the electrical power 303 generated by the power generation module 331 may be transmitted through the electrical transformation module 335 such that it may be converted into an electrical flow 305 that is suitable for consumption by computing equipment (e.g., a mobile data center and any number of DCUs of a distributed computing system).

[0117] To that end, the electrical transformation module 335 may comprise power conditioning equipment typically including one or more step-down transformers. Such module 335 may be adapted to reduce the voltage of an incoming electrical flow 303 by one or more "steps down" into a secondary electrical flow 305 comprising a lower voltage.

[0118] In one embodiment, the electrical transformation module 335 may comprise a 1 MVA step-down transformer adapted to step down the voltage of an incoming electrical flow 303 having a voltage of from about 480 V to about 4.16 kV. In such cases, the electrical transformation module 335 may convert the incoming electrical flow 303 to a reduced-power output electrical flow 305 having a voltage of about 208 V or about 240 V.

[0119] Alternatively, when larger turbine-type power generation modules 331 are employed, the electrical transformation module 335 may reduce voltage in a plurality of steps. For example, the

electrical transformation module may receive an incoming electrical flow 303 having a voltage of from about 4.16 kV to about 12 kV to and may step down the voltage to about 480 V in a first step. And the module may then further reduce the voltage, via one or more additional steps down, in order to provide a reduced-power output electrical flow 305 having a voltage of about 208 V.

[0120] In certain embodiments, the electrical transformer module 335 may also comprise a main breaker capable of cutting off all downstream electrical flows, which allows an operator to quickly de-power any attached computing equipment in the case of operational work or emergency shut-down. Additionally or alternatively, terminals of the electrical transformation module 335 may be fitted with "quick connects," which are pre-terminated inside the module. Such quick connects allow oilfield electricians to quickly connect the electrical transformation module 335 to the power generation module 331 and to a component of the distributed computing system without extensive on-site fabrication and termination work.

[0121] In the illustrated embodiment, only one power generation module 331 provides electrical power 303 to the electrical transformation module 335. Accordingly, the power generation module 331 may be directly wired from a terminal of the power generation module 331 into a primary side of the electrical transformation module 335.

[0122] Although only one power generation module 331 and one electrical transformation module 335 is shown in FIG. 3, it will be appreciated that any number of such components may be included in the power generation system 300. For example, two or more sets of power generation modules 331 and electrical transformation modules 335 may be employed, in a series configuration, to power any number of computing components (e.g., mobile data centers and DCUs).

[0123] Generally, such equipment may be added and/or removed, as required, to consume substantially all available natural gas supply. Moreover, the specific generators employed in the power generation modules 331, the number of such modules, and the configuration of such modules may also be selected with this goal in mind. For example, such equipment may be selected, configured, added to and/or removed from the electrical power generation system 300, as necessary to allow the system to consume at least about 75% (e.g., at least about 80%, at least about 85%, at least about 90%, or at least about 95%) of the natural gas supply. In this way, the system 300 may substantially reduce the amount of natural gas that must be flared during oil production.

[0124] Referring to FIG. 4, another exemplary electrical power generation system 400 is illustrated. As shown, the system 400 comprises a plurality of power generation modules (431a, 431b) in communication with a gas supply line 420 such that they may receive fuel gas 402 therefrom. The power generation modules (431a, 431b) are also in electrical communication with an electrical transformation module 435 via a parallel panel 460. And, as discussed above, the power generation modules (431a, 431b) may be in communication with one or more backup fuel supplies 437, such that they may receive backup fuel 408 (e.g., propane) therefrom.

[0125] As shown, the electrical power generation system 400 may comprise multiple power generation modules (431a, 431b) connected in parallel to a single electrical transformation module 435. In such embodiments, the multiple electrical power generation modules (431a, 431b) may be phase-synced such that their output electrical flows (403a, 403b) may be combined down-stream without misalignment of wave frequency.

[0126] Specifically, the multiple phase-synced electrical flows (403a, 403b) may be wired into a parallel panel 460, which merges and synchronizes the electrical flows into a single down-stream flow 404 with singular voltage, frequency, current and power metrics. This singular down-stream flow 404 may then be wired into a primary side of an electrical transformation module 435 for voltage modulation. For example, as discussed above, the singular down-stream flow 404 may be transmitted to the electrical transformation module 435 such that the flow may be converted into an output electrical flow 405 that is suitable for consumption by computing equipment (e.g., one or more mobile data centers of a distributed computing system including any number of DCUs).

