ELANCIUM
At the Nexus of Energy
and Blockchain Technology

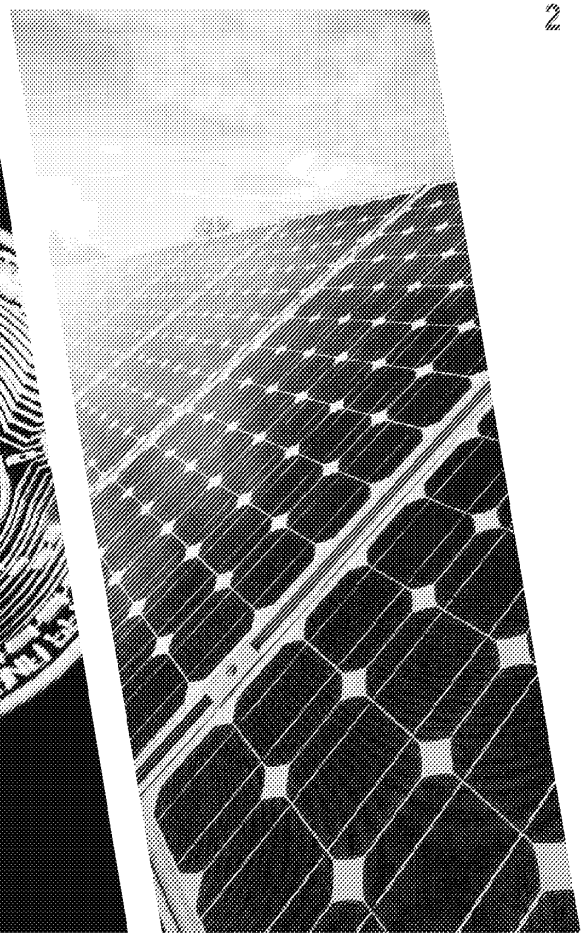
LANCIUM

OPPORTUNITY

EXECUTIVE SUMMARY

Lancium is solving two of today's most prominent problems in emerging technology





Exploding demand for electricity from cryptocurrency mining

Proof-of-Work blockchain currencies require a tremendous and growing amount of energy

Excess and wasted energy

Exponential renewable energy growth and wasted thermal energy is causing grid instability and environmental destruction

LANCIUM

LANCIUM

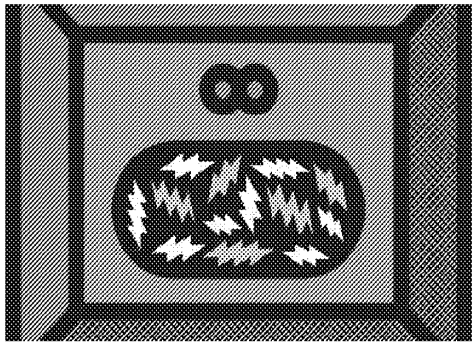
Creating a flexible datacenter solution that can uniquely capitalize on both of these growing problems

COMMERCIAL PLAN



- Lancium is currently raising US$10mm+ to fund commercial roll out of our *Lancium Core* and *Lancium Flex* modular mining units
- Deploying units in Q1 2018 with strong pipeline expected to convert throughout 2018
- Lancium has assembled an executive team with extensive experience in cryptocurrencies, industrial/power, enterprise software and corporate finance

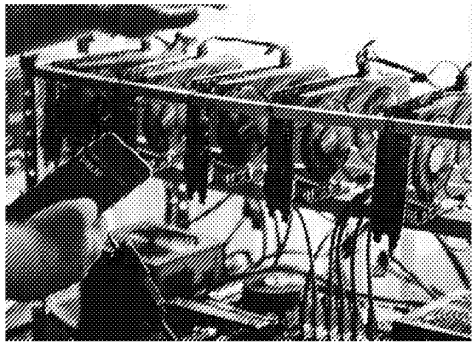
Bitcoin Energy Consumption: In the News



28 SEPTEMBER 2017

THE RIDICULOUS AMOUNT OF ENERGY IT TAKES TO RUN BITCOIN

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01 NOVEMBER 2017

One Bitcoin Transaction Now Uses as Much Energy as Your House in a Week

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01 NOVEMBER 2016

Bitcoins Energy Consumption An Unsustainable Protocol That Must Evolve?

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Solution: Capturing Wasted Energy

Oceans of Wasted Power

Renewable Power (Power Price: <$0.03/KWh)

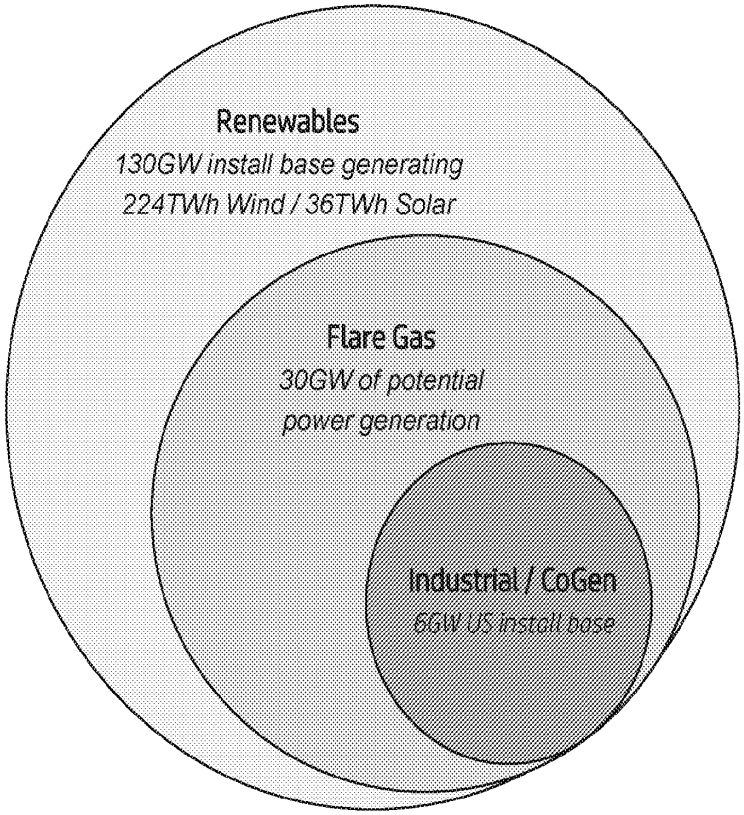
- Lowest LCOE for new generation (below NG)
- Government mandates to reach 30-50% renewable power
- High renewable penetration drives negative priced power

Flare Gas/Vented Methane (Power Price: <$0.05/KWh)

- Flare gas of ~10Bcfpd globally (~3% of the NG market)
- Flaring in the US is responsible for ~150MM tons of CO2
- Environmental regulation is very likely to increase

Industrial / CoGen (Power Price: <$0.04/KWh)

- Market already disrupted by growth in renewables
- Captive source of power with no alternative ("stranded")
- Opportunity set to grow as renewables penetration increases



Sources:
https://www.eia.gov/dnav/ng/hist/n9040us2a.htm
https://www.epa.gov/ghgemissions/global-greenhouse-gas-emissions-data

The Opportunity

Renewable Power Glut

Renewable energy growth is exploding and growing faster than anticipated

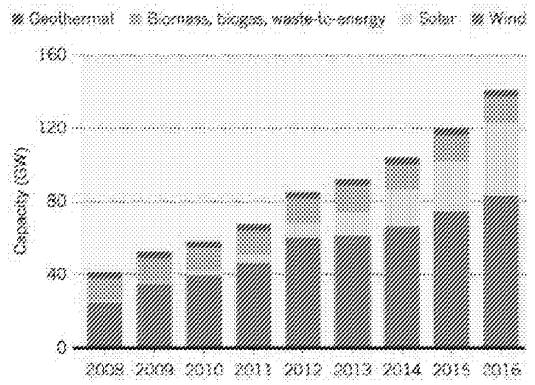
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- Negative power prices
- Volatility attributed to curtailment, congestion and load response requirements

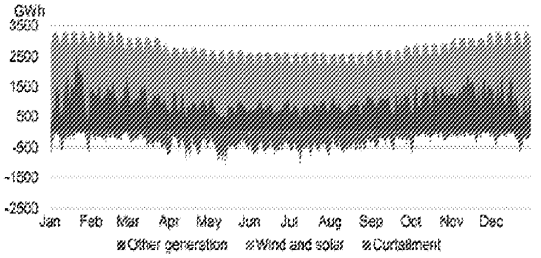
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There is limited industrial user for this power due to its volatility and scale, its distributed nature and forecast/technology development challenges

RENEWABLE ENERGY GROWING EXPONENTIALLY



SO ARE POWER CURTAILMENTS



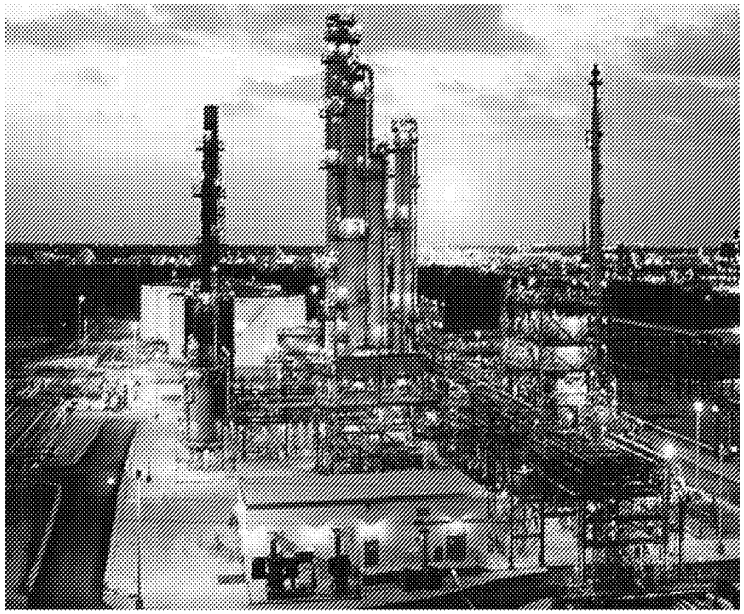
Source: Bloomberg New Energy Finance

Ex.1002
Cholla Energy LLC & OBM, Inc. / Page 377 of 611

The Opportunity

Industrial and CoGen

- Cogeneration underwritten for a different power environment
- Excess electricity now sold into a grid burdened by renewable over-generation
- Lancium will co-locate at industrial facilities and be preferred offtake at highly favorable power prices



The Opportunity

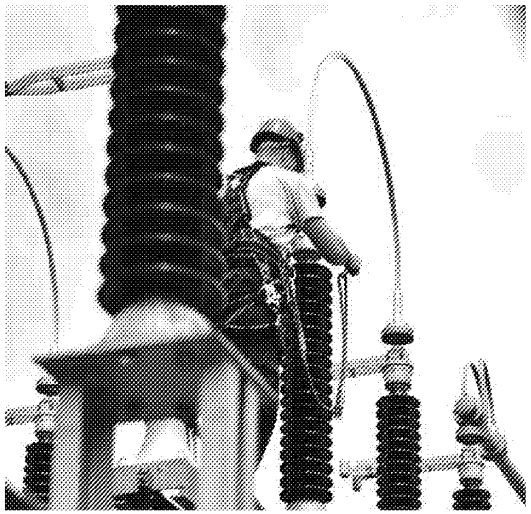
Flare Gas and Vented Methane

- Shale wells drilled for oil alone and pipeline constraints lead to heavy flaring
- Flared gas is one of the largest identifiable sources of CO2 emissions with methane up to 30x more harmful
- Lancium is evaluating partnerships to provide an integrated product offering to convert methane to power to bitcoin



POTENTIAL CUSTOMERS

POTENTIAL REVENUE STREAMS



INDEPENDENT POWER PRODUCERS

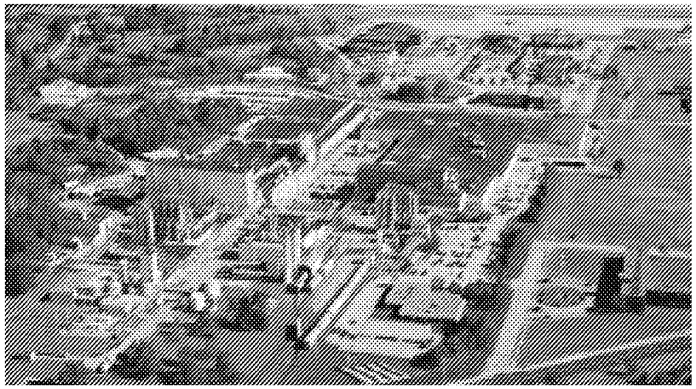
Value Proposition:

Power producers are forced to curtail production or sell power at negative prices at certain times

Lancium will provide power producers a "put" and receive free or nearly free power in exchange

POTENTIAL CUSTOMERS

POTENTIAL REVENUE STREAMS



INDUSTRIAL POWER/COGEN

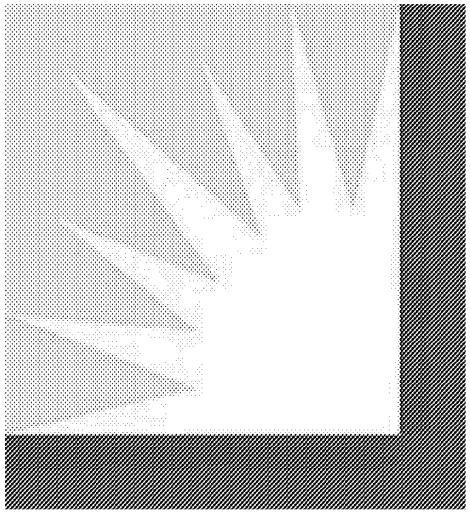
Value Proposition:

Capture power that would otherwise be sold into an adverse market

Lancium will locate units 'behind the fence' to capture this power and avoid Transmission and Distribution charges

POTENTIAL CUSTOMERS

POTENTIAL REVENUE STREAMS



UTILITIES

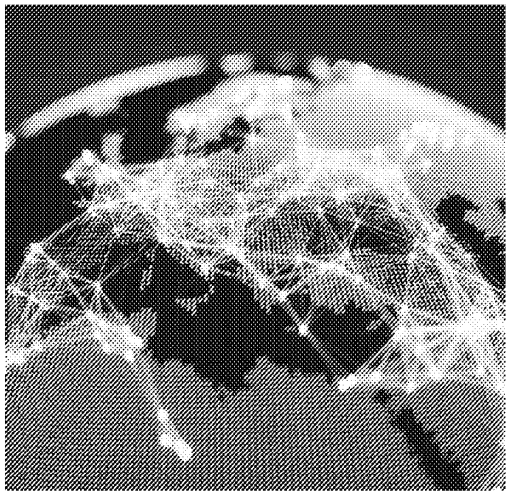
Value Proposition:

Consumer prices are rising despite low power prices due to volatility and inefficiency.

Lancium will sell, install and service a fleet of units to provide price stability and cost savings.

POTENTIAL CUSTOMERS

POTENTIAL REVENUE STREAMS



GRID

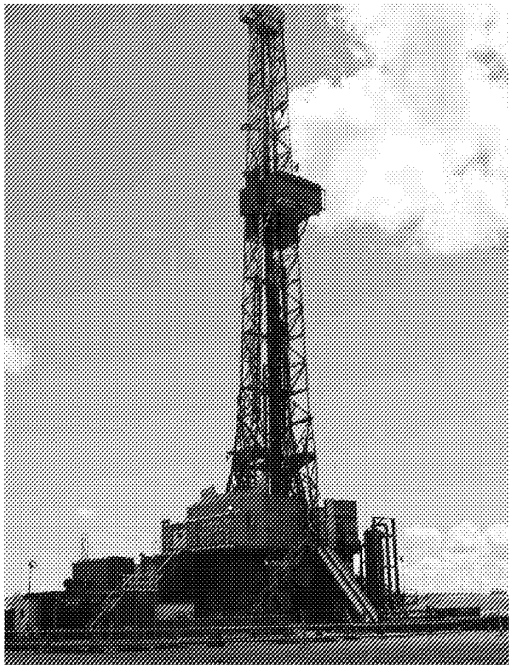
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Power grids are suffering from selective excessive power & heavy ramping needs causing instability and volatility

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POTENTIAL CUSTOMERS

POTENTIAL REVENUE STREAMS



E&P COMPANIES

Value Proposition:

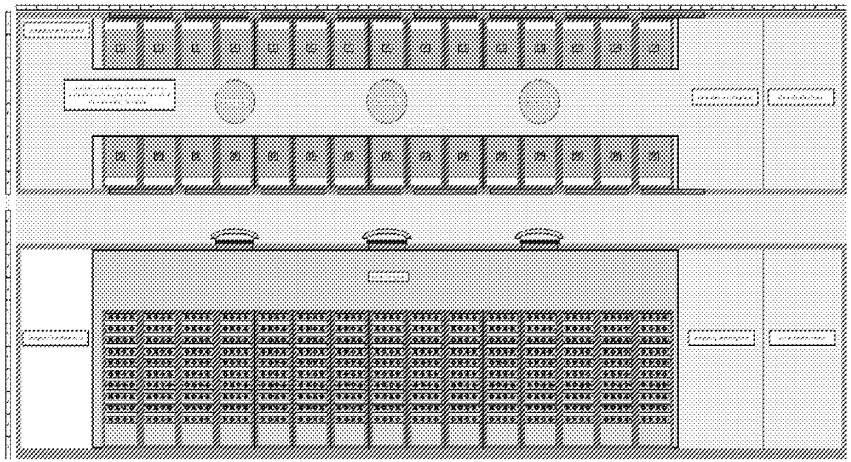
E&P's waste natural gas and fail to capture methane that is highly harmful to the environment

Lancium will provide a methane capture systems that will prevent flaring and use otherwise wasted natural gas to power our modular mining units

The Opportunity

THE LANCIUM SOLUTION

- Small footprint units that can absorb or drop load nearly instantly
- Units designed to draw 1MW each with ability to scale to any possible size
- Internally designed with multiple patent pending elements
- Fully mobile and modular to provide nearly instant solutions for any grid stability issues



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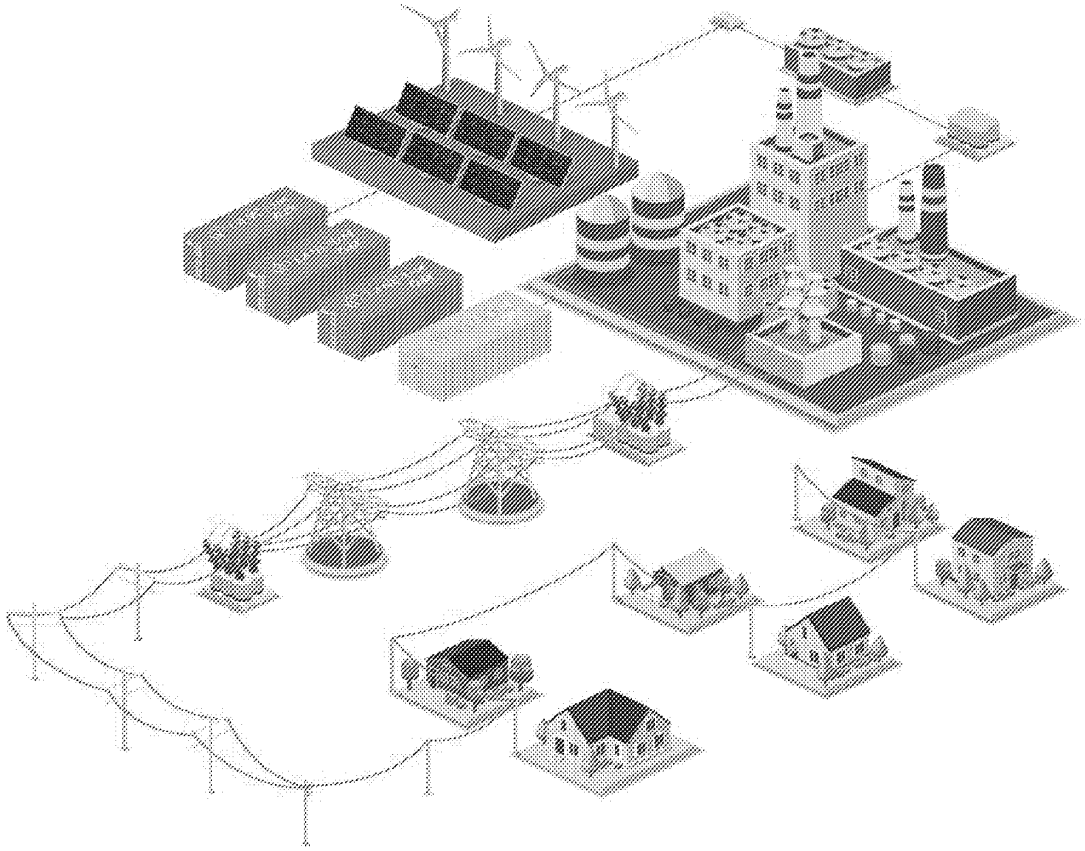
Ex.1002

The Lancium Fleet

	LANCIUM CORE	LANCIUM FLEX
Description	"Baseload" solution	"Peaker" solution
Run Time & Equipment	Will run 24/7 with leading edge mining equipment	Run selectively utilizing older generation mining equipment
Build Cost	Approx. $2mm	Approx. $200k
Power and Hashing Capacity	1MW with 10PH of BTC hashing power	1MW with 1PH BTC hashing power

The Lancium Fleet

- Flexible, modular, mobile units deployed throughout grid
- Fleet can move and grow/shrink as needed
- Lancium will constantly optimize Core/Flex deployment dynamically



CEO & CO-FOUNDER

MICHAEL MCNAMARA, CFA

Michael is a private investor and is currently on the board or serving as advisor to a number of start-up firms in the consumer, energy and technology space. Previously, Michael co-founded ROR Capital, a merchant bank focused on natural resources. Over several years, ROR partnered with leading Private Equity firms to successfully restructure a number of multi-billion dollar natural resource companies.

Michael spent 10 years on Wall Street at several multi-billion hedge funds focused on natural resource and event-driven investments ultimately part of teams overseeing $1bn+ of investments in the space. Michael began his career at PriceWaterhouseCoopers with roles in the consulting and accounting divisions. Michael graduated Magna Cum Laude from Georgetown University with degrees in Accounting and Finance and is a member of the New York Society of Security Analysts and the CFA Institute.

CO-FOUNDER

PRASHANT GUPTA, CFA, CPA (INACTIVE)

Prashant is an active private investor across multiple industries and geographies. Mr. Gupta most recently served as the Chief Financial Officer of Forbes 400 family office with significant portfolio of investments in hedge funds, real estate and gaming. Prashant oversaw all aspects of the family office's investment financing, structuring, accounting, audit, taxation and estate planning.

Prior to that, Prashant was a Senior Manager with Ernst & Young LLP, where he spent six years specializing in hedge funds, mutual funds and broker-dealers, two of which were spent in an offshore jurisdiction. Prashant received an M.S. degree in Accounting from the University of Virginia and a B.A., summa cum laude, in Economics and Accounting from Muskingum University. Prashant has been awarded an honorary Doctorate in Humane Letters by Muskingum University recognizing his distinguished career and achievements.

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CHIEF TECHNICAL OFFICER

DR. DAVID J. HENSON Ph.D., BCHE

Dr. Henson recently served as the Chief Executive Officer of Siemens Conceptual Engineering Services. He served as the Director of Emerging Technology for Siemens Oil & Gas Division with responsibility for developing and deploying Siemens based businesses & Siemens Oil & Gas provide field-proven compressors, gas and steam turbines, electric drives, motors and associated control and data systems. Siemens O&G division has approximately 16,000 employees worldwide.

Dr. Henson has more than 15 years experience in process engineering, project management, business development and commercial experience with international companies in both client and contractor roles. He has been an Executive Director at LWP Technologies Limited since January 2016.. He has been the Project Director for Dominions Cove Point LNG while at IHI E&C Dr. Henson holds a PhD in chemical engineering.

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CHIEF MINING OFFICER

DR. RAYMOND CLINE Ph.D

Dr. Cline is currently responsible for Lancium's cryptocurrency strategy and initiatives. Dr. Cline serves as a member of the IEEE Blockchain Initiative Steering Committee and is President/CEO of RWI Mining, LLC, a Blockchain mining firm.

He has participated in the development of a broad range of technologies, including high performance computing and communications technology, distance computing, collaborative computing, parallel processing, distributed computing, distributed object computing, distributed multimedia, networking protocols, and Asynchronous Transfer Mode (ATM) networking. He has applied these technologies to the development of systems to address needs in the petroleum, national security, manufacturing, and medical industries, with a specialization in recent years toward digital energy solutions (the application of dynamic, network centric operational models in the energy space).

Dr. Cline serves on the board of HARC, a research hub providing independent analysis on energy, air, and water issues to people seeking scientific answers, is a Fellow of the Borders, Trade, and Immigration Institute, a DHS Center of Excellence, and is a technical advisor to Advanced Green Computing Machines. Dr. Cline had previously led the Department of Energy funded Smart Grid Education and Training Coalition; was a member of the Executive Committee of TMAC, the Texas affiliate of the Manufacturing Extension Partnership (MEP) program of National Institute of Standards and Technology (NIST); served on the board of the Global Energy Safety Institute; and served as the Chairperson of the Cluster Development Committee of the Greater Houston Partnership Energy Collaborative.

Dr. Cline earned a PhD in Chemical Physics from the University of Illinois and a BS in Chemistry from Kent State University.

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STRATEGIC ADVISOR

BRUCE RISING

Bruce Rising is formerly Strategic Business Manager within Siemens Power Systems Sales. Previously, Bruce was manager of Marketing Intelligence in Siemens' Global Strategy group. Before joining Global Strategy, he was the manager of Regulatory Affairs for Siemens Energy where he assisted the Gas Turbine Association in Washington DC as the chairman of the Environmental Affairs Committee for six years. During that time he represented the gas turbine industry on the Natural Gas Council Committee on Gas interchangeability related to imported LNG, and the effort to delist gas turbines from the MACT ruling. He was a key author in a study requested by the Secretary of Energy to review the impact of unconventional energy supplies on the power sector.

Bruce's experience encompasses 30+ years in combustion, environmental control technology, and gas turbine technology issues. Prior to joining Siemens he was the manager of Emissions and Control Technology for RollsRoyce Allison in Indianapolis, and research scientist in Energy and Environmental R&D at Battelle Columbus Labs. He earned a BS in Chemical Physics and an MS in Fuel Science from Penn State. He is a member of the American Society of Mechanical Engineers, the Association for the Advancement of Science, the American Chemical Society and National Association of Corrosion Engineers. He holds seven patents related to energy production, emissions controls and engine diagnostics.