[0127] In such embodiments, each of the power generation modules (431a, 431b) and/or the parallel panel 460 may comprise a control system that allows for the module to be synchronized and paralleled with other power generation modules. The control system may allow load-sharing of up to 32 power generation modules via a data link and may provide power management capabilities, such as load-dependent starting and stopping, asymmetric load-sharing, and priority selection. Such functionality may allow an operator to optimize load-sharing based on running hours and/or fuel consumption.

Distributed Computing System

[0128] Referring to FIG. 5, an exemplary distributed computing system 500 according to an embodiment is illustrated. As shown, the system 500 may include one or more mobile data centers 510 comprising various electrical components, such as but not limited to: any number of DCUs 520, a communications system 555, an electrical power system 530, a backup power system 540, and/or a monitoring and control system 580.

[0129] Generally, each of the mobile data centers 510 may comprise a prefabricated housing or enclosure to contain and protect the various electronics. The enclosure may comprise a customized shipping container or other modular housing system designed for portability, durability, safety, stack-ability, ventilation, weatherproofing, dust control and operation in rugged oilfield conditions.

[0130] As shown, each of the mobile data centers 510 may comprise an electrical power system 530 adapted to receive electrical power 505 from an electrical transformation module of an electrical power generation system, as discussed above. More particularly, the power system 530 may receive an output electrical flow 505 from a secondary terminal of an electrical transformation module via cable trays, buried lines and/or overhead suspended lines. In certain embodiments, each mobile data center 510 may be fitted with quick connects (discussed above), which are pre-terminated into the power system 530.

[0131] In one embodiment, the electrical power system 530 of a may comprise one or more breaker panels in electrical communication with a series of power distribution units ("PDUs") or power channels. Such PDUs may also be in communication with the various electrical components of the mobile data center 510, such as DCUs 520, backup power systems 540 (e.g., batteries and/or solar panels), a communication system 555, and/or a monitoring and control system 580.

[0132] In certain embodiments, the breaker panels and/or PDUs of the power system 530 may be in communication with a monitoring and control system 580 of the mobile data center 510. And such monitoring and control system 580 may be in communication with the remote MC system (FIG. 1 at 180) via a network such that an operator may remotely control (activate and/or deactivate) these components and all electrical equipment in electrical communication therewith. This remote power control feature is important for efficiency and cost reduction in remote oilfield locations, where a human operator may not be present. For example, PDUs may be remotely

"power cycled" to reset, reboot or restart malfunctioning equipment without the expense or time required to deploy a human. As another example, breaker panel switches may be remotely controlled to turn on / off power to downstream systems without the need for human dispatch.

[0133] As shown, each of the mobile data centers 510 may comprise a plurality of DCUs 520, wherein the DCUs are powered via the power system 530 and, optionally, via the backup power system 540. As discussed above, the DCUs are adapted to conduct any number of processing-intensive tasks, such as but not limited to, graphics-intensive distributed computing processes, server functions, storage, virtual reality and/or augmented reality applications, tasks relating to the Golem Project, non-currency blockchain applications and/or cryptocurrency mining operations.

[0134] It will be appreciated that the number of mobile data centers, the number of DCUs contained in each mobile data center, and/or the processing power of such DCUs may be selected to utilize substantially all electrical power generated by the electrical power generation system. Moreover, such equipment may be added and/or removed from the distributed computing system 500, as desired or required, to consume substantially all electrical power generated by the electrical power generation system. For example, the components of the distributed computing system may be selected, configured, added and/or removed, as necessary to allow the system 500 to consume the maximum practical amount of the power generated by the electrical power generation system (typically in excess of 90% of the available power). This allows for revenue generated from distributed computing tasks to be maximized, while also maximizing consumption of produced natural gas via the electrical power generation system.

[0135] As discussed above, the mobile data centers 510 and the various electronic components contained there (e.g., DCUs 520, monitoring and control system 580, power system 530 and/or backup power system 540) may be connected to a network via wired or wireless connection to a communication system 555. The communication system 555 may comprise one or more modems, network switches, and network management computers to provide connectivity to the network, such as the Internet, via a fiber optic cable, fixed point wireless (laser, millimeter wave towers, microwave towers or the like used to relay high speed internet on a line-of-sight basis), satellite internet, cell-based internet or any other means of internet connection. And the components of the communication system 555 may be distributed throughout the mobile data center 510 as required

to connect all DCUs 520 into the network and to supply sufficient data input and output bandwidth for all connected components.

[0136] It will be appreciated that heat and airflow management are important considerations when operating in an oilfield, as outside air temperatures may vary widely from extreme cold to extreme heat. Moreover, excessive dust and precipitation must also be monitored and controlled during oilfield operation. Accordingly, in one embodiment, the monitoring and control system 580 may be adapted to control various parameters of the mobile data center 510, such as temperature, moisture, oxygen, power and/or others.