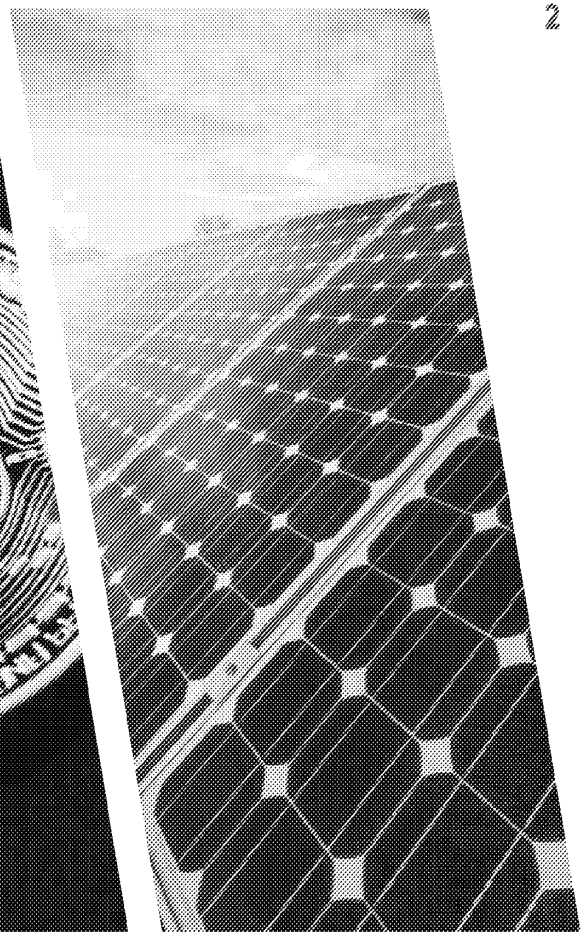
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EXPLODING DEMAND FOR ELECTRICITY FROM CRYPTOCURRENCY MINING

Proof-of-Work blockchain currencies require a tremendous and growing amount of energy

EXCESS AND WASTED RENEWABLE ENERGY

Exponential growth of solar and wind power is causing grid instability and wasted power

LANCIUM

LANCIUM

CREATING A DATACENTER SOLUTION THAT CAN UNIQUELY CAPITALIZE ON BOTH OF THESE GROWING PROBLEMS

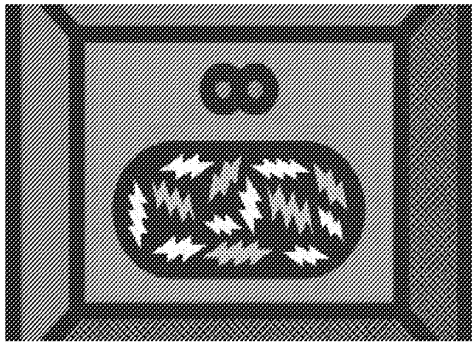
EXECUTIVE SUMMARY

COMMERCIAL PLAN



- Lancium is currently raising $1 to 2mm at a $3mm pre-money valuation of which Management has committed $750,000
- Use of proceeds will be to launch two commercial data centers, file multiple patents and make critical hires ahead of larger capital raise in Q1 2018
- Lancium has assembled an executive team with extensive experience in cryptocurrencies, industrial/power, enterprise software and corporate finance

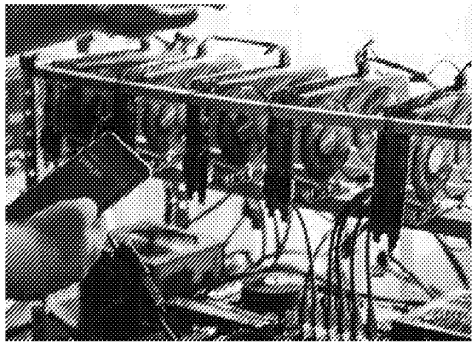
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THE OPPORTUNITY

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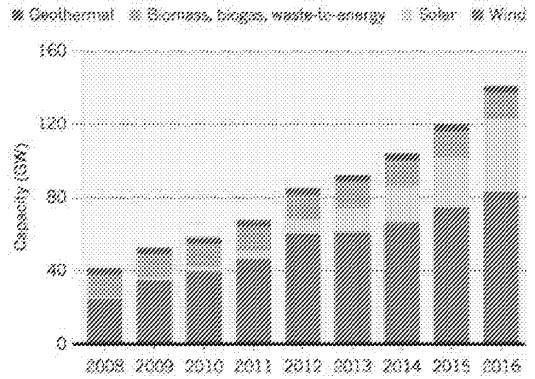
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- Volatility attributed to curtailment, congestion and load response requirements

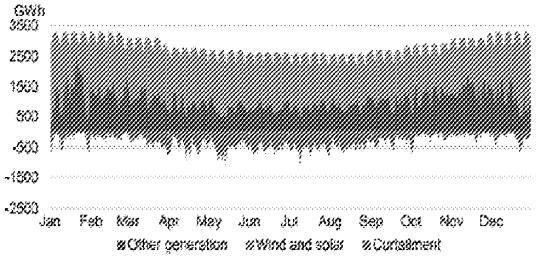
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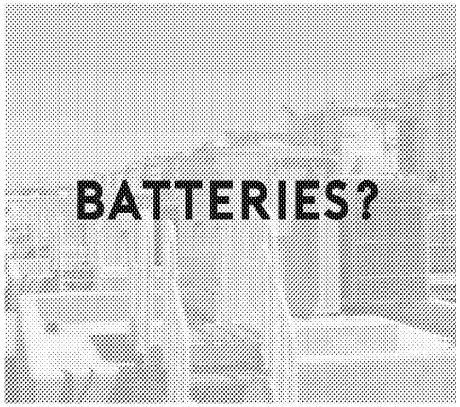
SO ARE POWER CURTAILMENTS



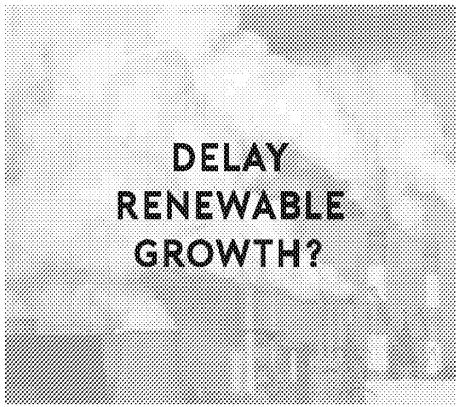
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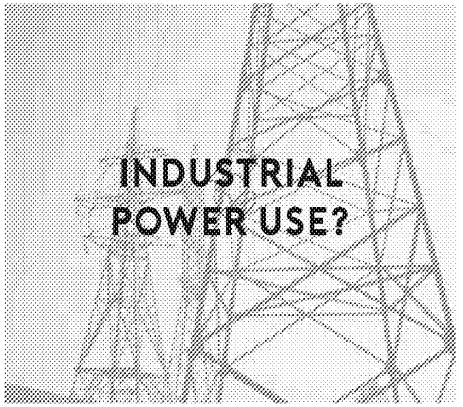
THE OPPORTUNITY: POSSIBLE SOLUTIONS



- Not Economically Feasible
- Earliest Scale Deployment 5+ Years Out



- Environmentaly Desstructive
- Politically Impossible
- Economically Foolish

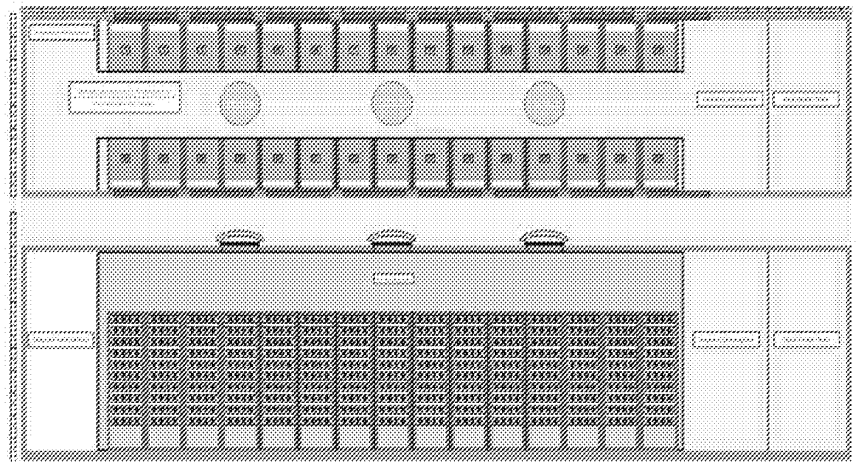


- Industrial Users Cannot Absorb and Drop Very Large Loads Quickly

THE OPPORTUNITY

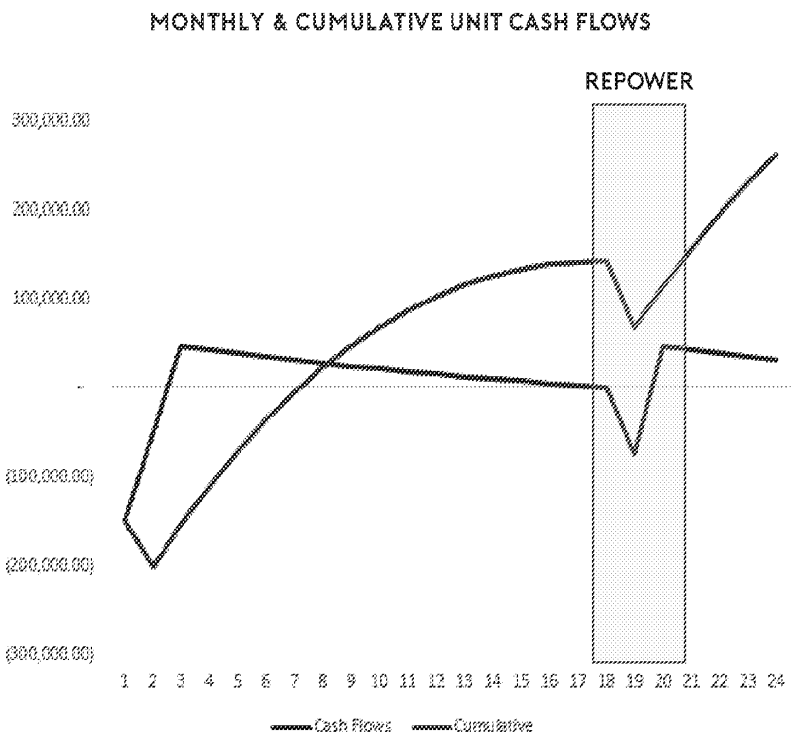
THE LANCIUM FLEX SOLUTION

- Small footprint units that can absorb or drop load nearly instantly
- Internally designed with multiple patent pending elements
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ECONOMIC CONSIDERATIONS

THE LANCIUM FLEX SOLUTION

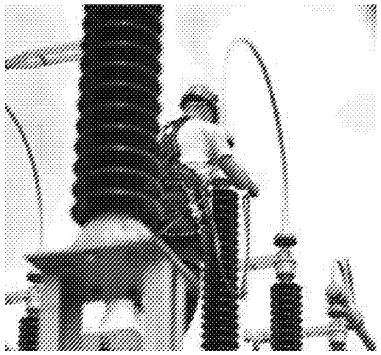


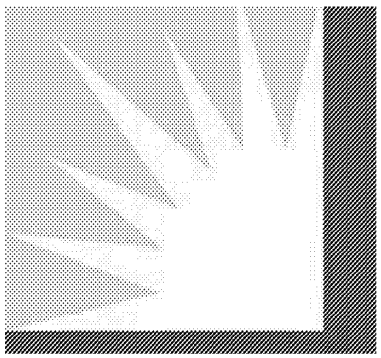
- Initial units will use older generation rigs (older gen rigs are more power consumptive)
- Unit cost of <$200k with illustrative IRR's of 50%+ (at $7,500/BTC and $0.025/KwH)
- If BTC prices drop drastically, hardware replaced to capitalize on rig price drop
- May be deployed "behind the meter" without incurring Transmission and Distribution Charges
- Units will need to be "repowered" with new mining equipment every 18 months
- Ample opportunity to optimize by changing fleet configurations

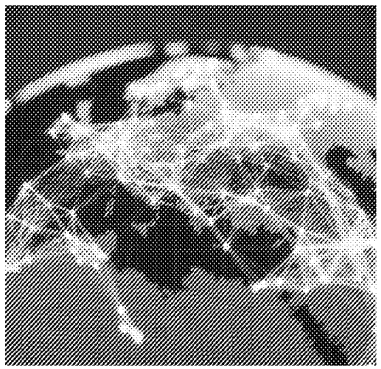
LANCIUM

POTENTIAL REVENUE STREAMS

POTENTIAL CUSTOMERS







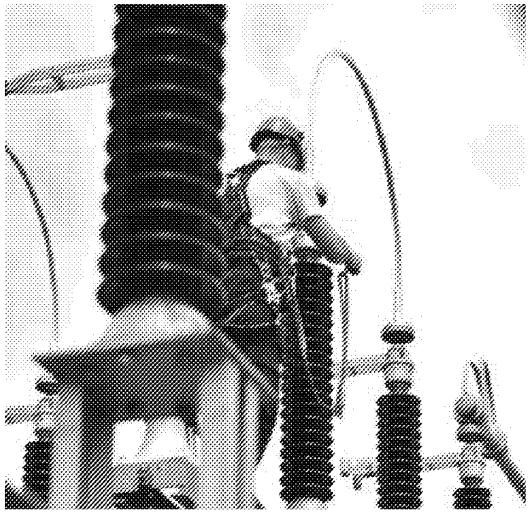
INDEPENDENT POWER PRODUCERS

UTILITIES

GRID

POTENTIAL CUSTOMERS

POTENTIAL REVENUE STREAMS



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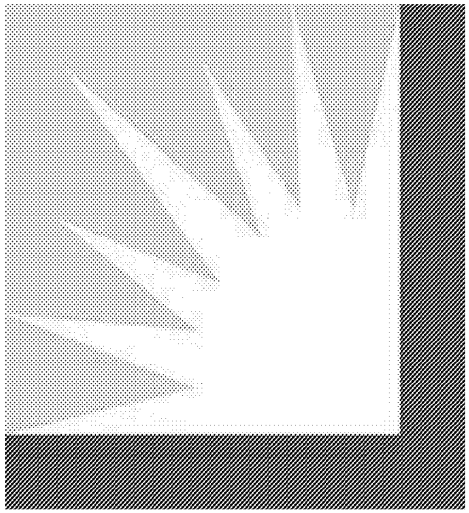
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POTENTIAL CUSTOMERS

POTENTIAL REVENUE STREAMS



UTILITIES

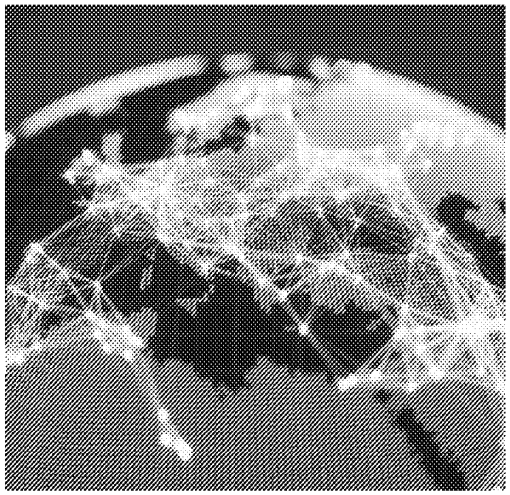
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POTENTIAL CUSTOMERS

POTENTIAL REVENUE STREAMS



GRID

Value Proposition:

Power grids are suffering from selective excessive power & heavy ramping needs causing instability and volatility.

Lancium will sell, install and service a fleet of units to provide price stability and cost savings.

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TIMELINE

Q4 2017

- File First Patents
- Build First Units & Optimize Design
- Raise $1-2mm

Q1 2018

- Deploy 1st units at IPPs (solar & wind)
- Join CA Independent System Operator as "participating load"
- Key Strategic Hires

Q2 / Q3 2018

- Expand geographical footprint (Europe)
- LOI or MOU w/ Major Utilities.
- Raise Institutional Capital & Enter into Lending Relationships.

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Ex.1002

CEO & CO-FOUNDER

MICHAEL MCNAMARA, CFA

Michael is a private investor and is currently on the board or serving as advisor to a number of start-up firms in the consumer, energy and technology space. Previously, Michael co-founded ROR Capital, a merchant bank focused on natural resources. Over several years, ROR partnered with leading Private Equity firms to successfully restructure a number of multi-billion dollar natural resource companies.

Michael spent 10 years on Wall Street at several multi-billion hedge funds focused on natural resource and event-driven investments ultimately part of teams overseeing $1bn+ of investments in the space. Michael began his career at PriceWaterhouseCoopers with roles in the consulting and accounting divisions. Michael graduated Magna Cum Laude from Georgetown University with degrees in Accounting and Finance and is a member of the New York Society of Security Analysts and the CFA Institute.

CO-FOUNDER

PRASHANT GUPTA, CFA, CPA (INACTIVE)

Prashant is an active private investor across multiple industries and geographies. Mr. Gupta most recently served as the Chief Financial Officer of Forbes 400 family office with significant portfolio of investments in hedge funds, real estate and gaming. Prashant oversaw all aspects of the family office's investment financing, structuring, accounting, audit, taxation and estate
planning.

Prior to that, Prashant was a Senior Manager with Ernst & Young LLP, where he spent six years specializing in hedge funds, mutual funds and broker-dealers, two of which were spent in an offshore jurisdiction. Prashant received an M.S. degree in Accounting from the University of Virginia and a B.A., summa cum laude, in Economics and Accounting from Muskingum University. Prashant has been awarded an honorary Doctorate in Humane Letters by Muskingum University recognizing his distinguished career and achievements.

CHIEF FINANCIAL OFFICER

SR.FINANCIAL EXECUTIVE (PENDING)

Senior capital markets professional with more than 18 years of progressive experience including equity research and investing, investor relations advisory, corporate finance, and strategy consulting. Twice awarded Institutional Investor's best of the buy-side and recognized by peers and executives for insight and candor. Proven success as a buyside investor, corporate advisor, and business developer with an extensive network of investors, research analysts, investment bankers, and corporate executives. Seasoned in counseling board of directors and C-level executives.

Currently Managing Director at a global consulting firm in the Corporate Finance and Strategic Communications segments where he has advised numerous Fortune 500 companies around key strategic initiatives including spin outs, acquisitions, capital allocation policies and IPO's.

B.A in finance from North Park University in Chicago, and earned Master's in business and administration from the Johnson School at Cornell University as well as the Smith School of Business at Queens University

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CHIEF TECHNICAL OFFICER

DR. DAVID J. HENSON Ph.D., BCHE

Dr. Henson recently served as the Chief Executive Officer of Siemens Conceptual Engineering Services. He served as the Director of Emerging Technology for Siemens Oil & Gas Division with responsibility for developing and deploying Siemens based businesses & Siemens Oil & Gas provide field-proven compressors, gas and steam turbines, electric drives, motors and associated control and data systems. Siemens O&G division has approximately 16,000 employees worldwide.

Dr. Henson has more than 15 years experience in process engineering, project management, business development and commercial experience with international companies in both client and contractor roles. He has been an Executive Director at LWP Technologies Limited since January 2016.. He has been the Project Director for Dominions Cove Point LNG while at IHI E&C Dr. Henson holds a PhD in chemical engineering.

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CHIEF MINING OFFICER

DR. RAYMOND CLINE PH.D

Dr. Cline is currently responsible for Lancium's cryptocurrency strategy and initiatives. Dr. Cline serves as a member of the IEEE Blockchain Initiative Steering Committee and is President/CEO of RWI Mining, LLC, a Blockchain mining firm.

He has participated in the development of a broad range of technologies, including high performance computing and communications technology, distance computing, collaborative computing, parallel processing, distributed computing, distributed object computing, distributed multimedia, networking protocols, and Asynchronous Transfer Mode (ATM) networking. He has applied these technologies to the development of systems to address needs in the petroleum, national security, manufacturing, and medical industries, with a specialization in recent years toward digital energy solutions (the application of dynamic, network centric operational models in the energy space).

Dr. Cline serves on the board of HARC, a research hub providing independent analysis on energy, air, and water issues to people seeking scientific answers; is a Fellow of the Borders, Trade, and Immigration Institute, a DHS Center of Excellence; and is a technical advisor to Advanced Green Computing Machines. Dr. Cline had previously led the Department of Energy funded Smart Grid Education and Training Coalition; was a member of the Executive Committee of TMAC, the Texas affiliate of the Manufacturing Extension Partnership (MEP) program of National Institute of Standards and Technology (NIST); served on the board of the Global Energy Safety Institute; and served as the Chairperson of the Cluster Development Committee of the Greater Houston Partnership Energy Collaborative.

Dr. Cline earned a PhD in Chemical Physics from the University of Illinois and a BS in Chemistry from Kent State University.

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STRATEGIC ADVISOR

BRUCE RISING

Bruce Rising is formerly Strategic Business Manager within Siemens Power Systems Sales. Previously, Bruce was manager of Marketing Intelligence in Siemens' Global Strategy group. Before joining Global Strategy, he was the manager of Regulatory Affairs for Siemens Energy where he assisted the Gas Turbine Association in Washington DC as the chairman of the Environmental Affairs Committee for six years. During that time he represented the gas turbine industry on the Natural Gas Council Committee on Gas Interchangeability related to imported LNG, and the effort to delist gas turbines from the MACT ruling. He was a key author in a study requested by the Secretary of Energy to review the impact of unconventional energy supplies on the power sector.

Bruce's experience encompasses 30+ years in combustion, environmental control technology, and gas turbine technology issues. Prior to joining Siemens he was the manager of Emissions and Control Technology for RollsRoyce Allison in Indianapolis, and research scientist in Energy and Environmental R&D at Battelle Columbus Labs. He earned a BS in Chemical Physics and an MS in Fuel Science from Penn State. He is a member of the American Society of Mechanical Engineers, the Association for the Advancement of Science, the American Chemical Society and National Association of Corrosion Engineers. He holds seven patents related to energy production, emissions controls and engine diagnostics.

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STRATEGIC ADVISOR & INVESTOR

STEWART HAIR

Stewart has 3 years of Crypto Currency mining experience guiding the build-out of over 6 megawatts infrastructure at multiple locations and installing 1,000s of miners producing greater than $20 million in value for the stakeholders. Stewart is a retired IT Infrastructure and Communications Services industry executive with 20 years of leadership and operational experience at HP, EDS, MCI Systemhouse, Telesat and most recently at M&A Technology as VP of Operations. Prior to joining the IT and Communications industry, Stewart gained extensive business experience in the manufacturing industry, overseeing day-to-day financial management while driving the exploitation of new technologies to improve corporate efficiency and profitability. In Canada where Stewart grew up after his parents emigrated from Scotland he achieved a professional accounting designation from the Canadian Society of Management Accounts and later as part of his role in the Satellite Communications Stewart received Top Secret clearance from the Canadian Federal Security authority. Stewart currently living in Texas and enjoying success as an entrepreneur helping to finance and guide start-up companies and development projects in value creation for their stakeholders.

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LANCIUM
At the Nexus of Energy
and Distributed Computing Technology

Exploding demand for electricity from computing

New advances in computing require a tremendous and growing amount of energy

Excess and wasted renewable energy

Exponential renewable energy growth and wasted petrochemical energy is causing grid instability and environmental destruction

LANCIUM



CREATING a datacenter solution that can uniquely capitalize on both of these growing PROBLEMS

The Opportunity

Renewable Power Glut

Renewable energy growth is exploding and growing faster than anticipated

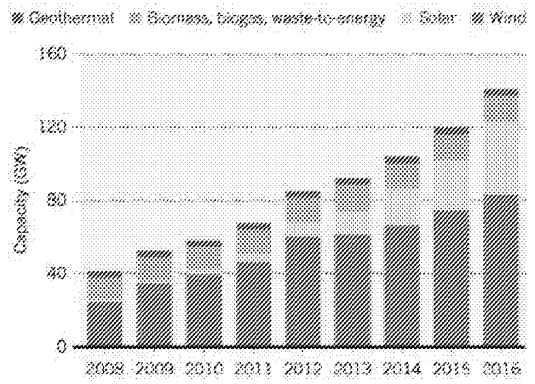
This growth is causing serious issues including:

- Negative power prices
- Volatility attributed to curtailment, congestion and load response requirements

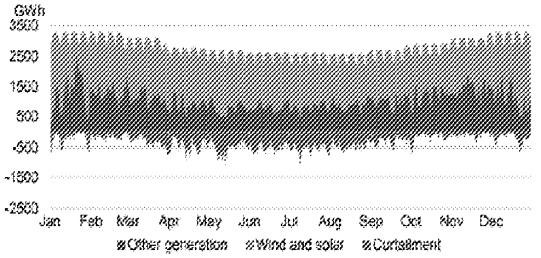
This power is effectively stranded and actually has a strong negative impact on the availability and stability of the power grid

There is limited industrial user for this power due to its volatility and scale, its distributed nature and forecast/technology development challenges

RENEWABLE ENERGY GROWING EXPONENTIALLY



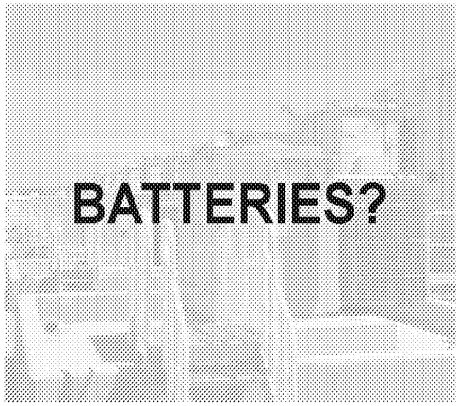
SO ARE POWER CURTAILMENTS



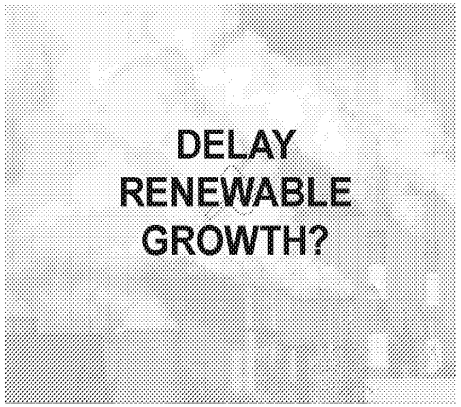
Source: Bloomberg New Energy Finance

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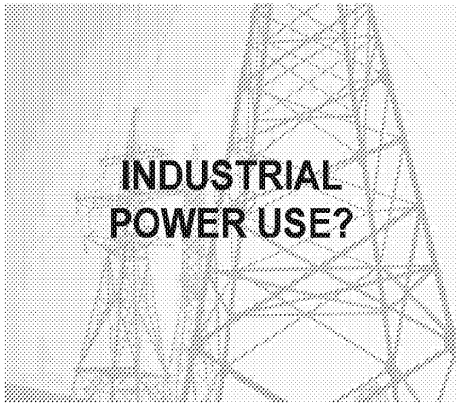
RENEWABLE: POSSIBLE SOLUTIONS



- Not Economically Feasible
- Earliest Scale Deployment 5+ Years Out



- Environmentaly Desstructive
- Politically Impossible
- Economically Foolish

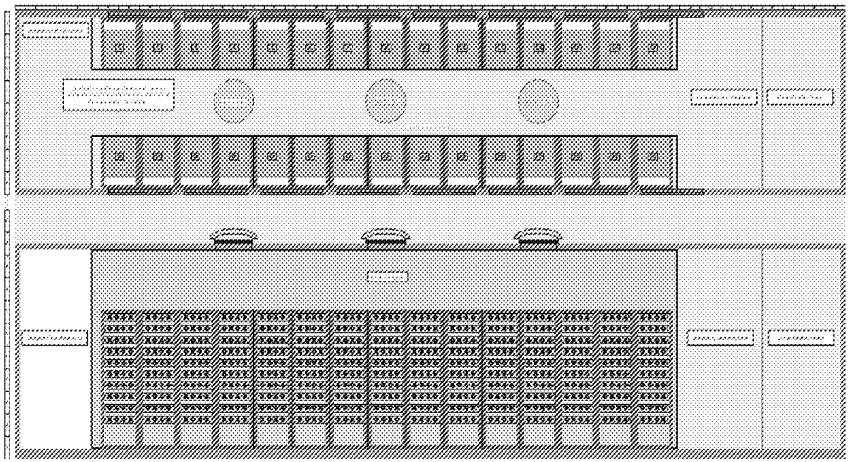


- Industrial Users Cannot Absorb and Drop Very Large Loads Quickly

The Opportunity

THE LANCIUM FLEX SOLUTION

- Small footprint units that can absorb or drop load nearly instantly
- Internally designed with multiple patent pending elements
- Fully mobile, modular and stackable to provide nearly instant solutions for any grid stability issues



The Opportunity

Optimal Site Configuration

FINANCIAL

- Economically curtailed generation or power priced below $25/MWh on average
- Relatively simple financial structure or operational control (merchant or no tax equity reopeners)
- Slight preference for ITC vs. PTC for simplicity
- Ability to avoid T&D charges if consumption occurs behind the meter (potentially favors ERCOT over SPP)

OPERATIONAL

- Ideally, a grid interconnection sufficient to power 200 kW of HVAC
- Sufficient surface area for 50 x 50 ft container
- Internet connection with relatively low latency (but no fiber or co-location is required)
- Colder climates are preferred but not required

The Opportunity

Potential Apex Sites and Advantages

SITES

- Merchant Wind in Texas:
  Cameron (165MW)
- Repowerings
- New Development Pipeline

ADVANTAGES

- Achieve the best possible prices for Apex's wind generation portfolio
- Reduce or eliminate economic curtailment
- Begin generating before full resolution of transmission bottlenecks and reduce congestion
- Potential solution for basis differentials to hub pricing

The Opportunity

Our Proposal to Apex

CAMERON WIND

- Lancium can commit to buying 1-2MW of power on a firm basis
- If Apex can identify and option 10 - 25MW of additional projects, Lancium can commit on a unit contingent basis and make the capital commitments to grow faster

APEX CLEAN ENERGY

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CEO & CO-FOUNDER

MICHAEL MCNAMARA, CFA

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ANGELO MIKESKA
INTELLECTUAL PROPERTY LAW

INVENTION DISCLOSURE FORM
Last Revised June 1, 2017

Briefly describe the problem solved by the inventive concept (HIGH-LEVEL OVERVIEW):

Volatile short duration power sources increase volatility in electric power grids due to dispatchability and forecast challenges, in both a positive and negative manner over the course of minutes. Such volatility reduces the efficiency of the power generation, transmission and distribution grid and results in pricing either negative or extremely high. Smart grids and smart devices system including storage can take advantage of this to reduce overall power demand and improve grid efficiency. A rampable data center with the ability to parallel process data, for the use of cryptocurrency ledger encryption can take advantage of such situations. Some examples of this are

Cloud cover on solar facilities – rapid load swings both up and down to 50% output in less than 1 minute. A newer facility solar facility has a larger solar panel to inverter ratio (DC collection voltage 900-1600 V DC to AC Transmission voltage - 33KV) to reduce the impact of this swing. This results in overproduction of electricity before the inverter at the collection voltage, which is grounded before the facility meter to the grid, namely on separate output terminals of the inverter, within the substation of the facility or within the DC collection system. A data processing center located at these points could absorb the excess power and avoid 'solar clipping' within the facility.

Rapid grid ramp rates drive economic curtailment – as the Sun rises, overall solar generation increases very quickly. The existing grid must ramp down to accommodate the excess power, in order to meet renewable mandates or based on economic consideration. This can result in periods of oversupply of power due to short duration mismatch or poor forecasting i.e. cloudy day or forest fire smoke and drive prices low or negative. The grid operator e.g. CAISO or NYISO or ERCOTT requests grid operators to economically curtail production and accept a negative price for their power. A rampable data center located at a facility could absorb power from the grid, reducing the oversupply and improving the grid stability

Repowering wind – generation 1 wind turbines (typically 1MW and less) can be repowered with larger modern wind turbines (greater than 1 MW) resulting in additional wind power from an existing wind resource. This power may be limited due to AC grid interconnect transmission line capacity, and power within the wind is subsequently constrained. In addition, repowering projects may be delayed due to the transmission constraint, resulting in lost operating capacity for the windfarm. A rampable data center located 'behind the meter' of the wind farm can absorb excess power. The data center can be either 1. Physically distributed within the wind farm itself for example 0-1 MW range at each windmill, operating at system collection voltage (typically XX volts AC) or at the windfarm collection branches for example 5 MW on each collection branch , or a the wind farm transformer where the voltage in transformed to AC grid voltage. The data centers may also be supported by AC power fed back from the grid, during periods of low or no wind. The data center rampable load characteristic offers an alternative price point to a wind farm operator than the grid.

Wake up voltage – Solar farms run on DC and use a DC/AC inverter to collect and supply energy to the transmission line. Such inverters require a certain wakeup voltage/power to function and export- any power generated before the inverter is run to ground. A data center as pervious described can absorb such load.

Windy days/Sunny days – seasonal wind variation for winds farms and sunny days for solar create oversupply to forecast demand or to poor initial wind resource characterization i.e. windier than originally designed. This can result in curtailment on a short or long term basis, namely where a renewable generator produces more than its original design or than the grid can accommodate. In certain circumstances the grid operator may request generators to reduce load

(curtail) or to accept a negative price. The generator may continue to supply power, and receive a negative price for that power. The generators incentive to sell power at a negative price may be due to tax benefits, minimum use or minimum load drivers. A data center could absorb such power, reducing the curtailment or utilizing the excess capacity. A such the economic and environmental efficiency of the renewable resource is improved and the penetration of renewable power is increased (assuming that the data center would have in any case be powered by the grid under normal circumstances)

Turn down limits – impacts from both ramp down and ramp up and absolute turndown and maximum output can result in periods of price volatility. An example is a natural gas generator with a turndown limit that results in an emissions limit eg dry low NOx burner turndown. Another is a nuclear plant, which has a minimum load due to boron poisoning of fuel system. A third is an emissions limited peaker facility which is number of starts restrained due to its operating permit Such cases lead to a situation where the generator must run or is not able to turn on, resulting in a power demand or (generation) that is not sufficient to absorb (or produce) the supply (demand). Pricing is low to negative or extremely hi in these 2 scenarios, both of which a rampable distributed data center can utilize via load increase or demand response (reduction). Such data center loads can be strategically located either within the substation (meter) of restrained facilities and absorb power, enabling such faculties to stay within their operational performance envelopes.

Briefly describe the solution provided by the inventive concept (HIGH-LEVEL OVERVIEW):

A method to centrally control distributed data centers via use of 3 separate but functionally combined mechanisms to enable smart grid like behavior

1. **A software/workrate control system using the data workflow stream or processor clock rate to control server and support equipment electrical consumption (lead lag power behavior) and level of work from facility server to facility server**
2. **An ability to parallel process data from mobile facility to mobile facility**
3. **A conventional smart grid electrical mechanism to control electrical consumption at each data center via shutdown of individual computers. Chipsets or processor, via existing utility telemetry systems.**

The method can be utilized to exhibits demand response behavior, as well as power conditioning and load tracking capability.

Demand response and power factor adjustment 20-120-% range - the processing load of an individual data processing computer or microprocessor or chipset with a computer or individual chip can be controlled via its internet connectivity namely its start and stop functionality. The ability to control such chips, while in a parallel configuration, enables load ramping via selective switching of individual chips. In addition, individual chip processing speed can be adjusted, than the normal steady state design point, typically from 20-120%. Due to the change of processing speed the support infrastructure for the chips, such as cooling, power and efficiency, changes as well, Some of these loads have leading characteristics and some of those have lagging characteristics. Thus, chips can be switched effectively switched on an off in terms of data processing, or their processing speed (clock) changed to achieve various configurations of the same processing capacity, at different power consumption values and vice versa. This characteristic enables both demand response (load adjustment) and power factor adjustment at various load points within the control range 20-120% either within an individual group of processors within a data center. The load reduction or power factor correction request signal can come from conventional grid operator telemetry and then is delivered via the data communications stream to individual chipset, computers, racks or data centers on a distributed basis, and result in specific changes/configuration

adjustment in chip speed, data on/off to achieve the result.

Do we need some examples of this e.g. is there are 2 mining boxes at one facility, show how it could achieve various power factor configurations at the same electrical and data load ???

Demand response 0-20% - individual chipsets or processors and their support systems e.g. cooling load, lighting etc can be switched off or on electrically in a staged manner instantaneously in the range 20 to 0 %. This can be achieved via conventional smart grid switching systems on breakers at any level such as individual racks of computer, individual data centers or as a distributed system of data centers, via signals from grid operators

Control mechanism 1 exhibits lead lag characteristics and can be used to condition power via adjustment of power factor i.e. the same load can be consumed using different configurations of 1, 2 and 3. Thus, power factor correction which impact T&D losses and effective grid capacity can be achieved via distributed server response.

The additional of a battery storage capability at the data center enables peak shaving and clipping in conjunction with the above behavior at an individual data center. If the data center is unable to absorb the full extent of negative, curtailed or cheap power, a battery bank can absorb excess for use at a later point in time, where the power can be used for data processing or sold to the grid as conventional power.

Describe the advantages of the inventive concept over prior solutions to the problem:

Conventional data centers are permanent facilities, with base load stable operation design and control systems. They have limited ability to ramp in load, as they are designed for mission critical service, with uninterruptible power supplies, backup generation, storage and large data (bandwidth) requirements.

IN the specific case, no storage or large bandwidth data is required. Redundancy is achieved by a network of data centers, a minimum number of which will be operating at any one time. The data center can ramp up or down to take advantage of power price, and processing capacity can be moved on an economic basis between the centers. In addition, the data center is movable, and can take advantage of seasonal variation which drives electrical generation and consumption.

These may include Windy winter months with oversupply of wind power due to wind farm infrastructure limitations (transformer size or transmission line constraints to the grid) or a location close to or within a wind farm. A similar scenario occurs during sunny summer months with location in or near a solar facility, spring runoff with location near a hydro facility or other such conditions which result in a low price electricity supply for example a nuclear plant with limited turndown during low periods of demand, or a gas turbine plant at the limit of its turndown /emission profile load.

Describe alternate embodiments of the invention and potential design-arounds that a competitor may employ:

The design methodologies described are applicable to other distributed loads, such as agriculture or residential hot water heating. Such hot water heating uses a very limited data set and is already commercially available.

ANGELO MIKESKA
INTELLECTUAL PROPERTY LAW

INVENTION DISCLOSURE FORM
Last Revised June 1, 2017

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Rapid solar ramp rates – as the Sun rises, overall solar generation increases very quickly. The existing grid must ramp down to accommodate the excess power, in order to meet renewable mandates or based on economic consideration. This can result in periods of oversupply of power due to short duration mismatch or poor forecasting i.e cloudy day or forest fire smoke and drive prices low or negative.

Solar clipping – as solar plants install more panel capacity relative to inverter power to alleviate the previous 2 issues, the actual installed capacity (DC) of the plant exceeds the inverter capacity. Additional power is clipped and grounded.

Repowering wind – generation 1 wind turbines (typically 1MW and less) are being repowered with larger modern wind turbines resulting in additional wind power from an existing wind resource. This power may be limited due to transmission line capacity, and power is subsequently constrained. In addition, repowering projects may be delayed due to the transmission constraint, resulting in lost operating capacity for the windfarm.

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Turn down limits – impacts from both ramp down and ramp up and absolute turndown and maximum output can result in periods of price volatility. An example is a natural gas generator with a turndown limit that results in an emissions limit e.g. dry low NOx burner turndown. Another is a nuclear plant, which has a minimum load due to boron poisoning of fuel system. A third is an emissions limited peaker facility which is number of starts restrained due to its operating permit Such cases lead to a situation where the generator must run or is not able to turn on, resulting in a power demand or (generation) that is not sufficient to absorb (or produce) the supply (demand). Pricing is low to negative or extremely hi in these 2 scenarios, both of which a rampable distributed data center can utilize via load increase or demand response (reduction)

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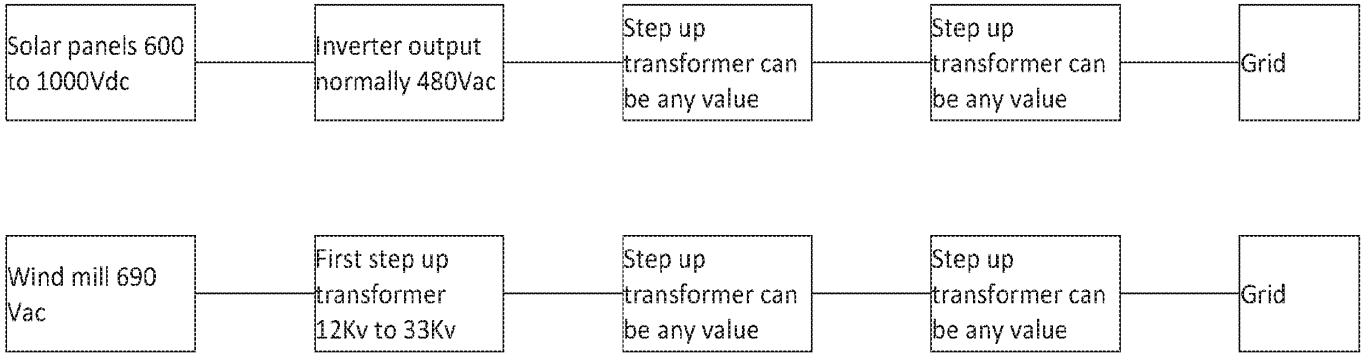
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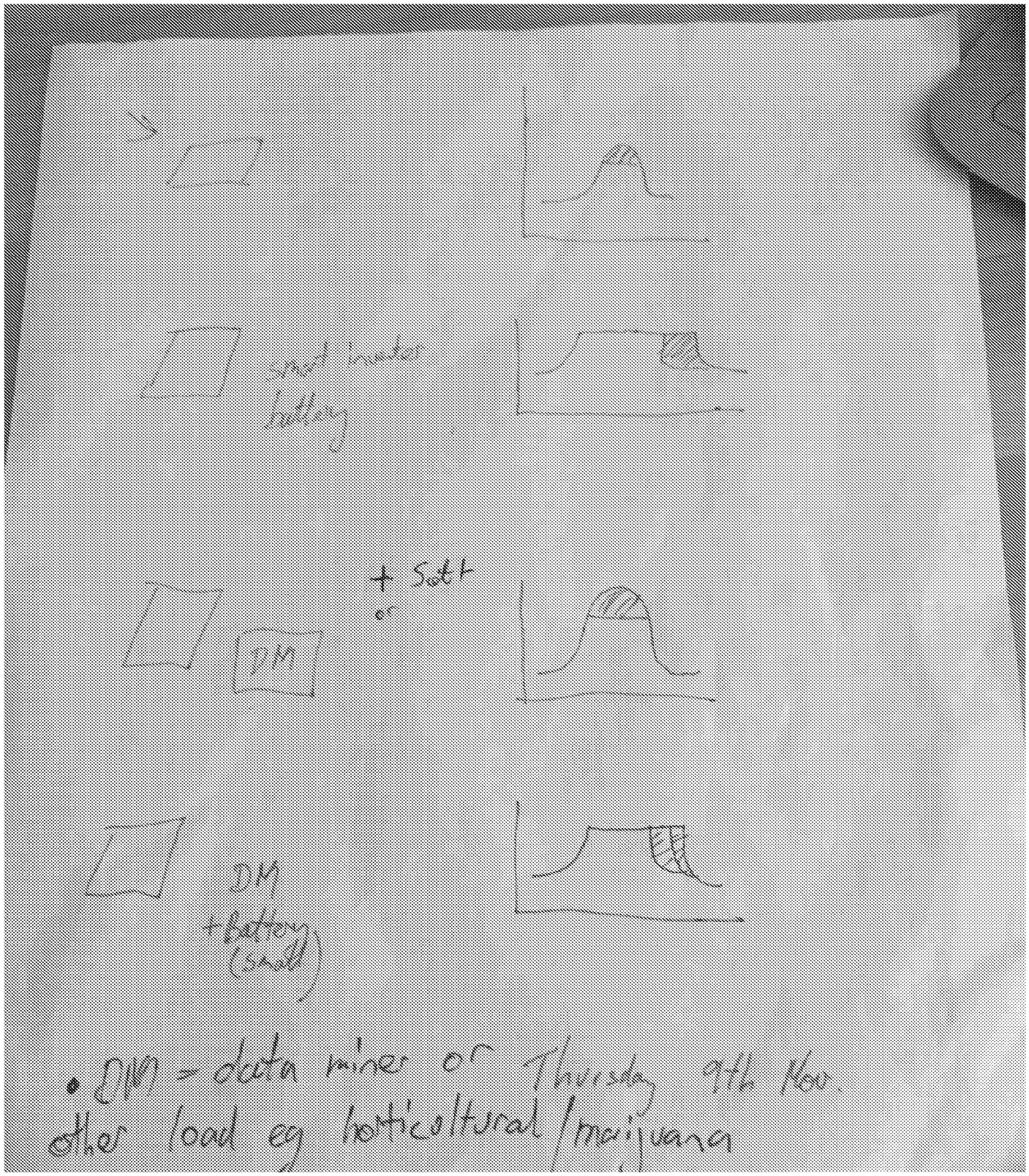
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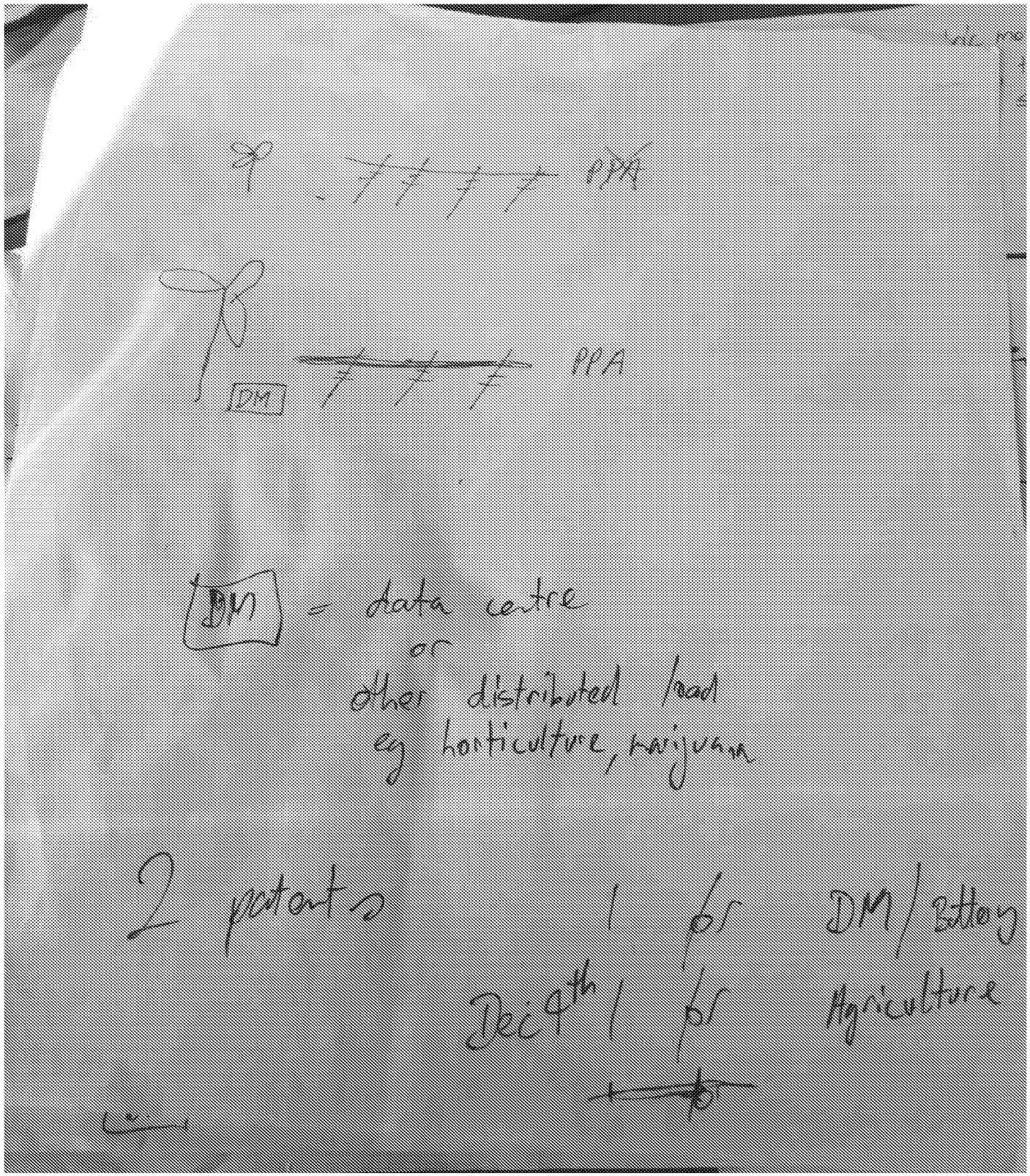
Difficult to say for sure what voltages we will run into. Generally, in the US, on solar farms, you will see voltages in the 600 to 1000 Vdc range (at the panels) with 600Vdc being the most common. From there, the DC feeds are pooled in a DC combiner and fed directly into an inverter. Inverter outputs can be whatever the site operator desires but most likely you will find 480 Vac at the output of the first (inverter) transformer. From there the voltage will be stepped up to whatever line voltage is available at the site: 12Kvac to 33Kvac +100Kvac etc. Ideally, the operator will step the voltage up as quickly as possible to reduce the conductor size required to transmit current over long distances.

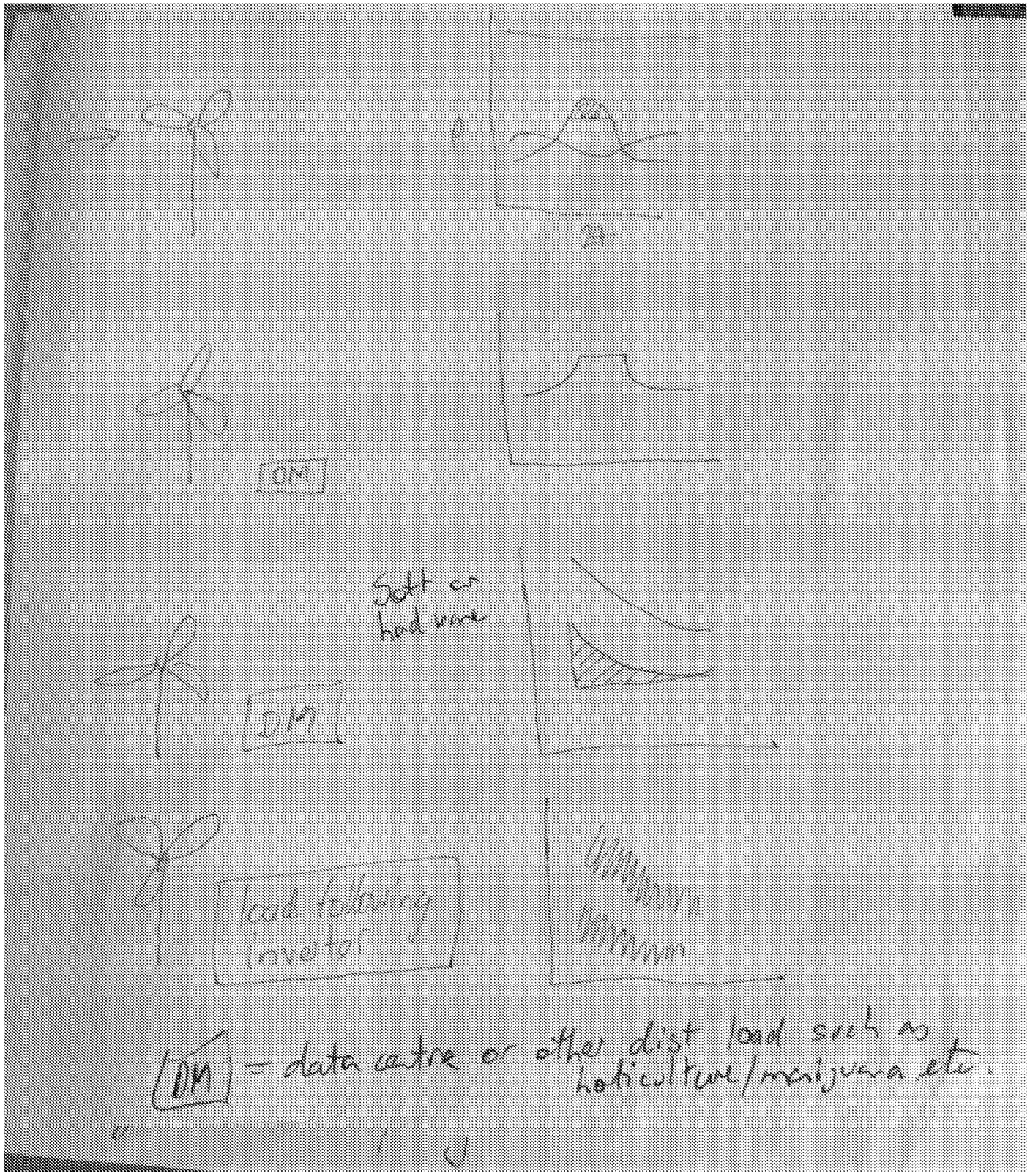
Wind farms are a different animal. Their generator outputs are around 690 Vac @ 60Hz. and are stepped up, either in the nacelle or in a ground based transformer to the most cost efficient voltage for the operator (usually 33Kv). While it is hard to say for sure, for land based wind farms I would expect to see voltages in the 12Kv to 33Kv range and off shore in the 33Kv range coming right from the tower.

Regardless of which type of generation used, the last transformer will step the voltages up to the highest voltage available at the site in order to connect to the grid. Therefore, any discussion with an operator would necessarily involve ascertaining where a connection into their system could be made and what voltages are present at the connection point. In all likelihood, we will be looking at step down transformers as any voltages at a collection point will be in the 33Kv range. I would suspect that you would not see voltages below 33Kv in a wind farm as the distances to the collection point can be quite long. Any chance of tapping into lower voltages there would be at the base of the towers.