[0137] In one embodiment, the mobile data center 510 may be designed with a cold aisle and a hot aisle. For example, the DCUs 520 may be located within vertically stacked, horizontal racks extending along a row within the mobile data center; and all of the DCUs may be positioned within the racks such that their intake fans point towards the cold aisle, while their exhaust fans point in an opposite direction, towards the hot aisle. It will be appreciated that one or more air inlets of the mobile data center 510 may be aligned with the cold aisle and one or more exhausts of the mobile data center be aligned with the hot aisle.

[0138] In one embodiment, the hot and cold aisles may be isolated / separated by employing a faceplate that extends along the row of stacked DCUs 520, adjacent to the exhaust-side thereof. Generally, the faceplate may comprise a metal, plastic, composite, wood or other thin and flat material having a plurality of precut apertures disposed therein. The apertures may be positioned such that each aperture is aligned with an exhaust fan of one of the DCUs. And the apertures may be sized/shaped to complement the size/shape of the DCU exhaust fans, such that each fan substantially fills/covers each aperture and such that each fan may transmit exhaust through one of the apertures. Accordingly, the faceplate forms a physical barrier between gaps in DCU exhaust fans, which helps to ensure that hot air does not recirculate from the hot aisle back to the cold aisle.

[0139] The hot aisle may be naturally vented to an exterior of the mobile data center 510, for example, with direct exhaust via one or more exhaust panels or vents. Alternatively, the mobile data center may include a forced air exhaust system, wherein exhaust fans force air out of the hot aisle and exhaust to the exterior. In such embodiments, the exhaust fans may communicate with the monitoring and control system 580 such that the fans may be automatically activated/deactivated as the temperature within the mobile data center increases/decreases.

[0140] In another embodiment, the mobile data center 510 may comprise various louvers, dampers, filters and/or awnings designed to protect against direct and wind-blown precipitation, as well as excessive dust intake. In such cases, dampers may be connected to the monitoring and control system 580 such that they may be automatically closed to seal and the mobile data center in the event of a power failure.

[0141] It will be appreciated that the mobile data center 510 may be further designed with various safety and security features specific to oilfield operations. For example, the mobile data center 510 may comprise one or more wireless cameras controlled by the monitoring and control system 580 and powered by the power system 530 and/or the backup power system 540. Such cameras may be specified for continuous remote monitoring and/or motion-activated recording. As another example, the mobile data center 510 may comprise may comprise motion activated lighting systems that serve as an additional crime deterrent and/or that may provide sufficient light to facilitate work during nighttime operations.

[0142] And as yet another example, the mobile data center 510 may comprise a fire suppression system designed to retard gas and electrical fires. In one embodiment, the monitoring and control system 580 may cause the dampers to automatically seal when extreme temperatures are detected (i.e., to cut off oxygen flow to a fire inside the mobile data center).

Computing Machines

[0143] Referring to FIG. 6, a block diagram is provided illustrating an exemplary computing machine 600 and modules 650 in accordance with one or more embodiments presented herein. The computing machine 600 may represent any of the various computing systems discussed herein, such as but not limited to, the DCUs (FIG. 5 at 520), the MC system (Fig. 1 at 180), the client devices (FIG. 1 at 160) and/or the third-party systems (FIG. 1 at 170). And the modules 650 may comprise one or more hardware or software elements configured to facilitate the computing machine 600 in performing the various methods and processing functions presented herein.

[0144] The computing machine 600 may comprise all kinds of apparatuses, devices, and machines for processing data, including but not limited to, a programmable processor, a computer, and/or multiple processors or computers. As shown, an exemplary computing machine 600 may include various internal and/or attached components, such as a processor 610, system bus 670, system

memory 620, storage media 640, input/output interface 680, and network interface 660 for communicating with a network 630.

[0145] The computing machine 600 may be implemented as a conventional computer system, an embedded controller, a server, a laptop, a mobile device, a smartphone, a wearable device, a set-top box, over-the-top content TV ("OTT TV"), Internet Protocol television ("IPTV"), a kiosk, a vehicular information system, one more processors associated with a television, a customized machine, any other hardware platform and/or combinations thereof. Moreover, a computing machine may be embedded in another device, such as but not limited to, a smartphone, a personal digital assistant ("PDA"), a tablet, a mobile audio or video player, a game console, a Global Positioning System ("GPS") receiver, or a portable storage device (e.g., a universal serial bus ("USB") flash drive). In some embodiments, such as the DCUs, the computing machine 600 may be a distributed system configured to function using multiple computing machines interconnected via a data network or system bus 670.