+ Salt
or
DM
+Battery
(small)
• DM = data miner or Thermostat 9th Hot
other load eg horticultural/marijuana


PPA
DM
PPA
DM = data centre
or
other distributed load
eg horticulture, marijuana
2 points
Dec 9th
DM / Ethoy
Agriculture


[DM]
Soft or hard wire
[DM]
load following inverter
Utility Grid
[DM] = data centre or other dist load such as horticulture/marijuana etc.

remote operated breaker - electric motor operated via SCADA, telemetry or other signal
C1 ramp rate
up TBD
down TBD
Data load
20-100%
ramp up TBD
ramp down TBD
- 100-120% overloading
- LAN/LTE/satellite etc
- DNP
0-20%
20-100%
100-120%
2
1
no data load electrical minimum
20% of total load
20% of total
Ex.1002
Cholla Energy LLC & OBM, Inc. / Page 436 of 611

Data control unit
DM 4
DM 11
DM 12
DM 13
DM 21
DM 22
DM 23
DM 3
DM 5
DM 6
DM 7
DM 8
DM 9
DM 10
etc

Electronic Acknowledgement Receipt	
EFS ID:	31480332
Application Number:	62616348
International Application Number:	
Confirmation Number:	5077
Title of Invention:	FLEXIBLE DATACENTER USING GREEN OR UNUTILIZED ENERGY SOURCES
First Named Inventor/Applicant Name:	David J. Henson
Customer Number:	106500
Filer:	Basil Michael Angelo
Filer Authorized By:	
Attorney Docket Number:	01128-000002 PPA
Receipt Date:	11-JAN-2018
Filing Date:	
Time Stamp:	19:26:11
Application Type:	Provisional

Payment information:

Submitted with Payment	yes
Payment Type	CARD
Payment was successfully received in RAM	$130
RAM confirmation Number	011218INTEFSW19264800
Deposit Account	
Authorized User	
The Director of the USPTO is hereby authorized to charge indicated fees and credit any overpayment as follows:	

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Provisional Cover Sheet (SB16)	sb0016.pdf	345349 8a1ce46c99e6f434c10f689f8f0b0b248dbc1c59	no	3
Warnings:					
This is not a USPTO supplied Provisional Cover Sheet SB16 form.					
Information:					
2	Application Data Sheet	aia0014.pdf	1819347 551510f6c393e3083d880bf8bc12e0f7e371fb4b	no	7
Warnings:					
Information:					
3	Specification	Specification.pdf	3080607 9100a58a856e9c3249ede5a3268b363a473bae3e	no	68
Warnings:					
Information:					
4	Fee Worksheet (SB06)	fee-info.pdf	29880 36b8561bf8a5894645ca02c5f9c9f3ece65e8c5a	no	2
Warnings:					
Information:					
		Total Files Size (in bytes):	5275183		

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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INTELLECTUAL PROPERTY
ORGANIZATION

DOCUMENT MADE AVAILABLE UNDER THE PATENT COOPERATION TREATY (PCT)

International application number:		**PCT/US2018/017950**
International filing date:		**13 February 2018 (13.02.2018)**
Document type:		**Certified copy of priority document**
Document details:	Country/Office:	**US**
	Number:	**62/616,348**
	Filing date:	**11 January 2018 (11.01.2018)**
Date of receipt at the International Bureau:		**24 February 2018 (24.02.2018)**

Remark: Priority document submitted or transmitted to the International Bureau in compliance with Rule 17.1(a),(b) or (b-*bis*)

34, chemin des Colombettes
1211 Geneva 20, Switzerland
www.wipo.int

PCT REQUEST

Original (for **SUBMISSION**)

0	**For receiving Office use only**	
0-1	International Application No.	PCT/US18/17950
0-2	International Filing Date	13 February 2018 (13.02.2018)
0-3	Name of receiving Office and "PCT International Application"	PCT INTERNATIONAL APPLICATION RO/US

0-4	**Form PCT/RO/101 PCT Request**	
0-4-1	Prepared Using	**PCT-SAFE [EFS-Web mode] Version 3.51.080.256 MT/FOP 20180101/0.20.5.24**
0-5	**Petition** The undersigned requests that the present international application be processed according to the Patent Cooperation Treaty	
0-6	**Receiving Office (specified by the applicant)**	**United States Patent and Trademark Office (USPTO) (RO/US)**
0-7	**Applicant's or agent's file reference**	**01128-000002**
I	**Title of Invention**	**METHOD AND SYSTEM FOR DYNAMIC POWER DELIVERY TO A FLEXIBLE DATACENTER USING UNUTILZED ENERGY SOURCES**
II	**Applicant**	
II-1	This person is	**Applicant only**
II-2	Applicant for	**All designated States**
II-4	Name	**LANCIUM LLC**
II-5	Address	**LANCIUM LLC C/O ANGELO MIKESKA PLLC 21 Waterway Avenue, Suite 300 The Woodlands, Texas 77380 United States of America**
II-6	State of nationality	**US**
II-7	State of residence	**US**
III-1	**Applicant and/or inventor**	
III-1-1	This person is	**Inventor only**
III-1-3	Inventor for	**All designated States**
III-1-4	Name (LAST, First)	**HENSON, David**
III-1-5	Address	**LANCIUM LLC C/O ANGELO MIKESKA PLLC 21 Waterway Avenue, Suite 300 The Woodlands, Texas 77380 United States of America**

PCT REQUEST

Original (for **SUBMISSION**)

III-2	**Applicant and/or inventor**	
III-2-1	This person is	Inventor only
III-2-3	Inventor for	All designated States
III-2-4	Name (LAST, First)	MCNAMARA, Michael
III-2-5	Address	LANCIUM LLC C/O ANGELO MIKESKA PLLC 21 Waterway Avenue, Suite 300 The Woodlands, Texas 77380 United States of America
III-3	**Applicant and/or inventor**	
III-3-1	This person is	Inventor only
III-3-3	Inventor for	All designated States
III-3-4	Name (LAST, First)	CLINE, Raymond
III-3-5	Address	LANCIUM LLC C/O ANGELO MIKESKA PLLC 21 Waterway Avenue, Suite 300 The Woodlands, Texas 77380 United States of America
IV-1	**Agent or common representative; or address for correspondence** The person identified below is hereby/ has been appointed to act on behalf of the applicant(s) before the competent International Authorities as:	Agent
IV-1-1	Name (LAST, First)	ANGELO, Basil
IV-1-2	Address	ANGELO MIKESKA PLLC 21 Waterway Avenue, Suite 300 The Woodlands, Texas 77380 United States of America
IV-1-3	Telephone No.	281-362-2839
IV-1-4	Facsimile No.	888-333-9698
IV-1-5	e-mail	docketing@angeloip.com
IV-1-5(a)	E-mail authorization The receiving Office, the International Searching Authority, the International Bureau and the International Preliminary Examining Authority are authorized to use this e-mail address, if the Office or Authority so wishes, to send notifications issued in respect of this international application:	as advance copies followed by paper notifications
IV-1-6	Agent's registration No.	62811
V	**DESIGNATIONS**	
V-1	**The filing of this request constitutes under Rule 4.9(a), the designation of all Contracting States bound by the PCT on the international filing date, for the grant of every kind of protection available and, where applicable, for the grant of both regional and national patents.**	

PCT REQUEST

Original (for **SUBMISSION**)

VI-1	**Priority claim of earlier national application**		
VI-1-1	Filing date	11 January 2018 (11.01.2018)	
VI-1-2	Number	62/616,348	
VI-1-3	Country or Member of WTO	US	
VI-2	**Priority document request**		
	The receiving Office is requested to prepare and transmit to the International Bureau a certified copy of the earlier application(s) identified above as item(s):	VI-1	
VI-3	**Incorporation by reference :**		
	where an element of the international application referred to in Article 11(1)(iii)(d) or (e) or a part of the description, claims or drawings referred to in Rule 20.5(a) is not otherwise contained in this international application but is completely contained in an earlier application whose priority is claimed on the date on which one or more elements referred to in Article 11(1)(iii) were first received by the receiving Office, that element or part is, subject to confirmation under Rule 20.6, incorporated by reference in this international application for the purposes of Rule 20.6.		
VII-1	**International Searching Authority Chosen**	United States Patent and Trademark Office (USPTO) (ISA/US)	
VIII	**Declarations**	Number of declarations	
VIII-1	Declaration as to the identity of the inventor	–	
VIII-2	Declaration as to the applicant's entitlement, as at the international filing date, to apply for and be granted a patent	–	
VIII-3	Declaration as to the applicant's entitlement, as at the international filing date, to claim the priority of the earlier application	–	
VIII-4	Declaration of inventorship (only for the purposes of the designation of the United States of America)	–	
VIII-5	Declaration as to non-prejudicial disclosures or exceptions to lack of novelty	–	
IX	**Check list**	Number of sheets	Electronic file(s) attached
IX-1	Request (including declaration sheets)	4	✓
IX-2	Description	26	–
IX-3	Claims	5	–
IX-4	Abstract	1	✓
IX-5	Drawings	8	–
IX-7	TOTAL	44	

PCT REQUEST

Original (for **SUBMISSION**)

	Accompanying Items	Paper document(s) attached	Electronic file(s) attached
IX-8	Fee calculation sheet	✓	–
IX-20	**Figure of the drawings which should accompany the abstract**	6	
IX-21	**Language of filing of the international application**	English	
X-1	**Signature of applicant, agent or common representative**	/Basil M. Angelo, Reg. #62811/	
X-1-1	Name (LAST, First)	ANGELO, Basil	
X-1-3	Capacity (if such capacity is not obvious from reading the request)		

FOR RECEIVING OFFICE USE ONLY

10-1	**Date of actual receipt of the purported international application**	13 February 2018 (13.02.2018)
10-2	**Drawings:**	
10-2-1	Received	
10-2-2	Not received	
10-3	**Corrected date of actual receipt due to later but timely received papers or drawings completing the purported international application**	
10-4	**Date of timely receipt of the required corrections under PCT Article 11(2)**	
10-5	**International Searching Authority**	ISA/US
10-6	**Transmittal of search copy delayed until search fee is paid**	

FOR INTERNATIONAL BUREAU USE ONLY

11-1	**Date of receipt of the record copy by the International Bureau**	

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE
(Docket No. 18-874-WO1-US)

In re Application of: David Henson et al	)	
	)	**Examiner: TBD**
US Application No: 16/482,495	)	
	)	
Filing Date: July 31, 2019	)	**Art Unit: TBD**
	)	
Title: Method and System for Dynamic Power Delivery to a Flexible Datacenter Using Unutilized Energy Sources	)	**Confirmation No.: 7727**

PRELIMINARY AMENDMENT

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

Please consider the following amendments and remarks before examination on the merits.

Amendments to the Specification begin on page 2 of this paper.

Remarks begin on page 3 of this paper.

AMENDMENTS TO THE SPECIFICATION

Please replace the first paragraph after CROSS-REFERENCE TO RELATED APPLICATIONS of the specification with the following amended paragraph:

This application is a U.S. national phase application under 35 USC 371 of International Patent Application no. PCT/US2018/017950, filed February 13, 2018, which claims the benefit of U.S. Patent Application no. 62/616348, filed January 11, 2018.

REMARKS

No new matter has been introduced into the present application as a result of the above amendments.

Prompt consideration and entry of this amendment prior to examination is respectfully requested. If there are any questions or comments regarding this amendment or application, the Examiner is encouraged to contact the undersigned attorney as indicated below.

Respectfully submitted,

Date: July 31, 2019

/Alexander D. Georges/
Alexander D. Georges
Registration No. 70,534

McDonnell Boehnen Hulbert & Berghoff LLP
300 South Wacker Drive
Chicago, Illinois 60606

Telephone: 312-913-0001
Facsimile: 312-913-0002

Electronic Acknowledgement Receipt

EFS ID:	36746180
Application Number:	16482495
International Application Number:	
Confirmation Number:	7727
Title of Invention:	Method and System for Dynamic Power Delivery to a Flexible Datacenter Using Unutilized Energy Sources
First Named Inventor/Applicant Name:	David Henson
Customer Number:	20306
Filer:	Alexander D. Georges
Filer Authorized By:	
Attorney Docket Number:	18-874-WO1-US
Receipt Date:	31-JUL-2019
Filing Date:	
Time Stamp:	18:41:15
Application Type:	U.S. National Stage under 35 USC 371

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		18-874-WO1-US_PrelimAmend2.pdf	119767 780a29797c6b177e389e65c4eb3039e81ab4b4cf	yes	3

	Multipart Description/PDF files in .zip description		
	Document Description	**Start**	**End**
	Preliminary Amendment	1	1
	Specification	2	2
	Applicant Arguments/Remarks Made in an Amendment	3	3
Warnings:			
Information:			
	Total Files Size (in bytes):	119767	

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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/SB/08a (02-18)
Approved for use through 11/30/2020. OMB 0651-0031
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE

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INFORMATION DISCLOSURE STATEMENT BY APPLICANT
(Not for submission under 37 CFR 1.99)

Application Number	
Filing Date	2019-07-31
First Named Inventor	David Henson
Art Unit	TBD
Examiner Name	TBD
Attorney Docket Number	18-874-WO1-US

U.S.PATENTS Remove

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	6288456		2001-09-11	CRATTY; William E.	
	2	6633823		2003-10-14	BARTONE; Erik J. et al.	
	3	7143300		2006-11-28	POTTER; Mark R. et al.	
	4	7647516		2010-01-12	RANGANATHAN; Parthasarathy et al.	
	5	7702931		2010-04-20	GOODRUM; Alan L. et al.	
	6	7779276		2010-08-17	BOLAN; Joseph Edward et al.	
	7	7861102		2010-12-28	RANGANATHAN; Parthasarathy et al.	
	8	7921315		2011-04-05	LANGGOOD; John K. et al.	

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
	Application Number	
	Filing Date	2019-07-31
	First Named Inventor	David Henson
	Art Unit	TBD
	Examiner Name	TBD
	Attorney Docket Number	18-874-WO1-US

	9	7970561		2011-06-28	PFEIFFER; Clemens	
	10	8001403		2011-08-16	HAMILTON; James R. et al.	
	11	8006108		2011-08-23	BREY; Thomas M. et al.	
	12	8214843		2012-07-03	BOSS; Gregory J. et al.	
	13	8374928		2013-02-12	GOPISETTY; Sandeep et al.	
	14	8447993		2013-05-21	GREENE; Daniel H. et al.	
	15	8571820		2013-10-29	PFEIFFER; Clemens	
	16	8627123		2014-01-07	JAIN; Navendu et al.	
	17	8789061		2014-07-22	PAVEL; Milan et al.	
	18	8799690		2014-08-05	DAWSON; Christopher J. et al.	
	19	9003211		2015-04-07	PFEIFFER; Clemens	

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
	Application Number	
	Filing Date	2019-07-31
	First Named Inventor	David Henson
	Art Unit	TBD
	Examiner Name	TBD
	Attorney Docket Number	18-874-WO1-US

	20	9003216		2015-04-07	SANKAR; Sriram et al.	
	21	9026814		2015-05-05	AASHEIM; Jered et al.	
	22	9207993		2015-12-08	JAIN; Navendu	
	23	9218035		2015-12-22	LI; Tao et al.	
	24	9552234		2017-01-24	BOLDYREV; Sergey et al.	
	25	10367353		2019-07-30	MICHAEL; T. Mcnamara	

If you wish to add additional U.S. Patent citation information please click the Add button. Add

U.S.PATENT APPLICATION PUBLICATIONS Remove

Examiner Initial*	Cite No	Publication Number	Kind Code[1]	Publication Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear
	1	20080030078		2008-02-07	WHITTED; William et al.	
	2	20080094797		2008-04-24	COGLITORE; Giovanni et al.	
	3	20090055665		2009-02-26	MAGLIONE; Stephen C. et al.	

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
	Application Number	
	Filing Date	2019-07-31
	First Named Inventor	David Henson
	Art Unit	TBD
	Examiner Name	TBD
	Attorney Docket Number	18-874-WO1-US

	4	20100211810		2010-08-19	ZACHO; Carl Edvard Martin	
	5	20100328849		2010-12-30	EWING; Carrel W. et al.	
	6	20110238342		2011-09-29	PFEIFFER; Clemens	
	7	20120000121		2012-01-05	SWANN; James J.	
	8	20120072745		2012-03-22	AHLUWALIA; Vikas et al.	
	9	20120300524		2012-11-29	FORNAGE; Martin et al.	
	10	20130006401		2013-01-03	SHAN; Xinxin	
	11	20130063991		2013-03-14	XIAO; Yuan et al.	
	12	20130086404		2013-04-04	SANKAR; Sriram et al.	
	13	20130187464		2013-07-25	SMITH; Mark Berry et al.	
	14	20130306276		2013-11-21	DUCHESNEAU; David D.	

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
	Application Number	
	Filing Date	2019-07-31
	First Named Inventor	David Henson
	Art Unit	TBD
	Examiner Name	TBD
	Attorney Docket Number	18-874-WO1-US

	15	20140137468		2014-05-22	CHING; Gregory M.	
	16	20140379156		2014-12-25	KAMEL; Michel Roger et al.	
	17	20150155712		2015-06-04	MONDAL; Subrata K.	
	18	20150229227		2015-08-13	AELOIZA; Eddy C. et al.	
	19	20160198656		2016-07-14	MCNAMARA; Brad et al.	
	20	20160212954		2016-07-28	ARGENTO; Onofrio	
	21	20160324077		2016-11-10	FRANTZEN; Kohlar T. et al.	
	22	20170104336		2017-04-13	ELBSAT; Mohammad N. et al.	
	23	20180144414		2018-05-24	LEE; Ja-Chin Audrey et al.	

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FOREIGN PATENT DOCUMENTS Remove

Examiner Initial*	Cite No	Foreign Document Number[3]	Country Code[2] i	Kind Code[4]	Publication Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear	T[5]

EFS Web 2.1.18

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
	Application Number	
	Filing Date	2019-07-31
	First Named Inventor	David Henson
	Art Unit	TBD
	Examiner Name	TBD
	Attorney Docket Number	18-874-WO1-US

	1	103163904	CN	A	2013-06-19	UNIV ZHEJIANG TECHNOLOGY.	English Abstract	X
	2	2015199629	WO	A1	2015-12-30	DOKUZ EYLÜL ÜNIVERSITESI REKTÖRLÜGÜ [TR]		☐

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NON-PATENT LITERATURE DOCUMENTS Remove

Examiner Initials*	Cite No	Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc), date, pages(s), volume-issue number(s), publisher, city and/or country where published.	T5
	1	BIRD L., et al., "Wind and Solar Energy Curtailment: Experience and Practices in the United States," National Renewable Energy Lab (NREL), Technical Report NREL/TP-6A20-60983, March 2014, 58 pages.	
	2	EPEX Spot, "How They Occur, What They Mean," https://www.epexspot.com/en/company-info/basics_of_the_power_market/negative_prices, 2018, 2 pages.	
	3	International Search Report and Written Opinion of PCT Application No. PCT/US2018/017955, mailed on 30 April 2018, 22 pages.	
	4	International Search Report and Written Opinion of PCT Application No. PCT/US2018/017950, mailed on 31 May 2018, 15 pages.	
	5	Notice of Allowance mailed on 02 April 2019, for U.S. Patent Application No. 16/175,335, filed on 30 October 2018, 12 pages.	
	6	Notice of Allowance mailed on 29 July 2019, for U.S. Patent Application No. 16/245,532, filed on 11 January 2019, 13 pages.	
	7	SOLUNA., "Powering the Block Chain," August 2018, version 1.1, 29 pages.	

If you wish to add additional non-patent literature document citation information please click the Add button Add

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
	Application Number	
	Filing Date	2019-07-31
	First Named Inventor	David Henson
	Art Unit	TBD
	Examiner Name	TBD
	Attorney Docket Number	18-874-WO1-US

EXAMINER SIGNATURE			
Examiner Signature		Date Considered	

*EXAMINER: Initial if reference considered, whether or not citation is in conformance with MPEP 609. Draw line through a citation if not in conformance and not considered. Include copy of this form with next communication to applicant.

[1] See Kind Codes of USPTO Patent Documents at www.USPTO.GOV or MPEP 901.04. [2] Enter office that issued the document, by the two-letter code (WIPO Standard ST.3). [3] For Japanese patent documents, the indication of the year of the reign of the Emperor must precede the serial number of the patent document. [4] Kind of document by the appropriate symbols as indicated on the document under WIPO Standard ST.16 if possible. [5] Applicant is to place a check mark here if English language translation is attached.

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
	Application Number	
	Filing Date	2019-07-31
	First Named Inventor	David Henson
	Art Unit	TBD
	Examiner Name	TBD
	Attorney Docket Number	18-874-WO1-US

CERTIFICATION STATEMENT

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.

☒ 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	/Alexander D. Georges/	Date (YYYY-MM-DD)	2019-07-31
Name/Print	Alexander D. Georges	Registration Number	70534

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Bibliographic data: CN103163904 (A) — 2013-06-19

Photovoltaic greenhouse solar energy distribution method based on crop growth mode and device thereof

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Abstract of CN103163904 (A)

A photovoltaic greenhouse solar energy distribution method based on a crop growth mode includes: firstly, building an illumination need model based on green house crops, a photovoltaic cell equivalent mathematical model and a luminous environment mathematical model of crop canopies, building a multi-parameter, multivariable and nonlinearity coupling pair time differential equation, achieving utilizing an optimization algorithm to design, regulate and control a photovoltaic greenhouse cell array under conditions of different illumination intensity, different illumination angles and different temperatures by solving the differential equation, and achieving solar energy reasonable distribution of photovoltaic cell maximum electric energy production under a condition which satisfies greenhouse crop growth conditions. The invention provides a device used for achieving the photovoltaic greenhouse solar energy distribution method based on the crop growth mode. The invention provides the photovoltaic greenhouse solar energy distribution method based on the crop growth mode and the device of the photovoltaic greenhouse solar energy distribution method based on the crop growth mode, and the photovoltaic greenhouse solar energy distribution method based on the

crop growth mode is capable of effectively achieving greenhouse photovoltaic power generation and effective regulation and control of crop growth and energy.

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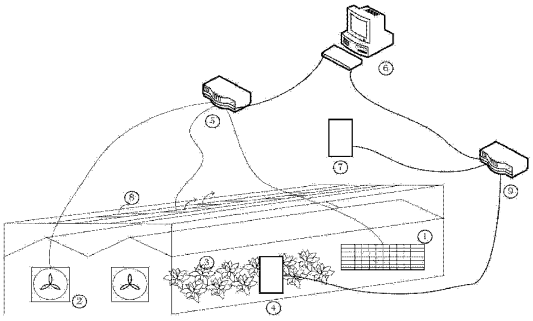
权利要求书2页 说明书7页 附图3页

(54)发明名称

一种基于作物生长模式的光伏温室太阳能分配方法及其装置

(57)摘要

一种基于作物生长模式的光伏温室太阳能分配方法，首先建立基于温室作物的光照需求模型、光伏电池等效数学模型和作物冠层的光环境数学模型，建立多参数、多变量、非线性耦合对时间微分方程，通过微分方程的求解实现不同光照强度、光照角度和温度条件下，利用优化算法对光伏温室电池阵列进行设计和调控，实现满足温室作物生长条件下光伏电池最大发电量的太阳能能量合理分配。以及提供一种实现基于作物生长模式的光伏温室太阳能分配方法的装置。本发明提供一种有效实现温室光伏发电和作物生长、能量有效调控的基于作物生长模式的光伏温室太阳能分配方法及其装置。



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1. 一种基于作物生长模式的光伏温室太阳能分配方法，其特征在于：所述分配方法包括以下步骤：

1）建立基于温室作物的光照需求模型、光伏电池等效数学模型和作物冠层的光环境数学模型，其中，

所述光伏电池等效数学模型和基于温室作物的光照需求模型由下列物理模型表示：在温室作物单叶气孔阻力 r_s，忽略 CO_2 浓度的微小影响，采用湿度因素和阻止在设定的叶温度下增加气孔阻力，得出的关系如下：

$$r_s = r_{\min} f(\overline{I_s}) f(T_c) f(X_c - X_a)$$

其中，$\overline{I_s}$ 为单位叶面积的平均短波辐射；T_c 单位是℃；x 单位是 gm^{-3}；r_{min} 最小气孔阻力最优系数；

根据作物生长整个过程的需求，对光伏面板面积 a，b 值，以及面板个数进行有效的约束；

所述作物冠层的光环境数学模型的建立过程：根据不同光伏电池阵列面积、布局和角度等对太阳光直接辐射、散射辐射的影响，并考虑作物生长对辐射影响等因素，基于双向光线跟踪技术，建立光伏电池阵列影响下的室内光环境模型；

温室光伏面板影响下的改进双向光线跟踪技术采用整体光照模型表示为：

$$I = k_c G + \int_s I_i' d\omega_i [k_d K_d (N_0 \cdot L_0) + k_m K_m (N_0 \cdot H_0)^n] + \int_s \frac{I_i' d\omega_i}{\pi} [k_d' K_d' |(N_0 \cdot L_0)| + k_t K_t (N_0 \cdot H_0)^n]$$

（1）

式中，k_cG 为传统光线跟踪技术求出的光伏温室内部辐射强度，G 为室外太阳辐射强度，k_c 为遮挡材料的透光率。如果被光伏面板遮档，则 k_c 为光伏面板的透光率；如无遮挡，k_c 的为温室覆盖材料的透光率；第二项为对光源经镜面反射后形成的所有间接点光源求和；第三项为对光源经规则透射后产生的所有间接点光源求和；I_i' 是间接点光源的入射光亮度；K_d 为漫反射率；K_d′ 为漫透射率；k_d 为漫反射系数；k_d' 为漫透射系数；K_m 为镜面反射率；k_m 为镜面反射系数；K_t 为规则透射率；k_t 为规则透射系数；N_0 为单位法向量；L_0 为单位光线向量；$d\omega_i$ 为入射角的立体角。室外光源假设为理想的点光源，针对电池面板安装对作物冠层的光环境影响进行有效的建模，确定位置比例系数 K_i；并利用整体光照明模型计算作物冠层的光照强度和光环境部分，选取作物生长周期内关键时期不同气候条件下太阳直射的关键角度作为模拟的对象；

2）建立多参数、多变量、非线性耦合对时间微分方程，通过微分方程的求解实现不同光照强度、光照角度和温度条件下，并结合优化算法对光伏温室电池阵列进行设计和调控，实现满足温室作物生长条件下光伏电池最大发电量的太阳能能量合理分配。

2. 如权利要求 1 所述的一种基于作物生长模式的光伏温室太阳能分配方法，其特征在于：所述步骤 2）中，优化算法为遗传算法，根据建立模型的约束条件，采用遗传算法优化布局和面积参数，优化参数优化参数温室开间边界与第一块电池面板和第二块电池面板的距离 x1、x2，电池面板与温室屋脊的距离 y，每块电池面板的长度 a，宽度 b，优化过程步骤如下：

2.1）初始化后 x1、x2、y、a、b 参数群体，每个参数随机生成 n 个个体作为初始群体 P(0)，

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设置最大进化代数 T ；

2.2) 计算种群适应度值，并判断种群最优解是否满足设置值 ；

2.3）若满足，直接输出最优结果 ；

2.4）若不满足 ：程序对初始种群各个的适应度值进行排序，根据排序的结果选择粒子，对优秀粒子直接遗传，对在进行交叉和变异运算，产生新的种群 ；

2.5）然后，计算新种群判断是否满足设置值，或达到最大迭代次数 T，则以进化过程中所得到的具有最大适应度个体作为最优解输出，终止计算。若满足直接得出最优结果，若不满足进入下次循环，如此循环运行，最终得出最优 x1, x2, y, a, b 结果，从而实现温室光伏面板阵列的优化设计。

3. 一种用于实现如权利要求 1 所述的基于作物生长模式的光伏温室太阳能分配方法的装置，其特征在于 ：所述装置包括角度调节传动机构，所述温室屋顶光伏阵列的电池面板连接角度调节传动机构，所述角度调节传动机构由减速电机、连接轴、主动齿轮，直行齿条、从动齿轮、旋转轴、支撑轴承、滑动轴承、齿轮 - 弧形齿条、滚动滑轮、环境传感器、与控制执行系统组成，齿轮 - 直行齿条，齿轮 - 弧形齿条连接部都有定位销和齿条长度调整紧固螺母组成，在直行齿轮齿条的下面设置可易于使齿条滑动并提供支撑面的滚轮。

4. 如权利要求 3 所述的装置，其特征在于 ：根据由于电池面板在转动过程中弧形齿条的空间位置变化，通过分段圆弧的转速跟不同直径直径的换算，从 0 度到最大角度可分为 3 个阶段，每个阶段的运行时间与全部开启时间和 3 个不同直径的关系如下 ：$t_1 = T/(1+\frac{R_3+R_2}{R_1})$ ，$t_2 = T/(1+\frac{R_3+R_1}{R_2})$ ，$t_1 = T/(1+\frac{R_3+R_2}{R_1})$ ，采用控制减速电机的运行时间实现达到电池面板角度的控制。

5. 如权利要求 3 或 4 所述的装置，其特征在于 ：所述温室屋顶光伏阵列与控制执行系统连接，所述控制执行系统由信号采集器、嵌入式计算机、继电器信号输出器、减速电机组成 ；

所述的信号采集器，接收室内外光照、温湿度传感器数据，并进行预处理操作后上传至嵌入式计算机 ；

所述的嵌入式计算机，为温室光伏发电和环境控制的核心，接收数据采集器上传的数字室内外光照、温湿度等信号，识别当前的环境、光照状态，并向继电器信号输出器发出相应的控制指令 ；

所述的继电器信号输出器，接收嵌入式计算机发出的控制指令，产生对应的强电信号，完成光伏电池面板减速电机的驱动 ；

所述的减速电机通过两级齿轮齿条控制机构与光伏面板相连，根据计算机发出的指令，完成光伏面板的开度调节。

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一种基于作物生长模式的光伏温室太阳能分配方法及其装置

技术领域

[0001] 本发明涉及光伏发电温室的设计方法和调控领域，尤其是涉及一种光伏温室太阳能分配方法。

背景技术

[0002] 目前，全球经济发展导致的诸多环保问题已成为世界关注的焦点，同时作为最重要能源物质的煤炭、石油、天然气等可利用化石能源终将面临枯竭，开发可再生替代能源已势在必行。在核能面临安全危机、生物质能遭遇粮食安全等情况下，太阳能发展作为新能源产业突出的地位，因此既能实现太阳能发电，又能保证粮食和农产品安全供应的光伏温室必将具有重要的发展前景。既可在保证种植生产效果的同时，充分利用到太阳能这一取之不尽的可再生能源，无论是对温室园艺产业，还是对全人类的生存环境都具有非常重要的意义。

[0003] 为了提高输出效率和降低发电成本，光伏温室发展的关键技术问题是如何协调分配温室内作物生长和光伏发电对太阳光照的需求。实现满足作物生长的情况下，实现光伏发电效率的最大化，而其中温室屋面光伏面板的布局与调控设计是解决这个问题的关键。因此本发明基于温室作物的光照需求模型、光伏电池等效数学模型和作物冠层的光环境数学模型，并结合优化算法对光伏温室电池阵列进行设计和调控，实现满足温室作物生长条件下光伏电池最大发电量的太阳能能量合理分配。

[0004] 因此研究不同光伏电池阵列面积、布局和角度等对温室内光环境的影响基本规律分析，是有助于协调分配温室内作物生长和光伏发电对太阳光照的需求。实现温室内光分布的均匀度，有利于室内所有作物的正常生长，也有利于光伏发电的效率最高。因此温室屋面光伏面板阵列的合理设计对于光伏温室的研制与开发 具有非常重要的意义。

[0005] 研究光伏温室发电电池阵列设计与调控方法主要有试验设计方法和数学模型模拟方法。试验设计方法比较简单、直观、有效，缺点是投资大，周期长且优化设计困难。数学模拟投资小、易计算，可以对试验方法无法实现的特殊条件或复杂状态进行模拟及相关状态转换处理，但必须根据实际研究对象特征进行修正才能使其有效性得到保证。

[0006] 光伏温室由于要试验各种气候条件下的实验数据，务必试验周期较长。如果在设计不成熟的情况下进行现场施工与试验，会造成较大的作物等经济损失，且容易造成反复返工等问题。因此，采用数学模拟方法在设计光伏温室面板阵列，并在保证作物生长的条件下，对温室面板阵列设计与调控进行优化设计，确保光伏温室电池阵列设计的科学合理性。

发明内容

[0007] 为了克服现有无法实现温室光伏发电和作物生长以及能量有效调控的技术问题，本发明提供一种有效实现温室光伏发电和作物生长、能量有效调控的基于作物生长模式的光伏温室太阳能分配方法及其装置。

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[0008] 本发明解决其技术问题所采用的技术方案是：

[0009] 一种基于作物生长模式的光伏温室太阳能分配方法，所述分配方法包括以下步骤

[0010] 1）建立基于温室作物的光照需求模型、光伏电池等效数学模型和作物冠层的光环境数学模型，其中，

[0011] 所述光伏电池等效数学模型和基于温室作物的光照需求模型由下列物理模型表示：在温室作物单叶气孔阻力 r_s，忽略 CO_2 浓度的微小影响，采用湿度因素和阻止在设定的叶温度下增加气孔阻力，得出的关系如下：

[0012] $$r_s = r_{\min} f(\overline{I_s}) f(T_c) f(X_c - X_a)$$

[0013] 其中，$\overline{I_s}$ 为单位叶面积的平均短波辐射；T_c 单位是℃；x 单位是 gm^{-3}；r_{min} 最小气孔阻力最优系数；

[0014] 根据作物生长整个过程的需求，对光伏面板面积 a，b 值，以及面板个数进行有效的约束；

[0015] 所述作物冠层的光环境数学模型的建立过程：根据不同光伏电池阵列面积、布局和角度等对太阳光直接辐射、散射辐射的影响，并考虑作物生长对辐射影响等因素，基于双向光线跟踪技术，建立光伏电池阵列影响下的室内光环境模型；

[0016] 温室光伏面板影响下的改进双向光线跟踪技术采用整体光照模型表示为：

[0017]

$$I = k_c G + \int_s I_i' d\omega_i [k_d K_d (N_0 \cdot L_0) + k_m K_m (N_0 \cdot H_0)^n] + \int_s \frac{I_i' d\omega_i}{\pi} [k_d' K_d' |(N_0 \cdot L_0)| + k_t K_t (N_0 \cdot H_0)^n]$$

[0018] （1）

[0019] 式中，k_cG 为传统光线跟踪技术求出的光伏温室内部辐射强度，G 为室外太阳辐射强度，k_c 为遮挡材料的透光率。如果被光伏面板遮档，则 k_c 为光伏面板的透光率；如无遮挡，k_c 的为温室覆盖材料的透光率；第二项为对光源经镜面反射后形成的所有间接点光源求和；第三项为对光源经规则透射后产生的所有间接点光源求和；I_i' 是间接点光源的入射光亮度；K_d 为漫反射率；K_d' 为漫透射率；k_d 为漫反射系数；k_d' 为漫透射系数；K_m 为镜面反射率；k_m 为镜面反射系数；K_t 为规则透射率；k_t 为规则透射系数；N_0 为单位法向量；L_0 为单位光线向量；$d\omega_i$ 为入射角的立体角。室外光源假设为理想的点光源，针对电池面板安装对作物冠层的光环境影响进行有效的建模，确定位置比例系数 K_i；并利用整体光照明模型计算作物冠层的光照强度和光环境部分，选取作物生长周期内关键时期不同气候条件下太阳直射的关键角度作为模拟的对象；

[0020] 2）建立多参数、多变量、非线性耦合对时间微分方程，通过微分方程的求解实现不同光照强度、光照角度和温度条件下，并结合优化算法对光伏温室电池阵列进行设计和调控，实现满足温室作物生长条件下光伏电池最大发电量的太阳能能量合理分配。

[0021] 进一步，所述步骤 2）中，优化算法为遗传算法，根据建立模型的约束条件，采用遗传算法优化布局和面积参数，优化参数温室开间边界与第一块电池面板和第二块电池面板的距离 x1、x2，电池面板与温室屋脊的距离 y，每块电池面板的长度 a，宽度 b，优化过程步骤如下：

[0022] 2.1）初始化后 x1、x2、y、a、b 参数群体，每个参数随机生成 n 个个体作为初始群体 P(0)，设置最大进化代数 T；

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[0023] 2.2）计算种群适应度值，并判断种群最优解是否满足设置值；

[0024] 2.3）若满足，直接输出最优结果；

[0025] 2.4）若不满足：程序对初始种群各个的适应度值进行排序，根据排序的结果选择粒子，对优秀粒子直接遗传，对在进行交叉和变异运算，产生新的种群；

[0026] 2.5）然后，计算新种群判断是否满足设置值，或达到最大迭代次数 T，则以进化过程中所得到的具有最大适应度个体作为最优解输出，终止计算。若满足直接得出最优结果，若不满足进入下次循环，如此循环运行，最终得出最优 x1, x2, y, a, b 结果，从而实现温室光伏面板阵列的优化设计。

[0027] 再进一步，所述装置包括角度调节传动机构，所述温室屋顶光伏阵列的电池面板连接角度调节传动机构，所述角度调节传动机构由减速电机、连接轴、主动齿轮，直行齿条、从动齿轮、旋转轴、支撑轴承、滑动轴承、齿轮－弧形齿条、滚动滑轮、环境传感器、与控制执行系统组成，齿轮－直行齿条，齿轮－弧形齿条连接部都有定位销和齿条长度调整紧固螺母组成，在直行齿轮齿条的下面设置可易 于使齿条滑动并提供支撑面的滚轮。

[0028] 进一步，根据由于电池面板在转动过程中弧形齿条的空间位置变化，通过分段圆弧的转速跟不同直径直径的换算，从 0 度到最大角度可分为 3 个阶段，每个阶段的运行时间与全部开启时间和 3 个不同直径的关系如下：$t_1 = T/(1+\frac{R_3+R_2}{R_1})$，$t_2 = T/(1+\frac{R_3+R_1}{R_2})$，$t_1 = T/(1+\frac{R_3+R_2}{R_1})$，采用控制减速电机的运行时间实现达到电池面板角度的控制。

[0029] 更进一步，所述控制执行系统由信号采集器、嵌入式计算机、继电器信号输出器、减速电机组成；

[0030] 所述的信号采集器，接收室内外光照、温湿度传感器数据，并进行预处理操作后上传至嵌入式计算机；

[0031] 所述的嵌入式计算机，为温室光伏发电和环境控制的核心，接收数据采集器上传的数字室内外光照、温湿度等信号，识别当前的环境、光照状态，并向继电器信号输出器发出相应的控制指令；

[0032] 所述的继电器信号输出器，接收嵌入式计算机发出的控制指令，产生对应的强电信号，完成光伏电池面板减速电机的驱动；

[0033] 所述的减速电机通过两级齿轮齿条控制机构与光伏面板相连，根据计算机发出的指令，完成光伏面板的开度调节。

[0034] 本发明的有益效果主要表现在：

[0035] 1）可以较好的模拟光伏温室室内光环境，是在模拟研究室内光照环境的有效方法。

[0036] 2）本方法不受设计光伏温室地点、结构等参数的限制，方便、快捷，应用范围广，并节约了设计时间和设计成本。

[0037] 3）本装置可实现温室光伏发电和作物生长有效生长的能量有效调控。

附图说明

[0038] 图 1 是光伏温室与控制示意图；附图 1 中：1－湿帘 2－风机 3－作物 4－室内温湿度、

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光照传感器 5- 执行控制器 6- 嵌入式计算机 7- 室外辐射传感器 8- 光伏电池面板 9- 数据采集器。

[0039] 图 2 是电池面板转动传动机构与优化参数；附图 2 中 1- 减速电机 2- 连接轴 3- 主动 4- 直行齿条 5- 支撑轴承 6- 转动轴 7- 弧形齿轮齿条 8- 光伏电池面板 9- 从动齿轮 10- 驱动轴。

[0040] 图 3 是主从齿轮 - 齿条驱动简图；附图 3 中 1- 主动齿轮 2- 直形齿条 3- 滚轮 4- 从动齿轮。

[0041] 图 4 是齿条空间运动与转动角度的关系计算简图。

[0042] 图 5 是光伏电池阵列优化设计流程简图。

图 6 是本发明选取电池面板长宽分别为 1650*990mm 的多晶硅片的选择布局分析的排列方式：图 6（a）沿温室纵向直行排列；图 6（b）交错排列；图 6（c）沿温室横向、纵向间隔排列方式。

具体实施方式

[0043] 下面结合附图，下面对本发明进行详细说明。

[0044] 参照图 1 ～图 6，一种基于作物生长模式的光伏温室太阳能分配方法，建立基于双向光线跟踪的温室内作物冠层光环境模型，以现代国内大量应用的文洛式 (VENLO) 玻璃温室为实例，结合叶片气孔阻力起决定性的作物生长光照模型和光伏电池等效数学模型，采用遗传算法结合的优化算法，以保证满足作物生长光环境下的光伏电池较大发电量，并保证在较快时间内最终实现温室光伏面板阵列的优化设计。

[0045] 所述的基于双向光线跟踪的温室内作物冠层光环境模型，即根据不同光伏电池阵列面积、布局和角度等对太阳光直接辐射、散射辐射的影响，并考虑作物生长对辐射影响等因素，基于双向光线跟踪技术，建立光伏电池阵列影响下的室内光环境模型。

[0046] 由于不同光伏电池阵列面积、布局和太阳直射角度等因素情况很多，如果每个角度、面积布局等都组合进行模拟运算，则模拟的工作量非常大、在实际操作过程中，要完全模拟上述各种情况几乎是不可能的，而且其中多数情况也没有非常必要。针对此问题，就必须选取关键参数的模型研究方法，即在考察所研究对象时，分析在模拟条件中哪些因素对模拟其重大作用，哪些是次要的，不起决定作用的。

[0047]

[0048]

[0049]

[0050] 太阳直射的角度可从半球型各点动态变化的过程模拟温室内植物冠层的光环境。其中根据温室的建造方向和维度等，选取太阳不同季节关键日，分为晴天、阴天和下雨情况，分别进行模拟一日内室内光环境的变化情况。由于布局不同，对温室每个地方光环境的影响不同，因此在不同布局下，选取室内几个关键点的光环境模拟分析。

[0051] 正向跟踪能够计算环境的镜面反射光和规则透射光对漫反射表面光亮度的影响。双向光线跟踪技术采用的整体光照模型可表示为：

[0052]

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$$I = k_c G + \int_s I_i' d\omega_i [k_d K_d (N_0 \cdot L_0) + k_m K_m (N_0 \cdot H_0)^n] + \int_s \frac{I_i' d\omega_i}{\pi} [k_d' K_d' |(N_0 \cdot L_0)| + k_t K_t (N_0 \cdot H_0)^n]$$

[0053] （1）

[0054] 式中，$k_c G$ 为传统光线跟踪技术求出的光伏温室内部辐射强度，G 为室外太阳辐射强度，k_c 为遮挡材料的透光率。如果被光伏面板遮档，则 k_c 为光伏面板的透光率；如无遮挡，k_c 的为温室覆盖材料的透光率；第二项为对光源经镜面反射后形成的所有间接点光源求和；第三项为对光源经规则透射后产生的所有间接点光源求和；I_i' 是间接点光源的入射光亮度；K_d 为漫反射率；K_d' 为漫透射率；k_d 为漫反射系数；k_d' 为漫透射系数；K_m 为镜面反射率；k_m 为镜面反射系数；K_t 为规则透射率；k_t 为规则透射系数；N_0 为单位法向量；L_0 为单位光线向量；$d\omega_i$ 为入射角的立体角。

[0055] 室外光源（太阳辐射）假设为理想的点光源，以方便确定到达被照射点的光能大小。针对电池面板安装对作物冠层的光环境影响进行有效的建模，不仅考虑太阳直射的因素，还需要考虑漫反射的影响，主要是识别其中的位置比例系数 K_i 的确定。位置比例系数 K_i 根据光伏面板布局对室内光照环境对不同位置的影响分析，结合简化试验模拟确定合理参数值。并利用整体光照明模型计算作物冠层的光照强度和光环境部分，选取作物生长周期内关键时期不同气候条件下太阳直射的关键角度作为模拟的对象，减少模拟的计算量，以便计算机能尽快实现收敛。

[0056] 结合温室作物的光照需求、光伏电池等效数学模型和上述的作物冠层的光环境数学模型，建立多参数、多变量、非线性耦合对时间微分方程，通过微分方程的求解实现不同光照强度、光照角度和温度条件下的作物生长和光伏发电的光照实时协调分配机制。光伏电池的数学模型和作物光需求可由下列物理模型表示。

[0057] 根据光伏太阳电池板的内部结构和输出伏安特性得到光伏方阵的等效电路由一个受光强和温度影响的电流源并联上一个二极管再串联一个电阻组成。光伏电 池的数学模型可表示如下：

[0058] $$I = I_{PH} - I_0 \cdot \left(e^{\frac{q \cdot (V + I \cdot R_S)}{nkT}} - 1 \right) - \frac{U + R_S \cdot I}{R_{SH}} \qquad (2)$$

[0059] 理想情况下 RS 可近似为零，RSH 近似为无穷大，简化为：

[0060] $$I = I_{PH} - I_0 \cdot \left(e^{\frac{q \cdot V}{nkT}} - 1 \right)$$

[0061] P=V • I （3）

[0062] I 为输出电流；IPH 为光生电流；I0 为反向饱和电流；q 为电子电荷；V 为输出电压；Rs 为串联电阻；n 为二极管品质因子；k 为波尔兹曼常数；T 为开氏温度；RSH 为并联电阻；

[0063] 温室作物生长的光合作用与蒸腾作用相互关联，是植物生长的必要条件，其中受外部环境影响重要的叶片气孔阻力起决定性的作用，因此所述的作物光需求可由气孔阻力来体现。在温室作物单叶气孔阻力（r_s），忽略 CO_2 浓度的微小影响，采用湿度因素和阻止在一定的叶温度下增加气孔阻力，得出的关系如下：

[0064] $$r_s = r_{\min} f(\overline{I_s}) f(T_c) f(X_c - X_a) = r_{\min} \left[\frac{\overline{I_s} + k_{s1}}{\overline{I_s} + k_{s2}} \right] \left[\frac{e^{0.3T_c} + 258}{e^{0.3T_c} + 27} \right] \left[4 \times 10^{-3} + e^{-0.73(x_c - x_a)} \right] \qquad (4)$$

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[0065] 其中，$\overline{I_s}$ 为单位叶面积的平均短波辐射；T_c 当前室内温度，单位是℃；x_c, x_a 分为室内实际绝对湿度和饱和绝对湿度，单位是 gm^{-3}；r_{min} 最小气孔阻力最优系数。k_{s1}, k_{s2} 为合适的修正系数，不同的作物有所区别，如番茄作物修正值分别为 4.3，0.54。

[0066] 利用优化算法得到满足温室作物生长条件下的光伏电池最大发电量是光伏温室电池面板阵列的核心任务。针对这一问题，采用一种实码遗传算法的优化方法来实现光伏温室电池面板阵列优化设计，实现满足作物生长光环境下的光伏电池较大发电量。

[0067] 本发明根据建立模型的约束条件，采用遗传算法（GA）优化布局和面积等参数。优化参数如附图 2 中参数 x1, x2, y, a, b，优化流程如附图 5，过程步骤如下：

[0068] 1）初始化后 x1、x2、y、a、b 参数群体，每个参数随机生成 n 个个体作为初始群体 P(0)，设置最大进化代数 T。

[0069] 2）计算种群适应度值，并判断种群最优解是否满足设置值；

[0070] 3）若满足，直接输出最优结果；

[0071] 4）若不满足：程序对初始种群各个的适应度值进行排序，根据排序的结果选择粒子，对“优秀”粒子直接遗传，对在进行交叉和变异运算，产生新的种群；

[0072] 4）然后，计算新种群判断是否满足设置值，或达到最大迭代次数 T，则以进化过程中所得到的具有最大适应度个体作为最优解输出，终止计算。若满足直接得出最优结果，若不满足进入下次循环，如此循环运行，最终得出最优 x1, x2, y, a, b 结果，从而实现温室光伏面板阵列的优化设计。

[0073] 光伏温室电池面板的角度调节传动机构如附图 2 所示，由减速电机、连接轴、主动齿轮，直行齿条、从动齿轮、旋转轴、支撑轴承、滑动轴承、齿轮－弧形齿条、滚动滑轮、环境传感器、与控制执行系统组成。滑动轴承实现电池面板和支撑轴的旋转支撑，满足面板具有旋转运动的能力。可方便安装与拆卸，同时轴自身转动不影响或干涉面板旋转的功能。

[0074] 减速电机选用功率为 0.55kw，传动比为 1：300，输出转速为 2.8rpm，额定转速为 1400r/min，具体型号为 DWPSV75。连接轴选用材料为 45 钢直径为 Φ32mm 的轴，采用弹性套柱销联轴器连接，其孔直径为 Φ32mm. 主动齿轮孔径为 Φ32mm，直径为 50mm。传动齿轮选用 A 型直形齿条。为了增加转动轴的扭矩，经校核设计了从动齿轮的分度圆直径为 Φ150mm，采用直径为 Φ50mm 长度为 300mm 轴。采用弹性套柱销联轴器连接转动轴选用 Φ32*3.0 热镀锌钢管。主从齿轮的转动比为 1：3。

[0075] 齿轮－弧形齿条连接部都有定位销和齿条长度调整紧固螺母 M8 组成，方便齿 条长度和位置的调整。齿轮－弧形齿条与电池面板的连接采用 M8 螺栓连接，并采用过盈配合，满足旋转运动的能力。在直行齿轮齿条的下面设置可易于使齿条滑动的滚轮，同时也为齿轮的支撑滚轮。

[0076] 齿轮齿条中主从齿轮转动比固定，减速电机轴的转速与转动轴的转速比固定。电机转速计算中可直接与弧形齿条转速配合计算。由于电池面板在转动过程中，弧形齿条的空间位置是变化，导致同样的转速引起在单位时间内的转动角度不是匀速的，齿条运动位置图如附图 3 所示。可把弧形分为三段圆形结构，直径分别为 R_1, R_2, R_3,。因此可把角度转速分三个阶段，平均转动每个角度 β 所用的时间是不同的，从 0 度到最大角度开启每阶段用的时间分别为 t_1, t_2, t_3，从 0 度到最大角度开启电机运转的时间为 T。根据圆弧周长的计算，

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可获得 t_1, t_2, t_3 与直径 R_1, R_2, R_3 和整个开启 T 的关系，$t_1 = T/(1+\frac{R_3+R_2}{R_1})$，$t_2 = T/(1+\frac{R_3+R_1}{R_2})$，$t_1 = T/(1+\frac{R_3+R_2}{R_1})$。

[0077] 因此通过该方法控制电机运转的时间达到电池面板角度较精确的控制。

[0078] 完成光伏温室环境参数和执行机构状态识别与相应的控制功能，由信号采集器、嵌入式计算机、继电器信号输出器、减速电机组成。

[0079] 所有的信号传送采用串行总线接口中的 Controller Area Network（简称 CAN）总线技术。CAN 收发器采用基于美国德州仪器（Texas Instruments, TI）的 CAN 和隔离技术相结合的器件低功耗器件，具体型号为 ISO1050。

[0080] 所述的信号采集器，采集芯片有接收室内外光照、温湿度传感器数据，并进行预处理操作后上传至嵌入式计算机；

[0081] 所述的嵌入式计算机，可选用工业计算机。为带有 CAN 总线接收卡的温室光伏发电和环境控制的核心，接口卡可可选用 PCI-7841，接收数据采集器上传的室内外光照、温湿度等信号，识别当前的环境、光照状态等数字信号，并向继电器信号输出器发出相应的控制指令；

[0082] 所述的继电器信号输出器，接收嵌入式计算机发出的控制指令，产生对应的强电信号，完成光伏电池面板减速电机，风机和水泵等执行机构的驱动；

[0083] 所述的减速电机通过两级齿轮齿条控制机构与光伏面板相连，根据计算机发出的指令，完成光伏面板的开度调节。还有温室降温机构湿帘水泵、风机的开启调节室内的温度。

[0084] 最后，还需要注意的是，以上列举的仅是本发明的一个具体实施例。显然，本发明不限于以上实施例，还可以有许多变形，如温室电池多（单）晶硅面板换成光伏薄膜或光伏玻璃的优化设计等。本领域的普通技术人员还能从本发明公开的内容直接导出或联想到的所有变形，均应认为是本发明的保护范围。

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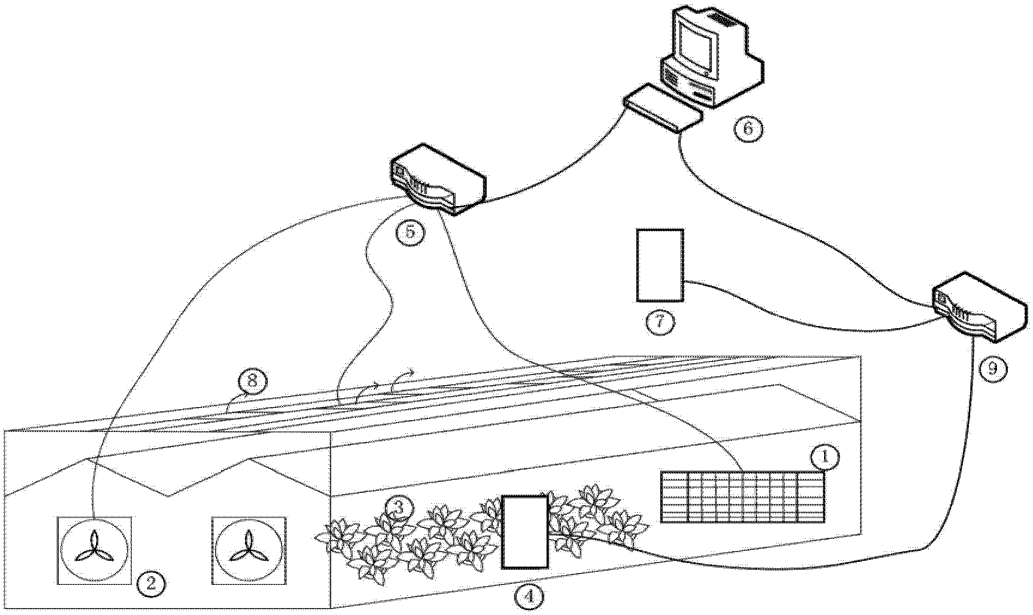


图 1

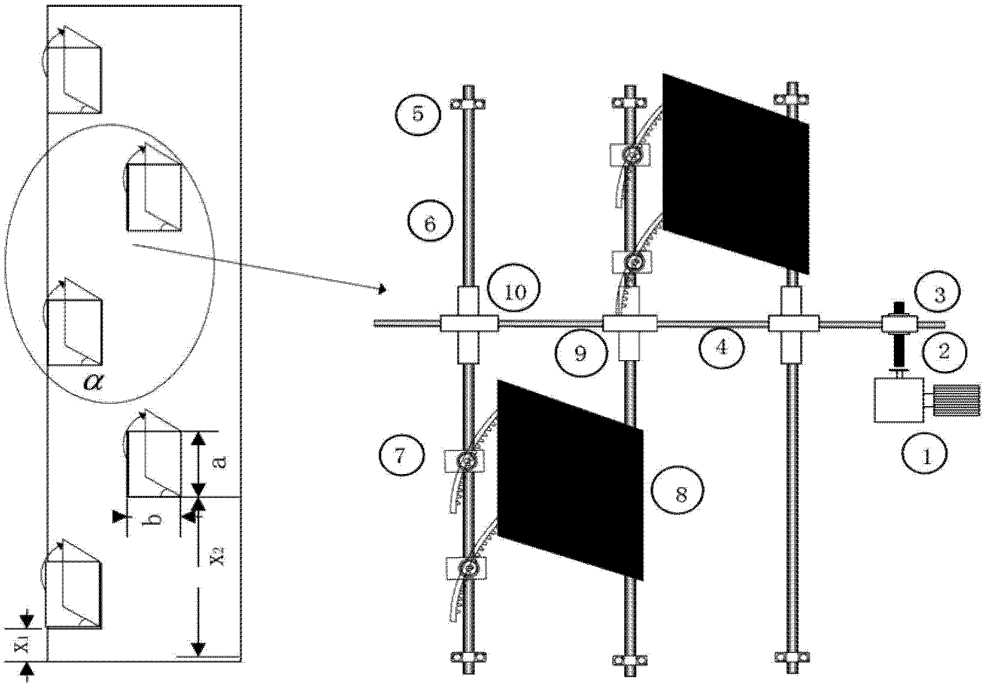


图 2

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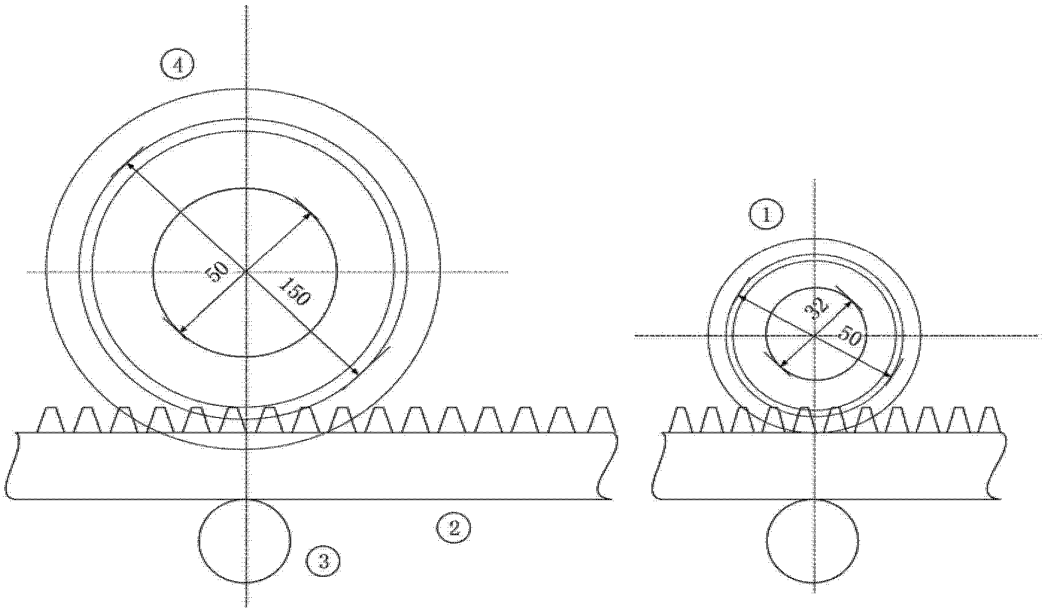