[0146] The processor 610 may be configured to execute code or instructions to perform the operations and functionality described herein, manage request flow and address mappings, and to perform calculations and generate commands. The processor 610 may be configured to monitor and control the operation of the components in the computing machine 600. The processor 610 may be a general-purpose processor, a processor core, a multiprocessor, a reconfigurable processor, a microcontroller, a digital signal processor ("DSP"), an application specific integrated circuit ("ASIC"), a graphics processing unit ("GPU"), a field programmable gate array ("FPGA"), a programmable logic device ("PLD"), a controller, a state machine, gated logic, discrete hardware components, any other processing unit, or any combination or multiplicity thereof. The processor 610 may be a single processing unit, multiple processing units, a single processing core, multiple processing cores, special purpose processing cores, coprocessors, or any combination thereof. In addition to hardware, exemplary apparatuses may comprise code that creates an execution environment for the computer program (e.g., code that constitutes one or more of: processor firmware, a protocol stack, a database management system, an operating system, and a combination thereof). According to certain embodiments, the processor 610 and/or other components of the computing machine 600 may be a virtualized computing machine executing within one or more other computing machines.

[0147] The system memory 620 may include non-volatile memories such as read-only memory ("ROM"), programmable read-only memory ("PROM"), erasable programmable read-only memory ("EPROM"), flash memory, or any other device capable of storing program instructions or data with or without applied power. The system memory 620 also may include volatile memories, such as random-access memory ("RAM"), static random-access memory ("SRAM"), dynamic random-access memory ("DRAM"), and synchronous dynamic random-access memory ("SDRAM"). Other types of RAM also may be used to implement the system memory. The system memory 620 may be implemented using a single memory module or multiple memory modules. While the system memory is depicted as being part of the computing machine 600, one skilled in the art will recognize that the system memory may be separate from the computing machine without departing from the scope of the subject technology. It should also be appreciated that the system memory may include, or operate in conjunction with, a non-volatile storage device such as the storage media 640.

[0148] The storage media 640 may include a hard disk, a compact disc read only memory ("CD-ROM"), a digital versatile disc ("DVD"), a Blu-ray disc, a magnetic tape, a flash memory, other non-volatile memory device, a solid-state drive ("SSD"), any magnetic storage device, any optical storage device, any electrical storage device, any semiconductor storage device, any physical-based storage device, any other data storage device, or any combination or multiplicity thereof. The storage media 640 may store one or more operating systems, application programs and program modules such as module, data, or any other information. The storage media may be part of, or connected to, the computing machine 600. The storage media may also be part of one or more other computing machines that are in communication with the computing machine such as servers, database servers, cloud storage, network attached storage, and so forth.

[0149] The modules 650 may comprise one or more hardware or software elements configured to facilitate the computing machine 600 with performing the various methods and processing functions presented herein. The modules 650 may include one or more sequences of instructions stored as software or firmware in association with the system memory 620, the storage media 640, or both. The storage media 640 may therefore represent examples of machine or computer readable media on which instructions or code may be stored for execution by the processor. Machine or computer readable media may generally refer to any medium or media used to provide instructions to the processor. Such machine or computer readable media associated with the modules may

comprise a computer software product. It should be appreciated that a computer software product comprising the modules may also be associated with one or more processes or methods for delivering the module to the computing machine 600 via the network, any signal-bearing medium, or any other communication or delivery technology. The modules 650 may also comprise hardware circuits or information for configuring hardware circuits such as microcode or configuration information for an FPGA or other PLD.

[0150] The input/output ("I/O") interface 680 may be configured to couple to one or more external devices, to receive data from the one or more external devices, and to send data to the one or more external devices. Such external devices along with the various internal devices may also be known as peripheral devices. The I/O interface 680 may include both electrical and physical connections for operably coupling the various peripheral devices to the computing machine 600 or the processor 610. The I/O interface 680 may be configured to communicate data, addresses, and control signals between the peripheral devices, the computing machine, or the processor. The I/O interface 680 may be configured to implement any standard interface, such as small computer system interface ("SCSI"), serial-attached SCSI ("SAS"), fiber channel, peripheral component interconnect ("PCI"), PCI express (PCIe), serial bus, parallel bus, advanced technology attachment ("ATA"), serial ATA ("SATA"), universal serial bus ("USB"), Thunderbolt, FireWire, various video buses, and the like. The I/O interface may be configured to implement only one interface or bus technology. Alternatively, the I/O interface may be configured to implement multiple interfaces or bus technologies. The I/O interface may be configured as part of, all of, or to operate in conjunction with, the system bus 670. The I/O interface 680 may include one or more buffers for buffering transmissions between one or more external devices, internal devices, the computing machine 600, or the processor 610.