图 3

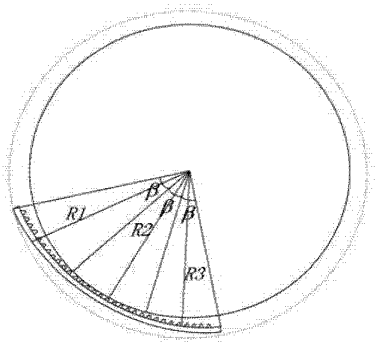


图 4

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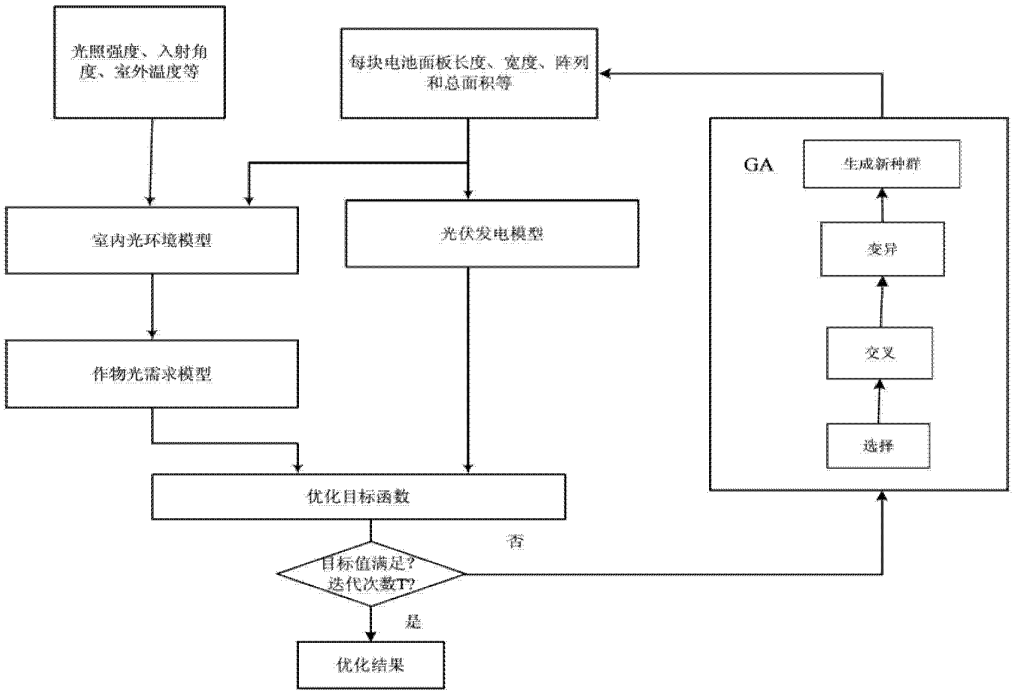


图 5

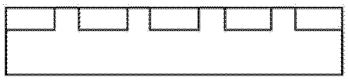


图 6(a)

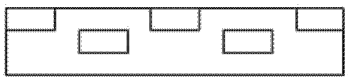


图 6(b)

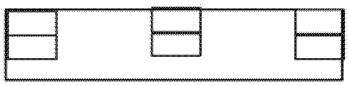


图 6(c)

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(54) **Title**: SOLAR POWERED THREE-AXIS MOBILE AGRICULTURAL AUTOMATION

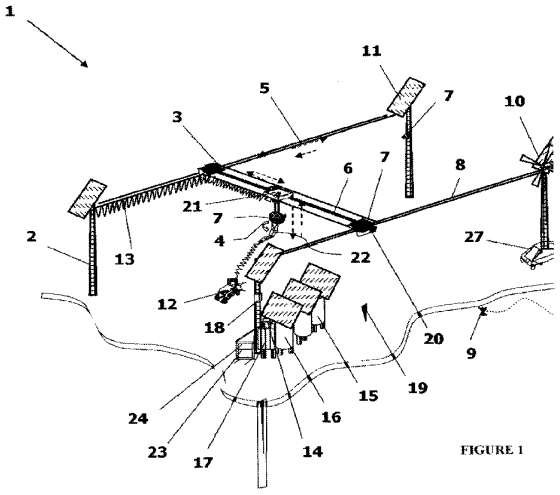


FIGURE 1

(57) **Abstract**: The present invention is related to a solar powered three-axis mobile agricultural automation of which the main energy source is solar energy; when reinforced, gains continuity with the support of wind, network and generator; and which carries out drop irrigation, sprinkler irrigation, agricultural spraying, subsoil moisture control and thermal leaf moisture analysis, macro visualization, fogging, shaking, harvesting, displaying, illumination, security operations and which also carries out driving and power supply operations by means of the electric tractor which moves on the soil.

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SOLAR POWERED THREE-AXIS MOBILE AGRICULTURAL AUTOMATION

Technical Field

The present invention is related to a solar powered three-axis mobile agricultural automation of which the main energy source is solar energy; when reinforced, gains continuity with the support of wind, network and generator; and which carries out drop irrigation, sprinkler irrigation, agricultural spraying, subsoil moisture control and thermal leaf moisture analysis, macro visualization, fogging, shaking, harvesting, displaying, illumination, security operations and which also carries out driving and power supply operations by means of the electric tractor which moves on the soil.

Prior Art

Agriculture is the oldest and still the most important economic activity that provides food, feed, fiber and necessary fuel for people to survive. With the continued increase in world population, it is necessary for agricultural production to also increase to meet the growing demand for food and bioenergy. Limited land, water and labor resources taken into account, the emphasis is on machinery rather than manpower.

Robotics and automation will particularly play an important role in the near future in meeting the needs of agricultural production in order to increase the quality of life for society. In recent years, robots have played a major role in increasing agricultural productivity, in industrial production, and in reducing the cost of products. In particular, GPS and vision-based self-guided tractors and combines have begun to take their place in the automation market in agriculture. More recently, farmers have started to perform processes such as pruning, thinning and harvesting, mowing, agricultural spraying, and removal of grass using automated machines or with autonomous systems.

For example, in the fruit cultivation sector, it was observed that using robotic platforms in the process of collecting fruits from branches was two times more efficient than workers using ladders for the same process. Developments in sensors and control systems allow optimum welding and harmful disease management. Automation systems provide great advantages in terms of cultivation, maintenance and harvesting of agricultural products.

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Difficult working conditions, decreasing energy resources and the need for clean energy has accelerated the development and use of technology in the field of agriculture. In present studies, various developments such as automation systems being mobile, energy storage, use of electric tractors, movement of carrier ropes and tree shaking systems, etc. have been observed. Other studies in the relevant field that stand out are irrigation systems, soil and crop cultivation machinery. In this context, fixed and mobile irrigation systems, mobile work machinery and robots have been developed.

The common feature of the applications is that they are ground contact systems which carry out processes by means of controlled arms. Their disadvantage is that they cause damage to the soil. In addition to the fact that they cannot be used in all types of fields, their maintenance and repair also requires expertise. Expanding agricultural automation is generally developed for programming and operating conventional farming tools. Irrigation can be considered a typical example. Systems selected according to the crop type are sprinklers, drip irrigation and wild flooding. While in sprinkler systems the run time of water pressure is controlled, in drip irrigation the water tank level and period of irrigation is controlled. The realization of applications with pipes laid in the ground has negative effects in terms of material life, protection of pipes, and blocking of machinery in the field. While irrigation systems with mobile capability which have become widespread in recent years, problems related to soil damage, moving hoses, garages and assembly have not been overcome. While solar-powered pumps and irrigation systems have become widespread, use of solar powered tractors has not.

In the invention of patent application number US 2011106451 of the known state of the art, a multi-sensor system measures diffuse reflectance of soil, soil conductivity, and other soil properties in situ, in three dimensions. The system includes a sensor shank used for X-Y axis measurements and a hydraulic probe implement containing a sensor probe for −Z axis measurements. It includes optical sensors and soil electrical conductivity sensors. It further encompasses a sensor that measures insertion force and a soil temperature sensor. These combinations of sensors are used to calibrate the system and to characterize the soil properties within a field or area.

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In patent document number US4612996 A of the known state of the art, a robotic tractor that travels on rails forming a grid over a crop field and automatically performs tasks in the field is described. The tractor is supported on extendable legs that carry dual tandem perpendicular wheel sets. A rotary implement bed supported by the tractor is adapted to carry implements.

In patent document number WO2013181069 A1 of the known state of the art, the invention is an agricultural tractor and consists of an electrical control unit and control system that controls the tractor. The control system is programmed such that the sensor related to the tractor's operating functions receive numerous real time signals.

The control system is also arranged to enable numerous output signals of controlled operating components. The control system enables predefined commands to be carried out by means of input being provided over the internet.

In the invention of patent document number EP2622955 A1 again of the known state of the art, the tractor has actuator which is controlled by control device and is actuated under external power, to adjust working parameter of machine. A sensor is connected to control device, to detect vertical position of machine, machine inclination in forward or sideward direction, and distance between machine and object. The control device is used to identify agricultural several topographical zones of field by means of signals of sensor.

The common feature of the above patents is that they are ground contact systems which carry out processes by means of controlled arms. Their disadvantage is that they cause damage to the soil. While they cannot be used in all types of fields, their maintenance and repair also requires expertise.

Expanding agricultural automation is generally developed for programming and operating conventional farming tools. Irrigation can be considered a typical example. Systems selected according to the crop type are sprinklers, drip irrigation and wild flooding. While in sprinkler system the run time of water pressure is controlled, in drip

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irrigation the water tank level and period of irrigation is controlled. The realization of applications with pipes laid in the ground has negative effects in terms of material life, protection of pipes, and blocking of machinery in the field. While irrigation systems with mobile capability which have become widespread in recent years, problems related to soil damage, moving hoses, garages and assembly have not been overcome. While solar-powered pumps and irrigation systems have become widespread, use of solar powered tractors has not.

Taking into account all of the above documents part of the known state of the art, these do not mention a system such as the solar powered three-axis mobile agricultural automation of the present invention to be used in agricultural activities.

Brief Description and Objectives of the Invention

The objective in developing the solar powered three-axis mobile agricultural automation is to provide the production of an efficient product using programmable agricultural activities, remote control and management systems and to provide savings by using low cost energy source.

Another objective in developing the invention is to enable cultivation with deformation in the soil and to provide up to date tracking of crop growth.

Description of Drawings Describing the Invention

The drawings prepared to better describe the solar powered three-axis mobile agricultural automation developed with this invention are specified below.

Figure 1 – View of the elements that constitute the solar powered three-axis mobile agricultural automation system.

Figure 2 - View of the chassis panel position when the chassis is located in the interior

Figure 3 - View of the tank position when the chassis is in tunnel

Figure 4 - View of the chassis panel position when the chassis is located in the exterior

Figure 5 - View of the pressurized tree shaking device

Figure 6 – Perspective view of the drip irrigation tank

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Definitions of the Components/Parts/Pieces Forming the Invention

The components/parts/pieces found in the figures to better describe the solar powered three-axis mobile agricultural automation realized by means of this invention are numbered individually as specified below.

1. Solar powered three-axis mobile agricultural automation
2. Carrier pole
3. X axis movement platform
4. Rotating head
5. Stretch ropes
6. Bridge ropes
7. Control elements
8. Parallel rope
9. Subsoil moisture sensor
10. Wind energy system
11. Solar cell panels
12. Electric tractor
13. Mobile conveyor line
14. Water pump
15. Compressed air tank
16. Water tank
17. Power supply
18. Control panel
19. Drip irrigation tank
20. DC overhead engine
21. Mobile platform body
22. Robotic arm
23. Controlled access gate
24. Cooling unit
25. Pressure shaker
26. Shaker piston

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27. Direct movement mechanism

Detailed Description of the Invention

The solar powered three-axis mobile agricultural automation (1) consists of a pair of ropes (8) parallel to each other placed on the stretch ropes (5) located on the top section of four carrier poles (2) positioned on the specified area. The movement of the stretch ropes (5) is possible by means of the DC overhead engine (20) connected to the pulley center on the pole (2). The stretch ropes (5) move the X axis movement platform (3) along the x axis. The mutual platform (21), which is placed on the bridge ropes (6) and which is idle on the bottom and fixed on the top, can move in the (z) direction with the movement of the rope (6). This platform (21) also provides the transfer of data, liquid, and air by means of the idle wheel located on the mobile conveyor line (13). This body (21) moves by means of the drive of the mobile bridge engine (20) to which the pulleys found on two ends of the platform (3) are connected. The body platform (21) provides balance stability to the four ropes (5, 8) with eight contact points. The rotating head (4), which can rotate 360 degrees with the vertical (y) axis motion of the four bedded columns located on the body (21), positions the poles (2) to the points referenced by means of laser measurements. Functional apparatuses are located on the side of the head (4), while a robotic arm (22) is located on its bottom to perform point-in commands.

In the automation system (1); data, energy, water and compressed air conveyor line (13) moves together with the spool connected to the stretch rope (5) in an accordion like manner. The conveyor line (13) operates similarly on the overhead bridge as well. The mobile platform body (21) passes over the bridge ropes (6) to reach the rotating head (4). The rotating head (4), which can be positioned to any point, performs agricultural activities in the area it is located by means of the robotic arm (22).

In the system's energy management, energy is obtained directly or indirectly from the solar cell panels (11) positioned on top of the carries poles (2) and the storage units (16), from the wind energy systems (10) and from the network if reinforcement exists.

If an electric tractor (12) is to be used within the framework of the control panel (18), the

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energy is directly directed to the tractor (12). Deep wells, water transfers and other activities are disabled. For example, if agricultural spraying is to be performed, the stock energy (compressed air) is provided to the pesticide and water tank (16) and transfer pressure is achieved. At other times, energy is used in deep water extraction and storage, air compression, irrigation, battery storage, feeding of other units and in the power battery group of the electric tractor (12).

The control panel (18) activates the related units by converting agricultural activities according to the type of agricultural field (field, garden) and the plant to be planted in accordance with basic data such as time, temperature, moisture, and energy into commands by means of sensor feedback into commands.

In irrigation, the subsoil moisture sensor (9) measures moisture and temperature. According to data, the drop and rain irrigation commands are chosen from the control panel (18). In drop irrigation, the water at the rotating head (4) is poured to the conical drop irrigation tanks (19) found at the determined area by means of the pouring apparatus on the robotic arm (22). In rain irrigation, micronized moistening in the form of multiple drops or pressurized air mixture is performed. The water pump (14) is enabled at the desired angle and time by means of the smart energy method.

In the liquid agricultural spraying process, pesticides and water at a particular location and of a certain type are provided to the water transfer line (13) with dosage control. Then pesticide is applied from the top and from the sides from the micronized head through the robotic arm (22) by providing pressurized air.

With the help of control elements (7) such as the camera and color sensors, the robotic arm (22), enables the collection of fruits and crops predefined in the program. The collection head on the arm (22) is changed in accordance with the crop type. The pressure shaker (25) is locked to the tree in the form of two half-moons and carries out shaking by means of the weight on the edge of the shaker piston (26) working in the opposite direction with the pressurized air coming from the compressed air tank (15). This process enables the collection of crops such as olives, which are found as small pieces on the

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branches.

The automation system (1) is enclosed in the application area. Exit, with the exception of the classic lid, is performed by means of the three step motion controlled access gate (23) under the control of the system (1). The sides of the system (1) are in the form of open chassis and the front and back panels serve as gates (23). In the first step, the front panel is the gate that closes the exit, the chassis enters the tunnel after it is full and this step is the standby lid position (Figure 2). In the second step, the lid which serves as a closed tank also serves as a cooling unit (24) due to the insulation and of the lid surfaces and the cooling capability of the tunnel (Figure 3). In the third step, the chassis moves outside by moving on the rail in three moves and serves as a back lid (Figure 4. Passage from the exterior to the interior and from the interior to the exterior is provided in a controlled manner.

The electric tractor (12) is fed from the three axis mobile energy transfer line and carries out tractor activities in all areas on-site and remotely. The panel energy used enables obtaining satisfactory power in a more economical manner. The water and air supplied from the transfer line (13) may be stored and carried in the tractor. By using shorter carries poles (2), the system (1) enables easy use in orchards. Moreover, it also manually carries out external activities by means of the energy storage batteries.

In uses of the system (1) in appropriate large land and for cultivated crops, the tanks (16, 19) are stationary and can change the work area with the progressive (worm) action at low speed (3m/h) by means of the electromotor movement mechanism (27) placed under the poles (2). The stretch ropes (5) in the system enable ease of movement. This enables more efficient operation with a single module.

Control elements (7) found in the system consisting of gas, audio, visual, lighting actuators may also be used for security functions with the appropriate programming. Movement and heat sensitive detectors provide deterrent effect against wild animals, birds and intrusions by spraying pressurized water via the robotic arm (22) or by applications such as sounding alarms.

By means of the solar powered three-axis mobile agricultural automation (1) which can be implemented in various areas such as parks, agricultural areas and gardens, a versatile integrated use through a single energy panel is provided; by means of the solar powered tractor application, a low cost and clean energy solution is provided. The system (1) provides ease of control by means of on-site or remote control.

The system (1) also provides easier efficient produce production by means of diversity in irrigation, time-independent application and subsoil and sub-leaf sensor (9) which does not damage the soil.

The automatic remote controlled spraying, shaking of trees and harvesting operations of the system (1) can be carried out without workers and thus provides saving in manpower.

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Cholla Energy LLC & OBM, Inc. / Page 484 of 611

CLAIMS

1. Solar powered three-axis mobile agricultural automation (1), characterized in that in comprises stretch ropes (5), bridge ropes (6) and parallel ropes (8) positioned between at least four carrier poles (2); three axis robotic arm (22) which performs on-site or remote controlled agricultural activities in accordance with data obtained from subsoil moisture sensor (9) and control elements (7) via the movement of the 360 degrees rotating head (4) on the platform (3) which moves as a result of the energy generated by the solar cell panels (11) and the wind energy system (10); water pump (14); and pressure shaker (25) which allows for the trees to be shaken.

2. The solar powered three-axis mobile agricultural automation according to claim 1, characterized in that it comprises a mobile platform (3) on which the three axis mobile rotating head (3) moves.

3. The solar powered three-axis mobile agricultural automation according to claim 1, characterized in that it comprises a solar powered electric tractor (12).

4. The solar powered three-axis mobile agricultural automation according to claim 1, characterized in that it converts the data obtained from the subsoil moisture sensor (9) and control elements (7) into agricultural activities.

5. The solar powered three-axis mobile agricultural automation according to claim 1, characterized in that it performs shaking, fogging, spraying, disinfecting, sprinkling processes by means of the transfer of the liquid and gas obtained from the mobile conveyor line (13) to the robotic arm (22).

6. The solar powered three-axis mobile agricultural automation according to claim 1, characterized in that it performs the irrigation processes by means of the water tank (14) and the drop irrigation tank (19).

7. The solar powered three-axis mobile agricultural automation according to claim 1,

characterized in that the energy generated by means of the solar panels (11) is stored as alternative energy in the power supply (17), compressed air tank (15) and water tank (16) or is directly used.

8. The solar powered three-axis mobile agricultural automation according to claim 1, characterized in that it comprises a direct movement mechanism located below the carrier poles (2) which has the feature of changing the workspace by means of allowing gradual movement with electrical engine mechanism according to the terrain conditions.

9. The solar powered three-axis mobile agricultural automation according to claim 1, characterized in that it comprises control elements (7) with gas, sound, video, lighting actuators.

10. The solar powered three-axis mobile agricultural automation according to claim 1, characterized in that it comprises a controlled access gate (23) providing for the controlled access from the exterior to the interior and also providing storage functions due to the insulation of the surface and the cooling feature of the tunnel.

Ex.1002
Cholla Energy LLC & OBM, Inc. / Page 486 of 611

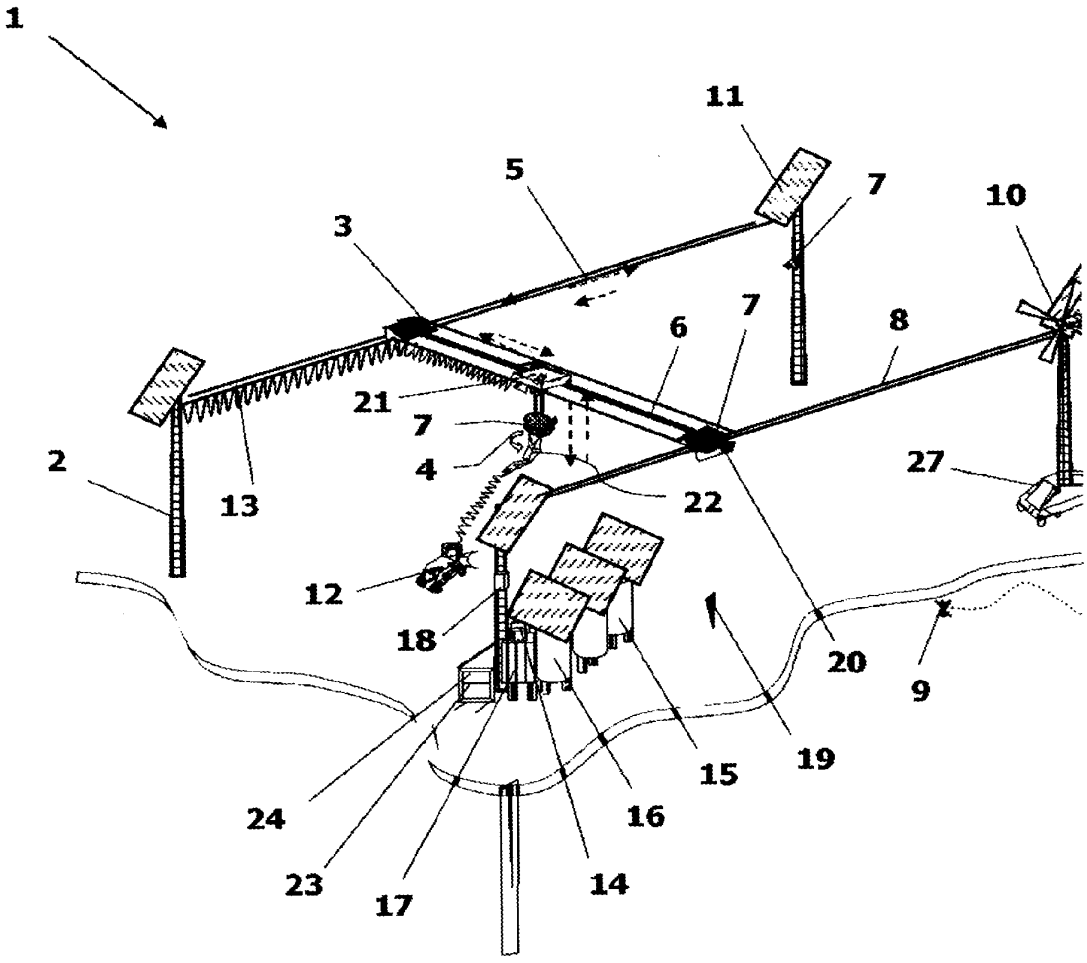


FIGURE 1

Ex.1002
Cholla Energy LLC & OBM, Inc. / Page 487 of 611



FIGURE 2

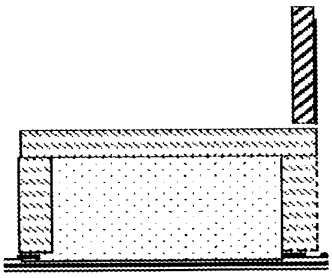


FIGURE 3



FIGURE 4

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Cholla Energy LLC & OBM, Inc. / Page 488 of 611

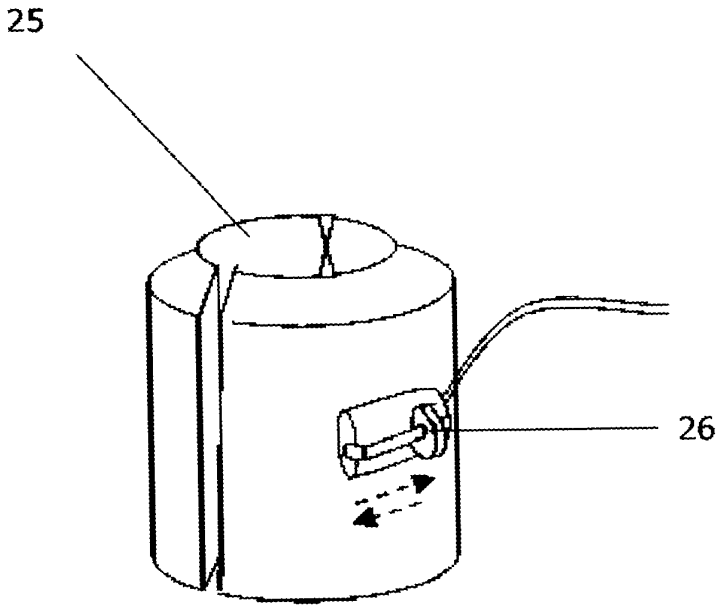


FIGURE 5

Ex.1002
Cholla Energy LLC & OBM, Inc. / Page 489 of 611

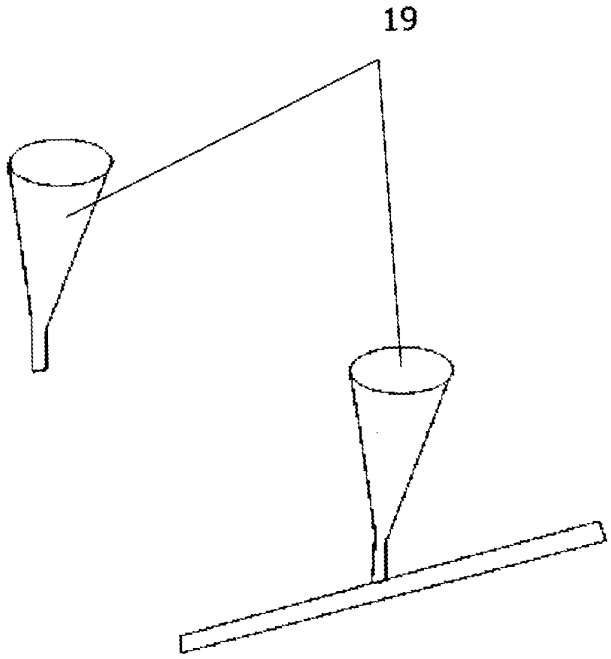


FIGURE 6

Ex.1002
Cholla Energy LLC & OBM, Inc. / Page 490 of 611

INTERNATIONAL SEARCH REPORT

International application No
PCT/TR2015/000168

A. CLASSIFICATION OF SUBJECT MATTER
INV. B25J9/00 A01G3/00 A01G13/00 B66C21/00 B25J9/02
B25J9/10
ADD.
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)
B25J A01G B66C

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)
EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 2003/145759 A1 (RODNUNSKY JAMES LEWIS [US]) 7 August 2003 (2003-08-07) paragraphs [0036] - [0040], [0047]; figure 1	1-9
Y	US 2013/345876 A1 (RUDAKEVYCH PAVLO [US]) 26 December 2013 (2013-12-26) paragraphs [0063] - [0067]; figures 1,3b	1,2,4,9
Y	US 2005/105970 A1 (FARIS SADEG M [US]) 19 May 2005 (2005-05-19) paragraphs [0012], [0016], [0046], [0047]; figures 1-8	1,7
Y	US 1 017 578 A (MCMILLAN WILLIAM PERRY [US]) 13 February 1912 (1912-02-13)	1
A	page 2, column 1, line 21 - line 36; figures 1-3	5,6

-/--

[X] Further documents are listed in the continuation of Box C.

[X] 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
25 September 2015	05/10/2015

Name and mailing address of the ISA/	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Champion, Jérôme

Form PCT/ISA/210 (second sheet) (April 2005)

INTERNATIONAL SEARCH REPORT

International application No
PCT/TR2015/000168

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	CN 103 625 300 A (UNIV JIANGSU) 12 March 2014 (2014-03-12) abstract; figures 1-3	3
Y	US 2 024 374 A (LANGEBRAKE MOODY E) 17 December 1935 (1935-12-17)	5,6
A	page 1, column 2, line 11 - line 23; figure 1	1
Y	FR 2 518 869 A1 (KERTESZETI EGYETEM [HU]) 1 July 1983 (1983-07-01)	8
A	figures 1-7	1
A	US 1 502 997 A (BLAKEMORE MARRIAN HARRY HERBER ET AL) 29 July 1924 (1924-07-29) figures 1-3	1,2
A	US 2005/024005 A1 (RODNUNSKY JIM [US] ET AL) 3 February 2005 (2005-02-03) paragraph [0119]; figure 12	1,2
A	US 2011/127229 A1 (LALIBERTE THIERRY [CA] ET AL) 2 June 2011 (2011-06-02) figures 1-2	1,2

Form PCT/ISA/210 (continuation of second sheet) (April 2005)

INTERNATIONAL SEARCH REPORT

International application No.
PCT/TR2015/000168

Box No. II Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:

2. ☒ Claims Nos.: 10
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:
see FURTHER INFORMATION sheet PCT/ISA/210

3. ☐ Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box No. III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.

2. ☐ As all searchable claims could be searched without effort justifying an additional fees, this Authority did not invite payment of additional fees.

3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:

4. ☐ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest

☐ The additional search fees were accompanied by the applicant's protest and, where applicable, the payment of a protest fee.

☐ The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.

☐ No protest accompanied the payment of additional search fees.

FURTHER INFORMATION CONTINUED FROM PCT/ISA/ 210

Continuation of Box II.2

Claims Nos.: 10

Non-establishment of opinion with regard to novelty, inventive step and industrial applicability

1.1 Claim 10 lacks clarity (Art. 6 PCT).

Indeed :

- the features "the exterior", "the interior", "the surface" and "the tunnel" have not been yet defined in the set of claims.
- the sentence "a controlled access gate providing storage functions due to the insulation of the surface and the cooling feature of the tunnel" is unclear and leaves the reader in doubt as to the meaning of the technical feature to which it refers, thereby rendering the definition of the subject-matter of said claim unclear.

1.2 The part of the description (paragraph page 8, lines 3 to 13) corresponding to claim 10 lacks clarity (Art. 5 PCT). Indeed :

- the terms "classic lid", "open chassis", "front and back panels", "the tunnel", "standby lid position", "lid surfaces", "the rail" and "the back lid" remain unclear or not defined.
- the whole paragraph and the associated figures 2 to 4 are not understandable in their entirety.

1.3 In conclusion, due to this lack of clarity in claim 10, figures 2 to 4 and the associated description, no meaningful search of claim 10 could be carried out at all (Article 17(2) PCT).

The applicant's attention is drawn to the fact that claims relating to inventions in respect of which no international search report has been established need not be the subject of an international preliminary examination (Rule 66.1(e) PCT). The applicant is advised that the EPO policy when acting as an International Preliminary Examining Authority is normally not to carry out a preliminary examination on matter which has not been searched. This is the case irrespective of whether or not the claims are amended following receipt of the search report or during any Chapter II procedure. If the application proceeds into the regional phase before the EPO, the applicant is reminded that a search may be carried out during examination before the EPO (see EPO Guidelines C-IV, 7.2), should the problems which led to the Article 17(2) declaration be overcome.

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/TR2015/000168

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 2003145759 A1	07-08-2003	US 2003145759 A1	07-08-2003
		WO 2004074064 A1	02-09-2004
US 2013345876 A1	26-12-2013	NONE	
US 2005105970 A1	19-05-2005	TW 200526112 A	16-08-2005
		US 2005105970 A1	19-05-2005
		WO 2005034611 A1	21-04-2005
US 1017578 A	13-02-1912	NONE	
CN 103625300 A	12-03-2014	NONE	
US 2024374 A	17-12-1935	NONE	
FR 2518869 A1	01-07-1983	NONE	
US 1502997 A	29-07-1924	NONE	
US 2005024005 A1	03-02-2005	AU 2004262354 A1	10-02-2005
		BR PI0412261 A	22-08-2006
		CA 2575354 A1	10-02-2005
		EP 1654185 A2	10-05-2006
		ES 2431521 T3	26-11-2013
		JP 2007503368 A	22-02-2007
		US 2005024005 A1	03-02-2005
		US 2006033463 A1	16-02-2006
		US 2008054836 A1	06-03-2008
		WO 2005013195 A2	10-02-2005
US 2011127229 A1	02-06-2011	DE 102010052433 A1	16-06-2011
		US 2011127229 A1	02-06-2011

PATENT COOPERATION TREATY

From the INTERNATIONAL SEARCHING AUTHORITY

To: BASIL ANGELO
ANGELO MIKESKA PLLC
21 WATERWAY AVENUE, SUITE 300
THE WOODLANDS, TX 77380

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)* 30 APR 2018
Applicant's or agent's file reference 01128-000003 PCT	**FOR FURTHER ACTION** See paragraphs 1 and 4 below
International application No. PCT/US2018/017955	International filing date *(day/month/year)* 13 February 2018
Applicant LANCIUM LLC	

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 01128-000003 PCT	**FOR FURTHER ACTION**	see Form PCT/ISA/220 as well as, where applicable, item 5 below.
International application No. PCT/US2018/017955	International filing date *(day/month/year)* 13 February 2018	(Earliest) Priority Date *(day/month/year)* 11 January 2018
Applicant LANCIUM LLC		

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 3 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. 2

   ☒ 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/US2018/017955

A. CLASSIFICATION OF SUBJECT MATTER
IPC(8) - A01G 9/16; A01G 9/14; A01G 9/24; H02S 10/40; H02S 20/30 (2018.01)
CPC - A01G 9/16; A01G 9/14; A01G 9/24; H02S 10/40; H02S 20/30 (2018.02)

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 - 47/17; 47/66.7; 47/66.6 (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.
X	US 2016/0198656 A1 (FREIGHT FARMS, INC.) 14 July 2016 (14.07.2016) entire document	1, 2, 15-23, 26
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Y		3-14, 24, 25
Y	US 2013/0187464 A1 (SELDON ENERGY PARTNERS, LLC et al) 25 July 2013 (25.07.2013) entire document	3-14, 25
Y	US 2015/0229227 A1 (ABB TECHNOLOGY AG) 13 August 2015 (13.08.2015) entire document	10, 32
Y	US 2016/0324077 A1 (HELICAL HOLDINGS, LLC) 10 November 2016 (10.11.2016) entire document	24
Y	US 2012/0000121 A1 (SWANN) 05 January 2012 (05.01.2012) entire document	27-35
Y	US 2017/0104336 A1 (JOHNSON CONTROLS TECHNOLOGY COMPANY) 13 April 2017 (13.04.2017) entire document	27-35
A	US 2016/0212954 A1 (ARGENTO) 28 July 2016 (28.07.2016) entire document	1-35
A	US 2014/0137468 A1 (CHING) 22 May 2014 (22.05.2014) entire document	1-35
A	WO 2015/199629 A1 (DOKUZ EYLÜL ÜNIVERSITESI REKTÖRLÜGÜ) 30 December 2015 (30.12.2015) entire document	1-35
A	US 2013/0006401 A1 (SHAN) 03 January 2013 (03.01.2013) entire document	1-35

☒ 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
16 April 2018	30 APR 2018
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)

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US2018/017955

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	CN 103163904 A (ZHEJIANG INDUSTRY UNIVERSITY) 19 June 2013 (19.06.2013) entire document	1-35

Form PCT/ISA/210 (continuation of second sheet) (January 2015)

PATENT COOPERATION TREATY

From the
INTERNATIONAL SEARCHING AUTHORITY

To: BASIL ANGELO
ANGELO MIKESKA PLLC
21 WATERWAY AVENUE, SUITE 300
THE WOODLANDS, TX 77380

PCT

WRITTEN OPINION OF THE
INTERNATIONAL SEARCHING AUTHORITY

(PCT Rule 43*bis*.1)

Date of mailing *(day/month/year)*	30 APR 2018

Applicant's or agent's file reference	FOR FURTHER ACTION
01128-000003 PCT	See paragraph 2 below

International application No.	International filing date *(day/month/year)*	Priority date *(day/month/year)*
PCT/US2018/017955	13 February 2018	11 January 2018

International Patent Classification (IPC) or both national classification and IPC
IPC(8) - A01G 9/16; A01G 9/14; A01G 9/24; H02S 10/40; H02S 20/30 (2018.01)
CPC - A01G 9/16; A01G 9/14; A01G 9/24; H02S 10/40; H02S 20/30 (2018.02)

Applicant LANCIUM LLC

1. This opinion contains indications relating to the following items:

- ☒ 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
- ☒ 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
- ☐ 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	16 April 2018	Blaine R. Copenheaver PCT Helpdesk: 571-272-4300 PCT OSP: 571-272-7774

Form PCT/ISA/237 (cover sheet) (January 2015)

WRITTEN OPINION OF THE INTERNATIONAL SEARCHING AUTHORITY

International application No.
PCT/US2018/017955

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:

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PCT/US2018/017955

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	3-14, 24, 25, 27-35	YES
	Claims	1, 2, 15-23, 26	NO
Inventive step (IS)	Claims	None	YES
	Claims	1-35	NO
Industrial applicability (IA)	Claims	1-35	YES
	Claims	None	NO

2. Citations and explanations:

Claims 1, 2, 15-23, and 26 lack novelty under PCT Article 33(2) as being anticipated by Freight Farms, Inc. (hereinafter Freight).

Regarding claim 1, Freight discloses a flexible growcenter (a system and method for a growing station, abstract, comprising a flexible and expandable container, [0034], [0042]) comprising: a mobile container (container 100 can be a recycled shipping container 102...Container 102 is also sealed in order to create a solid modular frame for expansion, [0035]; racks 402 can be moved, changed and/or reconfigured [0058]); a behind-the-meter power input system (container 102 can be modified to include a solar array 104 to harness solar energy and store it in a converter or batteries for later use, [therefore, using a behind-the-meter power input system using renewable energy to power the mobile container], [0036]); a power distribution system (an electrical panel, such as a 200 amp, 240 volt panel, can be coupled to one of the walls of container 102 for power distribution, [0057]); a growcenter control system (the components in container 102 can be coupled to monitoring system 600. FIG. 6 shows an illustrative system diagram of monitoring system 600 and FIG. 7 shows a front elevational view of monitoring system 600. Monitoring system 600 can include control center 602, CPU interface 604, and wireless interface 606 to allow user 608 to access the system remotely, [0052]); a climate control system (climate control system 204, [0037]), a lighting system (LED lighting system 206, [0037]); and an irrigation system (irrigation system 1800, [0037]); wherein the growcenter control system modulates power delivery to one or more components of the climate control system, the lighting system, and the irrigation system based on unutilized behind-the-meter power availability or an operational directive (as seen in Fig.16A and Fig.16B, a mobile app can be used to control the components of the growcenter, such as the lighting system, including turning components on and off, [0043], [0054]).

Regarding claim 2, Freight discloses the flexible growcenter, further comprising: a remote master control system (wireless interface 606 to allow user 608 to access the system remotely. Control center 602 preferably monitors and controls all of the components based on specifications set by user 608, [0052]. The remote system can be controlled by a mobile app, claim 17, Fig.17A-17F, [0054]).

Regarding claim 15, Freight discloses the flexible growcenter, wherein unutilized behind -the-meter power availability comprises one or more of excess local power generation at a local station level, excess local power generation that a grid cannot receive, local power generation subject to economic curtailment, local power generation subject to reliability curtailment, local power generation subject to power factor correction, low local power generation, start up local power generation situations, transient local power generation situations, or testing local power generation situations where there is an economic advantage to using local behind-the-meter power generation to power the flexible growcenter (in some embodiments, container 102 can be modified to include a solar array 104 to harness solar energy and store it in a converter or batteries for later use. One of ordinary skill in the art would recognize that other energy efficient solutions, such as insulation paint or planting additional crops on top of and around container 102, can also be incorporated into container 102 to make it even more energy efficient. Other renewable energy technologies, such as forms of solar and wind power, could also be added to increase functionality. All of these components can be relocated within the unit, outside the unit, on top of the unit, or next to the unit, to increase space, efficiency, and/or ease of access, [0036]; see also [0004] and [0005], offsite operations, therefore local power un-accessible, and to increase economically friendly farming).

Regarding claim 16, Freight discloses the flexible growcenter, wherein an operational directive comprises one or more of a local station directive, a remote master control directive, or a grid directive (in some embodiments, the components in container 102 can be coupled to monitoring system 600. FIG. 6 shows an illustrative system diagram of monitoring system 600 and FIG. 7 shows a front elevational view of monitoring system 600. Monitoring system 600 can include control center 602, CPU interface 604, and wireless interface 606 to allow user 608 to access the system remotely. Control center 602 preferably monitors and controls all of the components based on specifications set by user 608, [0052]. CPU interface 604 allows user 608 to have direct access to control center 602, and wireless interface 606 allows user 608 to have remote access to control center 602. Either connection allows user 608 to modify any pre-set levels, override pre-set levels, or simply monitor activity in container 102. Wireless interface 606 allows for control center 602 to provide remote alerts to user 608, giving user 608 the ability to change or override any preset characteristics. Referring to FIG. 8, an example of data 800 available to user 608 is shown. For example, available data 800 includes summary data 802 and input protocol data 804. Summary data 802 can provide user 608 with data on environmental conditions and plant growth. Input protocol data 804 is more flexible, and allows user 608 to input data to change environmental conditions or component performance, [0053]. FIGS. 16-17 show examples of the types of data that can be remotely monitored and controlled via monitoring system 600, [0054]).

Supplemental Box

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Regarding claim 17, Freight discloses the flexible growcenter, wherein an operational directive comprises one or more of a dispatchability directive or a forecast directive (in some embodiments, the components in container 102 can be coupled to monitoring system 600. FIG. 6 shows an illustrative system diagram of monitoring system 600 and FIG. 7 shows a front elevational view of monitoring system 600. Monitoring system 600 can include control center 602, CPU interface 604, and wireless interface 606 to allow user 608 to access the system remotely. Control center 602 preferably monitors and controls all of the components based on specifications set by user 608, [0052]. CPU interface 604 allows user 608 to have direct access to control center 602, and wireless interface 606 allows user 608 to have remote access to control center 602. Either connection allows user 608 to modify any pre-set levels, override pre-set levels, or simply monitor activity in container 102. Wireless interface 606 allows for control center 602 to provide remote alerts to user 608, giving user 608 the ability to change or override any preset characteristics. Referring to FIG. 8, an example of data 800 available to user 608 is shown. For example, available data 800 includes summary data 802 and input protocol data 804. Summary data 802 can provide user 608 with data on environmental conditions and plant growth. Input protocol data 804 is more flexible, and allows user 608 to input data to change environmental conditions or component performance, [0053]. FIGS. 16-17 show examples of the types of data that can be remotely monitored and controlled via monitoring system 600, [0054]. One of ordinary skill in the art would recognize that the monitoring system could monitor, control, and change any additional components that affect the environment or feeding conditions. In order to maintain conditions or provide alerts, control center 602 can include algorithms relating to environmental conditions prescribed by the user, [0056]).

Regarding claim 18, Freight lacks in the teaching of the flexible growcenter, wherein an operational directive comprises a workload directive based on actual behind-the-meter power availability or projected behind-the-meter power availability. Seldon teaches wherein an operational directive comprises a workload directive based on actual behind-the-meter power availability or projected behind-the-meter power availability (the batteries may be selected to provide up to 24 hours or more of power to the load 260. One or more battery banks 215 may also be used in the case when solar power may not be readily available due to natural or unnatural conditions, [0017]. In certain other embodiments, both the backup AC generator 235 and utility power 240 may be available. The connection to utility power 240 may also be used to supply excess power generated by the solar power system 100 to the utility power 240 grid. This excess power may be sold to or used by an energy provider or other power user connected to the utility power 240 grid, [0018]). Therefore, it would have been obvious to one of ordinary skill in the art during the time the invention was made to use the operational directive of Seldon in the invention of Freight. The motivation would have been to provide power to a load based on availability (Seldon, [0017], [0020]).

Regarding claim 19, Freight discloses the flexible growcenter, wherein the remote master control system dynamically adjusts power delivery to the flexible growcenter based on a remote master control directive (in some embodiments, the components in container 102 can be coupled to monitoring system 600. FIG. 6 shows an illustrative system diagram of monitoring system 600 and FIG. 7 shows a front elevational view of monitoring system 600. Monitoring system 600 can include control center 602, CPU interface 604, and wireless interface 606 to allow user 608 to access the system remotely. Control center 602 preferably monitors and controls all of the components based on specifications set by user 608, [0052]. CPU interface 604 allows user 608 to have direct access to control center 602, and wireless interface 606 allows user 608 to have remote access to control center 602. Either connection allows user 608 to modify any pre-set levels, override pre-set levels, or simply monitor activity in container 102. Wireless interface 606 allows for control center 602 to provide remote alerts to user 608, giving user 608 the ability to change or override any preset characteristics. Referring to FIG. 8, an example of data 800 available to user 608 is shown. For example, available data 800 includes summary data 802 and input protocol data 804. Summary data 802 can provide user 608 with data on environmental conditions and plant growth. Input protocol data 804 is more flexible, and allows user 608 to input data to change environmental conditions or component performance, [0053]. FIGS. 16-17 show examples of the types of data that can be remotely monitored and controlled via monitoring system 600, [0054]. One of ordinary skill in the art would recognize that the monitoring system could monitor, control, and change any additional components that affect the environment or feeding conditions. In order to maintain conditions or provide alerts, control center 602 can include algorithms relating to environmental conditions prescribed by the user, [0056]. The remote system can be controlled by a mobile app to provide remote control to the components of the greenhouse, claim 17, Fig.17A-17F. As seen in Fig.16A and Fig.16B, a mobile app can be used to control the components of the growcenter, such as the lighting system, including turning components on and off, [0043], [0054]).

Regarding claim 20, Freight discloses the flexible growcenter, wherein the climate control system comprises a humidity control system, a gas system, and an air conditioner/heater (in order to control the internal environment of container 102, the hydroponic system can include climate control system 204 (FIG. 2) that can measure and control humidity, carbon dioxide levels, temperature, and other related environmental factors, [0049]. A Heating, Ventilation and Air Conditioning (HVAC) unit or other climate control unit 204 and main fan 502 can also be coupled to one of the walls of container 102. Intermittent fans 1302 can be installed every ten to twenty feet to allow for proper air circulation, [0057]).

Regarding claim 21, Freight discloses the flexible growcenter, wherein the irrigation system comprises a water tank, a pump system, and a plurality of irrigation lines (in some embodiments, irrigation system 1800 is used to deliver a water/nutrient solution to the plants. FIG. 12 shows a perspective view and FIG. 18 shows a schematic view of the illustrative irrigation system 1800. Irrigation system 1800 can include nutrient reservoir 1802, nutrient doser (not shown), first set of tubing 1202, second set of tubing 1204, a pump (not shown), drip emitters (not shown), and return gutters 1804. In some embodiments, nutrient reservoir 1802 can be a 330 gallon tank with a reverse osmosis filter. Nutrient reservoir 1802 can be coupled to a nutrient doser (not shown), which controls the flow of nutrients into nutrient reservoir 1802 in order to maintain specific nutrient levels prescribed by the user, [0045]. Irrigation system 1800 can also include a first set and second set of tubing 1202 and 1204 for delivery of water/nutrient solution to grow channels 402 in racks 304, [0047]).

Regarding claim 22, Freight discloses the flexible growcenter, wherein the lighting system comprises a plurality of lights (the LED lighting system 206 is configured to provide artificial light in a controlled manner for the growth of the plants. In the some embodiments, LED lighting system 206 can utilize five foot long PHILIPS (Amsterdam, Netherlands) LED light bars of Deep Red/Blue 150 110 V grow lights, [0043]).

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Regarding claim 23, Freight discloses the flexible growcenter, wherein the mobile container comprises a storage container configured for placement on a ground surface (container 100 can be a recycled shipping container 102...Container 102 is also sealed in order to create a solid modular frame for expansion, [0035], [therefore, a shipping container can be placed on a ground surface])

Regarding claim 26, Freight lacks in the teaching of the flexible growcenter, wherein the DC nominal voltage from the plurality of storage cells are converted via a DC-to-AC inverter to three-phase nominal AC voltage for flexible growcenter use. However, Freight does teach providing power to a battery through solar panel converters (container 102 can be modified to include a solar array 104 to harness solar energy and store it in a converter or batteries for later use, [0036]). Seldon teaches wherein the DC nominal voltage from the plurality of storage cells are converted via a DC-to-AC inverter to three-phase nominal AC voltage for use (the battery bank 215 may be electrically connected to a DC to AC inverter 220. The output of the DC to AC inverter 220 may be optionally electrically connected to a rotary converter 225, or a transfer switch 230. Additionally, an optional backup AC generator may be electrically connected to the transfer switch 230, [0014]. The battery bank 215 provides a DC voltage and current to one or more DC to AC inverters 220. The DC to AC inverter 220 may be a single phase 120 VAC or 240 VAC inverter, or a two or three phase 208 VAC inverter, or any other DC to AC inverter as needed, [0018]). Therefore, it would have been obvious to one of ordinary skill in the art during the time the invention was made to use the AC voltage phase conversion of Seldon in the invention of Freight. The motivation would have been to provide power to a load based on voltage phase needs (Seldon, [0017], [0020]).

Claims 3-9, 11-14, and 25 lack an inventive step under PCT Article 33(3) as being obvious over Freight Farms, Inc. (hereinafter Freight) in view of Seldon Energy Partners, Llc et al. (hereinafter Seldon).

Regarding claim 3, Freight lacks in the teaching of the flexible growcenter, wherein the behind-the-meter power input system comprises an input configured to receive three-phase behind-the-meter AC voltage and a supervisory AC-to-AC step-down transformer configured to step down the three-phase behind-the-meter AC voltage to a single-phase supervisory nominal AC voltage or an input configured to receive single-phase supervisory nominal AC voltage from a local station or metered source. However, Freight does teach wherein the behind-the-meter power input system comprises an input configured to receive an AC voltage (another advantage of light curtain system 1400 is that conversion box 1404 allows for central conversion of AC to DC power. There is electrical waste each time current is converted from AC to DC, so a single point of conversion increases efficiency of the system, [0044]). Seldon is in the field of behind-the-meter power input systems (portable solar power system, abstract) and teaches an input configured to receive three-phase behind-the-meter AC voltage and a supervisory AC-to-AC step-down transformer configured to step down the three-phase behind-the-meter AC voltage to a single-phase supervisory nominal AC voltage or an input configured to receive single-phase supervisory nominal AC voltage from a local station or metered source (the battery bank 215 provides a DC voltage and current to one or more DC to AC inverters 220. The DC to AC inverter 220 may be a single phase 120 VAC or 240 VAC inverter, or a two or three phase 208 VAC inverter, or any other DC to AC inverter as needed, [0018]. The output voltage of the transfer switch 230 may vary based upon the output of the DC to AC inverter 220, rotary converter 225, alternate or backup AC generator 235, and utility power 240. In some embodiments, if there is no backup AC 235 or utility power 240 connected to the solar power system 100, then a transfer switch may 230 may not be needed. Transformer 245 may step-up or step-down the input voltage from the transfer switch 230 to three phase 480 VAC, or other voltages, for use by the load 260. The output of the transformer 245 may vary depending upon the needs of the load 260. For example, the transformer may output single phase, two phase, or three phase power at any voltage depending upon the needs of the load 260 and/or configuration of the electrical configuration 200, [0020]). Therefore, it would have been obvious to one of ordinary skill in the art during the time the invention was made to use the AC voltage transformer of Seldon in the invention of Freight. The motivation would have been to provide varied output based on load needs (Seldon, [0020]).

Regarding claim 4, Freight lacks in the teaching of the flexible growcenter, wherein the behind-the-meter power input system provides the single-phase supervisory nominal AC voltage to the growcenter control system. However, Freight does teach wherein the behind-the-meter power input system comprises an input configured to receive an AC voltage (another advantage of light curtain system 1400 is that conversion box 1404 allows for central conversion of AC to DC power. There is electrical waste each time current is converted from AC to DC, so a single point of conversion increases efficiency of the system, [0044]). Seldon teaches wherein the behind-the-meter power input system provides the single-phase supervisory nominal AC voltage to a source (the battery bank 215 provides a DC voltage and current to one or more DC to AC inverters 220. The DC to AC inverter 220 may be a single phase 120 VAC or 240 VAC inverter, or a two or three phase 208 VAC inverter, or any other DC to AC inverter as needed, [0018]. The output voltage of the transfer switch 230 may vary based upon the output of the DC to AC inverter 220, rotary converter 225, alternate or backup AC generator 235, and utility power 240. In some embodiments, if there is no backup AC 235 or utility power 240 connected to the solar power system 100, then a transfer switch may 230 may not be needed. Transformer 245 may step-up or step-down the input voltage from the transfer switch 230 to three phase 480 VAC, or other voltages, for use by the load 260. The output of the transformer 245 may vary depending upon the needs of the load 260. For example, the transformer may output single phase, two phase, or three phase power at any voltage depending upon the needs of the load 260 and/or configuration of the electrical configuration 200, [0020]). Therefore, it would have been obvious to one of ordinary skill in the art during the time the invention was made to use the AC voltage phase of Seldon in the invention of Freight. The motivation would have been to provide varied output based on load needs (Seldon, [0020]).

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Regarding claim 5, Freight lacks in the teaching of the flexible growcenter, wherein the behind-the-meter power input system comprises an input configured to receive three-phase behind-the-meter AC voltage and an operational AC-to-AC step-down transformer configured to controllably step down the three-phase behind-the-meter AC voltage to three-phase nominal AC voltage. However, Freight does teach wherein the behind-the-meter power input system comprises an input configured to receive an AC voltage (another advantage of light curtain system 1400 is that conversion box 1404 allows for central conversion of AC to DC power. There is electrical waste each time current is converted from AC to DC, so a single point of conversion increases efficiency of the system, [0044]). Seldon teaches wherein the behind-the-meter power input system comprises an input configured to receive three-phase behind-the-meter AC voltage and an operational AC-to-AC step-down transformer configured to controllably step down the three-phase behind-the-meter AC voltage to three-phase nominal AC voltage (the battery bank 215 provides a DC voltage and current to one or more DC to AC inverters 220. The DC to AC inverter 220 may be a single phase 120 VAC or 240 VAC inverter, or a two or three phase 208 VAC inverter, or any other DC to AC inverter as needed, [0018]. The output voltage of the transfer switch 230 may vary based upon the output of the DC to AC inverter 220, rotary converter 225, alternate or backup AC generator 235, and utility power 240. In some embodiments, if there is no backup AC 235 or utility power 240 connected to the solar power system 100, then a transfer switch may 230 may not be needed. Transformer 245 may step-up or step-down the input voltage from the transfer switch 230 to three phase 480 VAC, or other voltages, for use by the load 260. The output of the transformer 245 may vary depending upon the needs of the load 260. For example, the transformer may output single phase, two phase, or three phase power at any voltage depending upon the needs of the load 260 and/or configuration of the electrical configuration 200, [0020]). Therefore, it would have been obvious to one of ordinary skill in the art during the time the invention was made to use the AC voltage transformer of Seldon in the invention of Freight. The motivation would have been to provide varied output based on load needs (Seldon, [0020]).

Regarding claim 6, Freight lacks in the teaching of the flexible growcenter, wherein the growcenter control system controllably enables or disables generation of the three-phase nominal AC voltage by the operational AC-to-AC step-down transformer. However, Freight does teach wherein the behind-the-meter power input system comprises an input configured to receive an AC voltage (another advantage of light curtain system 1400 is that conversion box 1404 allows for central conversion of AC to DC power. There is electrical waste each time current is converted from AC to DC, so a single point of conversion increases efficiency of the system, [0044]). Seldon teaches wherein the control system controllably enables or disables generation of the three-phase nominal AC voltage by the operational AC-to-AC step-down transformer (the battery bank 215 provides a DC voltage and current to one or more DC to AC inverters 220. The DC to AC inverter 220 may be a single phase 120 VAC or 240 VAC inverter, or a two or three phase 208 VAC inverter, or any other DC to AC inverter as needed, [0018]. The output voltage of the transfer switch 230 may vary based upon the output of the DC to AC inverter 220, rotary converter 225, alternate or backup AC generator 235, and utility power 240. In some embodiments, if there is no backup AC 235 or utility power 240 connected to the solar power system 100, then a transfer switch may 230 may not be needed. Transformer 245 may step-up or step-down the input voltage from the transfer switch 230 to three phase 480 VAC, or other voltages, for use by the load 260. The output of the transformer 245 may vary depending upon the needs of the load 260. For example, the transformer may output single phase, two phase, or three phase power at any voltage depending upon the needs of the load 260 and/or configuration of the electrical configuration 200, [0020]). Therefore, it would have been obvious to one of ordinary skill in the art during the time the invention was made to use the AC voltage transformer of Seldon in the invention of Freight. The motivation would have been to provide varied output based on load needs (Seldon, [0020]).