[0151] The I/O interface 680 may couple the computing machine 600 to various input devices including mice, touch-screens, scanners, biometric readers, electronic digitizers, sensors, receivers, touchpads, trackballs, cameras, microphones, keyboards, any other pointing devices, or any combinations thereof. When coupled to the computing device, such input devices may receive input from a user in any form, including acoustic, speech, visual, or tactile input.

[0152] The I/O interface 680 may couple the computing machine 600 to various output devices such that feedback may be provided to a user via any form of sensory feedback (e.g., visual

feedback, auditory feedback, or tactile feedback). For example, a computing machine can interact with a user by sending documents to and receiving documents from a device that is used by the user (e.g., by sending web pages to a web browser on a user's client device in response to requests received from the web browser). Exemplary output devices may include, but are not limited to, displays, speakers, printers, projectors, tactile feedback devices, automation control, robotic components, actuators, motors, fans, solenoids, valves, pumps, transmitters, signal emitters, lights, and so forth. And exemplary displays include, but are not limited to, one or more of: projectors, cathode ray tube ("CRT") monitors, liquid crystal displays ("LCD"), light-emitting diode ("LED") monitors and/or organic light-emitting diode ("OLED") monitors.

[0153] Embodiments of the subject matter described in this specification can be implemented in a computing machine 600 that includes one or more of the following components: a backend component (e.g., a data server); a middleware component (e.g., an application server); a frontend component (e.g., a client computer having a graphical user interface ("GUI") and/or a web browser through which a user can interact with an implementation of the subject matter described in this specification); and/or combinations thereof. The components of the system can be interconnected by any form or medium of digital data communication, such as but not limited to, a communication network. Accordingly, the computing machine 600 may operate in a networked environment using logical connections through the network interface 660 to one or more other systems or computing machines across a network.

[0154] The processor 610 may be connected to the other elements of the computing machine 600 or the various peripherals discussed herein through the system bus 670. It should be appreciated that the system bus 670 may be within the processor, outside the processor, or both. According to some embodiments, any of the processor 610, the other elements of the computing machine 600, or the various peripherals discussed herein may be integrated into a single device such as a system on chip ("SOC"), system on package ("SOP"), or ASIC device.

Experiments

Experiment 1

[0155] In a first experiment, a flare mitigation system was deployed at a well site within the Bakken Field. The flare mitigation system included an electrical power generation system having

six engine-type power generation modules adapted to receive fuel gas from a fuel gas supply line. Specifically, the system included a first set of power generation modules including two 350 kW engine-type power generation modules and one 225 kW engine-type power generation module; and a second set of power generation modules that also included two 350 kW engine-type power generation modules and one 225 kW engine-type power generation module.

[0156] The first set of power generation modules was connected, via a first parallel panel, to a first electrical transformation module comprising a 1 MVA step down transformer. And the second set of power generation modules was connected, via a second parallel panel, to a second electrical transformation module comprising a 1 MVA step down transformer.

[0157] The first electrical transformation module received a first input electrical flow from the first parallel panel having a voltage of 480 V and transformed the flow into a first output electrical flow having a voltage of 208 V. The first output electrical flow was then distributed, via diesel locomotive ("DLO") cables on a cable tray, to an electrical power system of a first mobile data center. Specifically, the DLO cables were distributed to a plurality of breaker panels (e.g., 4 or 5) associated with the first mobile data center; each of the breaker panels was in electrical communication with 25 to 35 PDUs; and each of the PDUs was in electrical communication with up to 4 DCUs racked within the first mobile data center. Accordingly the first set of power generation modules was able to support from about 400 DCUs to about 700 DCUs (depending on the number of breaker panels and PDUs employed).

[0158] The second electrical transformation module received a second input electrical flow from the second parallel panel having a voltage of 480 V and transformed the flow into a second output electrical flow having a voltage of 208 V. The second output electrical flow was then distributed to up to 700 DCUs contained within a second mobile center, substantially as described above with respect to the first mobile data center.

[0159] Each of the first and second mobile data centers measured approximately 40' by 8' by 9.5' (e.g., the size of a High Cube shipping container). Both mobile data centers employed forced air with cold air entering through louvered, screened and filtered intakes on one long axis, and hot air exhausting through louvered and screened fan exhausts on the other long axis.

[0160] The above system was found to consume fuel gas at a rate of about 300 Mscfd. The system was further found to generate an electrical output of about 2 MW, wherein substantially all of such electrical output was utilized to power the DCUs contained within the mobile data centers.

Experiment 2

[0161] In a second experiment, a flare mitigation system was deployed at a well site within the D-J Basin. The flare mitigation system included an electrical power generation system having three engine-type power generation modules adapted to receive fuel gas from a fuel gas supply line. A first 1.8 MW engine-type power generation module was connected to both a first electrical transformation module and a second electrical transformation module. A second 1.8 MW engine-type power generation module was connected to both a third and a fourth electrical transformation module. And a third 1.8 MW engine-type power generation module was connected to both a fifth and a sixth electrical transformation module.

[0162] Each of the first, second, third, fourth, fifth and sixth electrical transformation modules comprised a 1 MVA step-down transformer adapted to receive a 480 V input electrical flow from a respective, connected power generation module and to transform such flow into an output electrical flow having a voltage of 208 V or 240 V. Each of the six electrical transformation modules was also in electrical communication with a separate mobile data center (substantially as described above with respect to Experiment 1), such that a total of six mobile data centers comprising a total of 2,100 DCUs were powered via the three 1.8 MW power generation modules.

[0163] The above system was found to consume fuel gas at a rate of about 900 Mscfd. The system was further found to generate an electrical output of about 5.4 MW, wherein substantially all of such electrical output was utilized to power the DCUs contained within the mobile data centers.

Experiment 3

[0164] In a third experiment, a flare mitigation system was deployed at a well site within the D-J Basin. The flare mitigation system included an electrical power generation system comprising a 350 kW or 385 kW engine-type power generation module adapted to receive fuel gas from a fuel gas supply line. The power generation module was connected to an electrical transformation

module comprising a 0.5 MVA step-down transformer, which transformed a 480 V electrical flow from the generator to a 208 V or 240 V output electrical flow (as described above).

[0165] The output electrical flow was then distributed to an electrical power system of a single 20' by 8' by 9.5' mobile data center, which employed power channels (rather than PDUs to support 264 DSUs). For ventilation, the mobile data center utilized natural aspiration via direct exhaust of DCUs to the container's exterior. Specifically, the mobile data center included a pair of awnings and protective walls extending from the air intake (a wall of metal gridding and filtration material on one long axis), as well as the air exhaust wall (a metal grid against which DCU exhaust fans were mounted directly on the other long axis).

[0166] The above system was found to consume fuel gas at a rate of about 70 Mscfd to about 80 Mscfd. Moreover, it was found that, in some cases, two paralleled 170 kW engine-type generators could be substituted for a single 350 kW or 385 kW engine-type generator.

* * *

[0167] Various embodiments are described in this specification, with reference to the detailed discussed above, the accompanying drawings, and the claims. Numerous specific details are described to provide a thorough understanding of various embodiments. However, in certain instances, well-known or conventional details are not described in order to provide a concise discussion. The figures are not necessarily to scale, and some features may be exaggerated or minimized to show details of particular components. Therefore, specific structural and functional details disclosed herein are not to be interpreted as limiting, but merely as a basis for the claims and as a representative basis for teaching one skilled in the art to variously employ the embodiments.

[0168] The embodiments described and claimed herein and drawings are illustrative and are not to be construed as limiting the embodiments. The subject matter of this specification is not to be limited in scope by the specific examples, as these examples are intended as illustrations of several aspects of the embodiments. Any equivalent examples are intended to be within the scope of the specification. Indeed, various modifications of the disclosed embodiments in addition to those shown and described herein will become apparent to those skilled in the art, and such modifications are also intended to fall within the scope of the appended claims.

[0169] It will be understood by those skilled in the art that the drawings are diagrammatic and that further items of equipment such as temperature sensors, pressure sensors, pressure relief valves, control valves, flow controllers, level controllers, holding tanks, storage tanks, and the like may be required in a commercial plant.

[0170] While this specification contains many specific implementation details, these should not be construed as limitations on the scope of any invention or of what may be claimed, but rather as descriptions of features that may be specific to particular embodiments of particular inventions. Certain features that are described in this specification in the context of separate embodiments can also be implemented in combination in a single embodiment. Conversely, various features that are described in the context of a single embodiment can also be implemented in multiple embodiments separately or in any suitable subcombination. Moreover, although features may be described above as acting in certain combinations and even initially claimed as such, one or more features from a claimed combination can in some cases be excised from the combination, and the claimed combination may be directed to a subcombination or variation of a subcombination.

[0171] Similarly, while operations are depicted in the drawings in a particular order, this should not be understood as requiring that such operations be performed in the particular order shown or in sequential order, or that all illustrated operations be performed, to achieve desirable results. In certain circumstances, multitasking and parallel processing may be advantageous. Moreover, the separation of various system modules and components in the embodiments described above should not be understood as requiring such separation in all embodiments, and it should be understood that the described program components and systems can generally be integrated together in a single software product or packaged into multiple software products.

[0172] All references including patents, patent applications and publications cited herein are incorporated herein by reference in their entirety and for all purposes to the same extent as if each individual publication or patent or patent application was specifically and individually indicated to be incorporated by reference in its entirety for all purposes.

CLAIMS

[0173] What is claimed is:

1. A flare mitigation system comprising:

an electrical power generation system comprising:

a power generation module adapted to:

receive a fuel gas stream comprising a fuel gas associated with a heat value of at least about 1,000 Btu/scf; and

consume the fuel gas stream to generate a high-voltage electrical output associated with a first voltage; and

an electrical transformation module in electrical communication with the power generation module, the electrical transformation module adapted to:

receive the high-voltage electrical output generated by the power generation module; and

transform the high-voltage electrical output into a low-voltage electrical output associated with a second voltage that is lower than the first voltage; and

a distributed computing system powered by the electrical power generation system, the distributed computing system comprising:

a communications system comprising one or more data satellite antennas, the communications system adapted to provide a network; and

a first mobile data center comprising:

an enclosure defining an interior space;

a plurality of distributed computing units located within the interior space of the enclosure, each of the plurality of distributed computing units in communication with the network; and

a power system located at least partially within the interior space of the enclosure, the power system in electrical communication with the electrical transformation module and the plurality of distributed computing units such

that the power system receives the low-voltage electrical output and powers each of the plurality of distributed computing units.

2. A system according to claim 1, wherein:

the power generation module comprises an engine-type generator;

the high-voltage electrical output is from about 70 kW to about 2 MW; and

the first voltage is from about 480 V to about 4.16 kV.

3. A system according to claim 2, wherein the second voltage is from about 208 V to about 240 V.

4. A system according to claim 3, wherein:

the high-voltage electrical output is from about 300 kW to about 400 kW;

the first voltage is about 480 V;

the enclosure of the first mobile data center comprises:

a length of about 20 feet;

a width of about 8 feet; and

a height of from about 8.5 feet to about 9.5 feet; and

the plurality of distributed computing units comprises at least about 200 distributed computing units.

5. A system according to claim 4, wherein the electrical power generation system is adapted to consume from about 50 Mscf to about 100 Mscf of fuel gas per day.

6. A system according to claim 3, wherein:

the high-voltage electrical output is from about 1 MW to about 2 MW;

the first voltage is about 480 V;

the enclosure of the first mobile data center comprises:

a length of about 40 feet;

a width of about 8 feet; and

a height of from about 8.5 feet to about 9.5 feet; and

the plurality of distributed computing units comprises at least about 400 distributed computing units.

7. A system according to claim 6, wherein the electrical power generation system is adapted to consume from about 100 Mscf to about 500 Mscf of fuel gas per day.

8. A system according to claim 6, wherein the distributed computing system further comprises a second mobile data center comprising:

a second enclosure defining an interior space, the second enclosure having a length, width and height substantially similar to the respective length, width and height of the enclosure of the first mobile data center;

a second plurality of distributed computing units located within the interior space of the second enclosure, each of the second plurality of distributed computing units in communication with the network; and

a second power system located at least partially within the interior space of the second enclosure, the second power system in electrical communication with the electrical transformation module and the second plurality of distributed computing units such that the power system receives the low-voltage electrical output and powers each of the second plurality of distributed computing units.

9. A system according to claim 6, wherein:

the electrical power generation system further comprises:

a second electrical transformation module in electrical communication with the power generation module, the second electrical transformation module adapted to:

receive the high-voltage electrical output generated by the power generation module; and

transform the high-voltage electrical output into a second low-voltage electrical output associated with the second voltage; and

the distributed computing system further comprises:

a second mobile data center comprising:

a second enclosure defining an interior space, the second enclosure having a length, width and height substantially similar to the respective length, width and height of the enclosure of the first mobile data center;

a second plurality of distributed computing units located within the interior space of the second enclosure, each of the second plurality of distributed computing units in communication with the network; and

a second power system located at least partially within the interior space of the second enclosure, the second power system in electrical communication with the electrical transformation module and the second plurality of distributed computing units such that the power system receives the low-voltage electrical output and powers each of the second plurality of distributed computing units.

10. A system according to claim 1, wherein:

the power generation module comprises a turbine-type generator;

the high-voltage electrical output comprises from about 2 MW to about 30 MW; and

the first voltage is from about 4.16 kV to about 12 kV.

11. A system according to claim 10, wherein the distributed computing system further comprises a second mobile data center comprising:

a second enclosure defining an interior space, the second enclosure having a length, width and height substantially similar to the respective length, width and height of the enclosure of the first mobile data center;

a second plurality of distributed computing units located within the interior space of the second enclosure, each of the second plurality of distributed computing units in communication with the network; and

a second power system located at least partially within the interior space of the second enclosure, the second power system in electrical communication with the electrical

transformation module and the second plurality of distributed computing units such that the second power system receives the low-voltage electrical output and powers each of the second plurality of distributed computing units.

12. A system according to claim 10, wherein:

the electrical power generation system further comprises:

a second electrical transformation module in electrical communication with the power generation module, the second electrical transformation module adapted to:

receive the high-voltage electrical output generated by the power generation module; and

transform the high-voltage electrical output into a second low-voltage electrical output associated with the second voltage; and

the distributed computing system further comprises:

a second mobile data center comprising:

a second enclosure defining an interior space, the second enclosure having a length, width and height substantially similar to the respective length, width and height of the enclosure of the first mobile data center;

a second plurality of distributed computing units located within the interior space of the second enclosure, each of the second plurality of distributed computing units in communication with the network; and

a second power system located at least partially within the interior space of the second enclosure, the second power system in electrical communication with the electrical transformation module and the second plurality of distributed computing units such that the second power system receives the low-voltage electrical output and powers each of the second plurality of distributed computing units.

13. A system according to claim 10, wherein the second voltage is from about 208 V to about 240 V.

14. A system according to claim 1, further comprising a monitoring and control system in communication with the distributed computing system via the network.

15. A system according to claim 1, further comprising a natural gas processing system in communication with the electrical power generation system, the natural gas processing system adapted to process raw natural gas into the fuel gas.

16. A system according to claim 1, wherein the plurality of distributed computing units are adapted to mine a cryptocurrency.

17. A flare mitigation system comprising:

an electrical power generation system comprising:

a first power generation module adapted to:

receive a first fuel gas stream comprising a fuel gas associated with a heat value of at least about 1,000 Btu/scf; and

consume the fuel gas stream to generate a first high-voltage electrical output associated with a first voltage;

a second power generation module adapted to:

receive a second fuel gas stream comprising the fuel gas; and

consume the second fuel gas stream to generate a second high-voltage electrical output associated with the first voltage;

a parallel panel in electrical communication with the first power generation module and the second power generation module, the parallel panel adapted to:

receive the first and second high-voltage electrical outputs; and

combine and synchronize the first and second high-voltage electrical outputs into a combined high-voltage electrical output; and

an electrical transformation module in electrical communication with the parallel panel, the electrical transformation module adapted to:

receive the combined high-voltage electrical output; and

transform the combined high-voltage electrical output into a low-voltage electrical output associated with a second voltage that is lower than the first voltage; and

a distributed computing system powered by the electrical power generation system, the distributed computing system comprising:

a communications system comprising one or more data satellite antennas, the communications system adapted to provide a network; and

a first mobile data center comprising:

an enclosure defining an interior space;

a plurality of distributed computing units located within the interior space of the enclosure, each of the plurality of distributed computing units in communication with the network; and

a power system located at least partially within the interior space of the enclosure, the power system in electrical communication with the electrical transformation module and the plurality of distributed computing units such that the power system receives the low-voltage electrical output and powers each of the plurality of distributed computing units.

18. A system according to claim 19, wherein:

the first power generation module comprises an engine-type generator;

the first high-voltage electrical output is from about 70 kW to about 2 MW;

the second power generation module comprises an engine-type generator;

the second high-voltage electrical output is from about 70 kW to about 2 MW; and

the first voltage is from about 480 V to about 4.16 kV.

19. A system according to claim 18, wherein the second voltage is from about 208 V to about 240 V.

20. A system according to claim 19, wherein the distributed computing system further comprises a second mobile data center comprising:

a second enclosure defining an interior space;

a second plurality of distributed computing units located within the interior space of the second enclosure, each of the second plurality of distributed computing units in communication with the network; and

a second power system located at least partially within the interior space of the second enclosure, the second power system in electrical communication with the electrical transformation module and the second plurality of distributed computing units such that the second power system receives the low-voltage electrical output and powers each of the second plurality of distributed computing units.

ABSTRACT

[0174] Systems and methods are provided to mitigate flaring of natural gas. A natural gas processing system may process raw natural gas into a fuel gas stream that may be used to power any number of on-site power generation modules. In turn, the power generation modules may convert the fuel gas stream into an electrical output, which may be employed to power any number of distributed computing units housed within one or more mobile data centers. In certain embodiments, the distributed computing units may be adapted to mine cryptocurrency or perform other distributed computing tasks to generate revenue.