Regarding claim 7, Freight lacks in the teaching of the flexible growcenter, wherein the behind-the-meter power input system provides three-phases of the three-phase nominal AC voltage to the power distribution system. However, Freight does teach wherein the behind-the-meter power input system comprises an input configured to receive an AC voltage (another advantage of light curtain system 1400 is that conversion box 1404 allows for central conversion of AC to DC power. There is electrical waste each time current is converted from AC to DC, so a single point of conversion increases efficiency of the system, [0044]). Seldon teaches wherein the behind-the-meter power input system provides three-phases of the three-phase nominal AC voltage to the power distribution system (the battery bank 215 provides a DC voltage and current to one or more DC to AC inverters 220. The DC to AC inverter 220 may be a single phase 120 VAC or 240 VAC inverter, or a two or three phase 208 VAC inverter, or any other DC to AC inverter as needed, [0018]. The output voltage of the transfer switch 230 may vary based upon the output of the DC to AC inverter 220, rotary converter 225, alternate or backup AC generator 235, and utility power 240. In some embodiments, if there is no backup AC 235 or utility power 240 connected to the solar power system 100, then a transfer switch may 230 may not be needed. Transformer 245 may step-up or step-down the input voltage from the transfer switch 230 to three phase 480 VAC, or other voltages, for use by the load 260. The output of the transformer 245 may vary depending upon the needs of the load 260. For example, the transformer may output single phase, two phase, or three phase power at any voltage depending upon the needs of the load 260 and/or configuration of the electrical configuration 200, [0020]). Therefore, it would have been obvious to one of ordinary skill in the art during the time the invention was made to use the AC voltage distribution of Seldon in the invention of Freight. The motivation would have been to provide varied output based on load needs (Seldon, [0020]).

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Regarding claim 8, Freight lacks in the teaching of the flexible growcenter, wherein the power distribution system controllably provides a single phase of the three-phase nominal AC voltage to one or more components of the climate control system, the irrigation system, and the lighting system. However, Freight does teach wherein the power distribution controllably provides an AC voltage to one or more components of the climate control system, the irrigation system, and the lighting system (another advantage of light curtain system 1400 is that conversion box 1404 allows for central conversion of AC to DC power. There is electrical waste each time current is converted from AC to DC, so a single point of conversion increases efficiency of the system, [0044]. An electrical panel, such as a 200 amp, 240 volt panel, can be coupled to one of the walls of container 102 for power distribution to the growing station system, [0057]). Seldon teaches wherein the power distribution system controllably provides a single phase of the three-phase nominal AC voltage to one or more components (the battery bank 215 provides a DC voltage and current to one or more DC to AC inverters 220. The DC to AC inverter 220 may be a single phase 120 VAC or 240 VAC inverter, or a two or three phase 208 VAC inverter, or any other DC to AC inverter as needed, [0018]. The output voltage of the transfer switch 230 may vary based upon the output of the DC to AC inverter 220, rotary converter 225, alternate or backup AC generator 235, and utility power 240. In some embodiments, if there is no backup AC 235 or utility power 240 connected to the solar power system 100, then a transfer switch may 230 may not be needed. Transformer 245 may step-up or step-down the input voltage from the transfer switch 230 to three phase 480 VAC, or other voltages, for use by the load 260. The output of the transformer 245 may vary depending upon the needs of the load 260. For example, the transformer may output single phase, two phase, or three phase power at any voltage depending upon the needs of the load 260 and/or configuration of the electrical configuration 200, [0020]). Therefore, it would have been obvious to one of ordinary skill in the art during the time the invention was made to use the AC voltage distribution of Seldon in the invention of Freight. The motivation would have been to provide varied output based on load needs (Seldon, [0020]).

Regarding claim 9, Freight lacks in the teaching of the flexible growcenter, wherein the growcenter control system controllably selects which phase of the three-phase nominal AC voltage the power distribution system provides to each components of the climate control system, the irrigation system, and the lighting system. However, Freight does teach wherein the power distribution controllably provides an AC voltage to one or more components of the climate control system, the irrigation system, and the lighting system (another advantage of light curtain system 1400 is that conversion box 1404 allows for central conversion of AC to DC power. There is electrical waste each time current is converted from AC to DC, so a single point of conversion increases efficiency of the system, [0044]. An electrical panel, such as a 200 amp, 240 volt panel, can be coupled to one of the walls of container 102 for power distribution to the growing station system, [0057]). Seldon teaches wherein the control system controllably selects which phase of the three-phase nominal AC voltage the power distribution system provides to each load (the battery bank 215 provides a DC voltage and current to one or more DC to AC inverters 220. The DC to AC inverter 220 may be a single phase 120 VAC or 240 VAC inverter, or a two or three phase 208 VAC inverter, or any other DC to AC inverter as needed, [0018]. The output voltage of the transfer switch 230 may vary based upon the output of the DC to AC inverter 220, rotary converter 225, alternate or backup AC generator 235, and utility power 240. In some embodiments, if there is no backup AC 235 or utility power 240 connected to the solar power system 100, then a transfer switch may 230 may not be needed. Transformer 245 may step-up or step-down the input voltage from the transfer switch 230 to three phase 480 VAC, or other voltages, for use by the load 260. The output of the transformer 245 may vary depending upon the needs of the load 260. For example, the transformer may output single phase, two phase, or three phase power at any voltage depending upon the needs of the load 260 and/or configuration of the electrical configuration 200, [0020]). Therefore, it would have been obvious to one of ordinary skill in the art during the time the invention was made to use the AC voltage distribution of Seldon in the invention of Freight. The motivation would have been to provide varied output based on load needs (Seldon, [0020]).

Regarding claim 11, Freight lacks in the teaching of the flexible growcenter, wherein the three-phase behind-the-meter AC voltage comprises a three-phase wind-generated AC voltage output by one or more wind turbines prior to an AC-to-AC step-up transformer that steps up the three-phase wind-generated AC voltage to a three-phase grid AC voltage. However, Freight does teach wherein the power distribution controllably provides an AC voltage to one or more components of the climate control system, the irrigation system, and the lighting system (another advantage of light curtain system 1400 is that conversion box 1404 allows for central conversion of AC to DC power. There is electrical waste each time current is converted from AC to DC, so a single point of conversion increases efficiency of the system, [0044]. An electrical panel, such as a 200 amp, 240 volt panel, can be coupled to one of the walls of container 102 for power distribution to the growing station system, [0057]) in which the power is wind generated (other renewable energy technologies, such as forms of solar and wind power, could also be added to increase functionality, [0036]). Seldon teaches wherein the three-phase behind-the-meter AC voltage comprises a three-phase solar-generated AC voltage output by one or more solar panels prior to an AC-to-AC step-up transformer that steps up the three-phase solar-generated AC voltage to a three-phase grid AC voltage (the battery bank 215 provides a DC voltage and current to one or more DC to AC inverters 220. The DC to AC inverter 220 may be a single phase 120 VAC or 240 VAC inverter, or a two or three phase 208 VAC inverter, or any other DC to AC inverter as needed, [0018]. The output voltage of the transfer switch 230 may vary based upon the output of the DC to AC inverter 220, rotary converter 225, alternate or backup AC generator 235, and utility power 240. In some embodiments, if there is no backup AC 235 or utility power 240 connected to the solar power system 100, then a transfer switch may 230 may not be needed. Transformer 245 may step-up or step-down the input voltage from the transfer switch 230 to three phase 480 VAC, or other voltages, for use by the load 260. The output of the transformer 245 may vary depending upon the needs of the load 260. For example, the transformer may output single phase, two phase, or three phase power at any voltage depending upon the needs of the load 260 and/or configuration of the electrical configuration 200, [0020]). Therefore, it would have been obvious to one of ordinary skill in the art during the time the invention was made to use the AC voltage step-up transformer of Seldon with the wind power generation of Freight. The motivation would have been to provide varied output based on load needs (Seldon, [0020]).

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Regarding claim 12, Freight lacks in the teaching of the flexible growcenter, wherein the three-phase behind-the-meter AC voltage comprises a three-phase solar-generated AC voltage output by a DC-to-AC inverter that inputs solar-generated DC voltage from one or more solar panels and prior to an AC-to-AC step-up transformer that steps up the three-phase solar--generated AC voltage to a three-phase grid AC voltage. However, Freight does teach wherein the power distribution controllably provides an AC voltage to one or more components of the climate control system, the irrigation system, and the lighting system (another advantage of light curtain system 1400 is that conversion box 1404 allows for central conversion of AC to DC power. There is electrical waste each time current is converted from AC to DC, so a single point of conversion increases efficiency of the system, [0044]. An electrical panel, such as a 200 amp, 240 volt panel, can be coupled to one of the walls of container 102 for power distribution to the growing station system, [0057]) in which the power is produced by solar panels (container 102 can be modified to include a solar array 104 to harness solar energy and store it in a converter or batteries for later use, [therefore, using a behind-the-meter power input system using renewable energy to power the mobile container]...other renewable energy technologies, such as forms of solar and wind power, could also be added to increase functionality, [0036]). Seldon teaches wherein the three-phase behind-the-meter AC voltage comprises a three-phase solar-generated AC voltage output by a DC-to-AC inverter that inputs solar-generated DC voltage from one or more solar panels and prior to an AC-to-AC step-up (the battery bank 215 provides a DC voltage and current to one or more DC to AC inverters 220. The DC to AC inverter 220 may be a single phase 120 VAC or 240 VAC inverter, or a two or three phase 208 VAC inverter, or any other DC to AC inverter as needed, [0018]. The output voltage of the transfer switch 230 may vary based upon the output of the DC to AC inverter 220, rotary converter 225, alternate or backup AC generator 235, and utility power 240. In some embodiments, if there is no backup AC 235 or utility power 240 connected to the solar power system 100, then a transfer switch may 230 may not be needed. Transformer 245 may step-up or step-down the input voltage from the transfer switch 230 to three phase 480 VAC, or other voltages, for use by the load 260. The output of the transformer 245 may vary depending upon the needs of the load 260. For example, the transformer may output single phase, two phase, or three phase power at any voltage depending upon the needs of the load 260 and/or configuration of the electrical configuration 200, [0020]). Therefore, it would have been obvious to one of ordinary skill in the art during the time the invention was made to use the AC voltage step-up transformer of Seldon with the wind power generation of Freight. The motivation would have been to provide varied output based on load needs (Seldon, [0020]).

Regarding claim 13, Freight lacks in the teaching of the flexible growcenter, wherein the three-phase behind-the-meter AC voltage comprises a three-phase gas-generated AC voltage output by a generator that inputs combustible gas diverted from a flare or venting system. However, Freight does teach wherein the power distribution controllably provides an AC voltage to one or more components of the climate control system, the irrigation system, and the lighting system (another advantage of light curtain system 1400 is that conversion box 1404 allows for central conversion of AC to DC power. There is electrical waste each time current is converted from AC to DC, so a single point of conversion increases efficiency of the system, [0044]. An electrical panel, such as a 200 amp, 240 volt panel, can be coupled to one of the walls of container 102 for power distribution to the growing station system, [0057]) in which the power is produced by renewable energy (container 102 can be modified to include a solar array 104 to harness solar energy and store it in a converter or batteries for later use, [therefore, using a behind-the-meter power input system using renewable energy to power the mobile container]...other renewable energy technologies, such as forms of solar and wind power, could also be added to increase functionality, [0036]) and provides a ventilation system (the hydroponic system also can include a ventilation system having a main fan and a plurality of intermittent fans, [0050]). Seldon teaches wherein the three-phase behind-the-meter AC voltage comprises a three-phase gas-generated AC voltage output by a solar powered generator (the battery bank 215 provides a DC voltage and current to one or more DC to AC inverters 220. The DC to AC inverter 220 may be a single phase 120 VAC or 240 VAC inverter, or a two or three phase 208 VAC inverter, or any other DC to AC inverter as needed, [0018]. The output voltage of the transfer switch 230 may vary based upon the output of the DC to AC inverter 220, rotary converter 225, alternate or backup AC generator 235, and utility power 240. In some embodiments, if there is no backup AC 235 or utility power 240 connected to the solar power system 100, then a transfer switch may 230 may not be needed. Transformer 245 may step-up or step-down the input voltage from the transfer switch 230 to three phase 480 VAC, or other voltages, for use by the load 260. The output of the transformer 245 may vary depending upon the needs of the load 260. For example, the transformer may output single phase, two phase, or three phase power at any voltage depending upon the needs of the load 260 and/or configuration of the electrical configuration 200, [0020]). Therefore, it would have been obvious to one of ordinary skill in the art during the time the invention was made to use the AC voltage distribution of Seldon in the invention of Freight, and further, use a generator that inputs combustible gas diverted from a flare or venting system, since the use of combustible gas as a renewable energy power source was well known in the art during the time the invention was made and requires only routine skill in the art . The motivation would have been to provide varied output based on load needs (Seldon, [0020]).

Regarding claim 14, Freight lacks in the teaching of the flexible growcenter, wherein the three-phase behind-the-meter AC voltage is a three-phase metered AC voltage. However, Freight does teach wherein the behind-the-meter power input system comprises an input configured to receive an AC voltage (another advantage of light curtain system 1400 is that conversion box 1404 allows for central conversion of AC to DC power. There is electrical waste each time current is converted from AC to DC, so a single point of conversion increases efficiency of the system, [0044]). Seldon teaches wherein the three-phase behind-the-meter AC voltage is a three-phase metered AC voltage (the battery bank 215 provides a DC voltage and current to one or more DC to AC inverters 220. The DC to AC inverter 220 may be a single phase 120 VAC or 240 VAC inverter, or a two or three phase 208 VAC inverter, or any other DC to AC inverter as needed, [0018]. The output voltage of the transfer switch 230 may vary based upon the output of the DC to AC inverter 220, rotary converter 225, alternate or backup AC generator 235, and utility power 240. In some embodiments, if there is no backup AC 235 or utility power 240 connected to the solar power system 100, then a transfer switch may 230 may not be needed. Transformer 245 may step-up or step-down the input voltage from the transfer switch 230 to three phase 480 VAC, or other voltages, for use by the load 260. The output of the transformer 245 may vary depending upon the needs of the load 260. For example, the transformer may output single phase, two phase, or three phase power at any voltage depending upon the needs of the load 260 and/or configuration of the electrical configuration 200, [0020]). Therefore, it would have been obvious to one of ordinary skill in the art during the time the invention was made to use the AC voltage distribution of Seldon in the invention of Freight. The motivation would have been to provide varied output based on load needs (Seldon, [0020]).

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Regarding claim 25, Freight lacks in the teaching of the flexible growcenter, further comprising a battery system configured to convert the three-phase nominal AC voltage to DC nominal voltage and store power in a plurality of storage cells. However, Freight does teach providing power to a battery through solar panel converters (container 102 can be modified to include a solar array 104 to harness solar energy and store it in a converter or batteries for later use, [0036]). Seldon teaches a battery system configured to convert the three-phase nominal AC voltage to DC nominal voltage and store power in a plurality of storage cells (the battery bank 215 may be electrically connected to a DC to AC inverter 220. The output of the DC to AC inverter 220 may be optionally electrically connected to a rotary converter 225, or a transfer switch 230. Additionally, an optional backup AC generator may be electrically connected to the transfer switch 230, [0014]. The battery bank 215 provides a DC voltage and current to one or more DC to AC inverters 220. The DC to AC inverter 220 may be a single phase 120 VAC or 240 VAC inverter, or a two or three phase 208 VAC inverter, or any other DC to AC inverter as needed, [0018]). Therefore, it would have been obvious to one of ordinary skill in the art during the time the invention was made to use the AC voltage phase conversion of Seldon in the invention of Freight. The motivation would have been to provide power to a load based on voltage phase needs (Seldon, [0017], [0020]).

Claim 10 lacks an inventive step under PCT Article 33(3) as being obvious over Freight Farms, Inc. (hereinafter Freight) in view of Seldon Energy Partners, Llc et al. (hereinafter Seldon) and Abb Technology Ag (hereinafter Abb).

Regarding claim 10, Freight lacks in the teaching of the flexible growcenter, wherein the growcenter control system modulates a power factor correction factor by controllably adjusting which phase of the three-phase nominal AC voltage each component of the climate control system, the irrigation system, and the lighting system receive. However, Freight does teach wherein the power distribution controllably provides an AC voltage to one or more components of the climate control system, the irrigation system, and the lighting system (another advantage of light curtain system 1400 is that conversion box 1404 allows for central conversion of AC to DC power. There is electrical waste each time current is converted from AC to DC, so a single point of conversion increases efficiency of the system, [0044]. An electrical panel, such as a 200 amp, 240 volt panel, can be coupled to one of the walls of container 102 for power distribution to the growing station system, [0057]). Abb is in the field of control systems for electric distribution (abstract) including renewable energy systems ([0006]) and teaches wherein the control system modulates a power factor correction factor by controllably adjusting which phase of the three-phase nominal AC voltage a load receives (improved step-down AC/AC converters are needed for use in several applications, including applications involving grid-tie converters that are capable to supply active or reactive power free of harmonics, where a line-frequency transformer is needed to condition the voltage to that of a medium-voltage (MV) distribution system. The MV system in these applications is assumed to be a stiff voltage source compared with the grid-tie converter. Under these conditions, the step-down converter needs to be capable of stepping down the voltage from the distribution level to a level that the grid-tie converter can handle, and transferring active and reactive power free of harmonic, with the power factor controlled by the grid-tie converter, [0024]. The step-down converters described in detail below, an example of which is pictured in FIG. 1, allow for the stepping down of multi-phase (e.g., three-phase) voltage without the use of bulky line-frequency transformers or high/medium frequency transformers. These converters are based on a modified multi-phase AC chopper circuit, and can provide several benefits, including electric isolation from the distribution system in the event of a secondary fault condition, dynamic control of the secondary voltage for voltage regulation purposes, reduced secondary side common mode voltage, and high power-quality characteristics (i.e., low input current and output voltage total harmonic distortion, and near-unity power factor). These converters are suitable for use in varied applications, including energy storage systems, photovoltaic systems, wind generation systems, and fast electric vehicle charger systems, [0025]. Provided that in the low voltage side, the current is free of harmonics and the power factor is near unity, the converter also provides for high power-quality characteristics, as in low total harmonic distortion for input currents and output voltages, as well as near unity power factor, [0037]). Therefore, it would have been obvious to one of ordinary skill in the art during the time the invention was made to use the AC voltage power factor correction of Abb in the invention of Freight. The motivation would have been to provide varied output based on load and system capabilities (Abb, [0024], [0025]).

Claim 24 lacks an inventive step under PCT Article 33(3) as being obvious over Freight Farms, Inc. (hereinafter Freight) in view of Helical Holdings, Llc (hereinafter Helical).

Regarding claim 24, Freight lacks in the teaching of the flexible growcenter, wherein the mobile container comprises a storage trailer on wheels. Helical is in the field of flexible growcenters (a portable hydroponic greenhouse assembly for use in integrating a community hub for commercial transactions, abstract) and teaches wherein the mobile container comprises a storage trailer on wheels (FIG. 2 depicts a perspective view of portable greenhouse assembly 100 of the present invention being transported and relocated to a different location within container member 1. By way of illustration, but not limitation, greenhouse assembly 100 can be transported by way of a truck 8 and trailer hitch connection 9, or any other similar transportation means, such as, for example, by way of a skid connection, [0046]). Therefore, it would have been obvious to one of ordinary skill in the art during the time the invention was made to use the storage trailer on wheels of Helical in the invention of Freight. The motivation would have been to provide an easily transportable growcenter (Helical, [0046]).

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Claims 27-31 and 33-35 lack an inventive step under PCT Article 33(3) as being obvious over Swann in view of Johnson Controls Technology Company (hereinafter Johnson).

Regarding claim 27, Swann discloses a method of dynamic power delivery to a flexible growcenter using unutilized behind-the-meter power (self-regulating greenhouse, abstract, with an adaptable system, [0012]. The system includes a method of power delivery using photovoltaic solar panels, [0011], [0052]) comprising: monitoring unutilized behind-the-meter power availability (the photovoltaic panel and supplemental battery supply are monitored based on power availability, [0048-0052]); and enabling behind-the-meter power delivery to one or more components of a climate control system, a lighting system, and an irrigation system when the growcenter condition is met (in some embodiments, the fan 116 may be in communication with a photovoltaic panel (not pictured), such that the speed of the fan 116 is directly and completely controlled by the power output of the photovoltaic panel, [0048]. In the example of the fan 116 controlled by the output of a solar panel, the fan 116 will naturally regulate the internal environment of the greenhouse 100 by changing speed based upon radiation emitted by the sun. As the sun climbs in the sky during the day and emits more radiation both the temperature of the greenhouse 100 will increase and the voltaic panel will put out more power causing the fan 116 to spin faster, [0049]. The additional power source may be connected to photovoltaic panels that charge the power source during the day. The LED lights 222 may be activated only at night. The LED lights 222 may be in communication with a timer that turns the LED lights 222 on and off at the appropriate time, or the LED lights 222 may automatically turn on when the lighting dims and be allowed to run until the additional power source runs out of power, [0052]), but lacks in the teaching of determining when a growcenter ramp-up condition is met; and enabling behind-the-meter power delivery to one or more components of a climate control system, a lighting system, and an irrigation system when the growcenter ramp-up condition is met. Johnson is in the field of renewable energy dynamic power delivery (abstract) which can include providing behind the meter power to a building (building 318 can be connected to a PV field, [0069]) and teaches determining when a ramp-up condition is met (still referring to FIG. 8, process 800 is shown to include detecting a ramp rate condition of the PV power output based on the upper and lower bounds (step 808). Step 808 may include determining whether the PV power output is currently ramping-up, ramping-down, or not ramping. Ramping-up may occur when the PV power output PPV is increasing at a rate that exceeds the ramp rate compliance limit. Ramping-down may occur when the PV power output PPV is decreasing at a rate that exceeds the ramp rate compliance limit. If the PV power output PPV is neither ramping-up nor ramping-down the PV power output may be considered to be not ramping (e.g., not changing or changing at a rate within the ramp rate compliance limit), [0143]); and enabling behind-the-meter power delivery to one or more components when a ramp-up condition is met (referring now to FIG. 1, a photovoltaic energy system 100 is shown, according to an exemplary embodiment. In brief overview, system 100 converts solar energy into electricity using solar panels or other materials that exhibit the photovoltaic effect. The electricity generated by system 100 may be used locally by system 100 (e.g., used to power components of system 100), provided to a building or campus connected to system 100, supplied to a regional energy grid, and/or stored in a battery. System 100 may use battery storage to perform load shifting and/or ramp rate control. Battery storage can also be used to perform frequency regulation. A photovoltaic energy system 300 that uses battery storage to simultaneously perform both ramp rate control and frequency regulation is described in greater detail with reference to FIGS. 3A-8, [0052]. Further, the ramp rate is monitored to determine if the PV panels are ramping-up and controls the output power to the grid or building, [0066], [0069], [0084]. A load/rate predictor 1510 can also be used to control the ramp-up and load consumption detection and power distribution on a campus, [0218], [0219]). Therefore, it would have been obvious to one of ordinary skill in the art during the time the invention was made to use the ramped-up condition determination of Johnson in the invention of Swann. The motivation would have been to control the power output of the behind-the-meter power based on power availability (Johnson, abstract, [0004], [0007]).

Regarding claim 28, Swann lacks in the teaching of the method, further comprising: determining when a growcenter ramp-down condition is met; and disabling power delivery to one or more components of the climate control system, the irrigation system, and the lighting system when the growcenter ramp-down condition is met. However, Swann does teach disabling power delivery to a lighting system (the LED lights 222 may be activated only at night. The LED lights 222 may be in communication with a timer that turns the LED lights 222 on and off at the appropriate time, or the LED lights 222 may automatically turn on when the lighting dims and be allowed to run until the additional power source runs out of power, [0052]). Johnson teaches determining when a ramp-condition is met; and disabling power delivery to one or more components (controller 314 is configured to predict when solar intensity disturbances will occur and may cause power inverter 304 to ramp down the power output 316 provided to energy grid 312 preemptively. Instead of reacting to solar intensity disturbances after they occur, controller 314 can actively predict solar intensity disturbances and preemptively ramp down power output 316 before the disturbances affect PV field 302. Advantageously, this allows system controller 314 to perform both ramp down control and ramp up control by using only a portion of the energy provided by PV field 302 to generate power output 316 while the power output of PV field 302 is still high, rather than relying on energy from a battery. The remainder of the energy generated by PV field 302 (i.e., the excess energy) may be stored in battery 306 and/or dissipated, [0089]. Notably, a significant portion of triangular region 1206 occurs between times t1 and t2, before the disturbance affects PV field 302. As such, the decreasing ramp rate control provided by system 300 is a preemptive process triggered by detecting an approaching cloud, prior to the cloud casting a shadow upon PV field 302. In some embodiments, controller 314 uses a predictive control technique (e.g., feedforward control, model predictive control, etc.) to perform ramp down control in system 300. For example, controller 314 may actively monitor the positions, sizes, velocities, and/or other attributes of clouds/shadows that could potentially cause a solar intensity disturbance affecting PV field 302. When an approaching cloud is detected at time t1, controller 314 may preemptively cause power inverter 304 to begin ramping down power output 316. This allows power inverter 304 to ramp down power output 316 by limiting the energy generated by PV field 302 while the power output is still high, rather than requiring additional energy from a battery to perform the ramp down once the power output has dropped, [0100]). Therefore, it would have been obvious to one of ordinary skill in the art during the time the invention was made to use the ramped-down condition determination of Johnson in the invention of Swann. The motivation would have been to control the power output of the behind-the-meter power based on power availability (Johnson, abstract, [0004], [0007]).

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Regarding claim 29, Swann lacks in the teaching of the method, further comprising: receiving an operational directive to go offline; and disabling power delivery to the climate control system, the irrigation system, and the lighting system. However, Swann does teach disabling power delivery to a lighting system (the LED lights 222 may be activated only at night. The LED lights 222 may be in communication with a timer that turns the LED lights 222 on and off at the appropriate time, or the LED lights 222 may automatically turn on when the lighting dims and be allowed to run until the additional power source runs out of power, [0052]). Johnson teaches receiving an operational directive to go offline; and disabling power delivery (controller 314 is configured to predict when solar intensity disturbances will occur and may cause power inverter 304 to ramp down the power output 316 provided to energy grid 312 preemptively. Instead of reacting to solar intensity disturbances after they occur, controller 314 can actively predict solar intensity disturbances and preemptively ramp down power output 316 before the disturbances affect PV field 302. Advantageously, this allows system controller 314 to perform both ramp down control and ramp up control by using only a portion of the energy provided by PV field 302 to generate power output 316 while the power output of PV field 302 is still high, rather than relying on energy from a battery. The remainder of the energy generated by PV field 302 (i.e., the excess energy) may be stored in battery 306 and/or dissipated, [0089]. Notably, a significant portion of triangular region 1206 occurs between times t1 and t2, before the disturbance affects PV field 302. As such, the decreasing ramp rate control provided by system 300 is a preemptive process triggered by detecting an approaching cloud, prior to the cloud casting a shadow upon PV field 302. In some embodiments, controller 314 uses a predictive control technique (e.g., feedforward control, model predictive control, etc.) to perform ramp down control in system 300. For example, controller 314 may actively monitor the positions, sizes, velocities, and/or other attributes of clouds/shadows that could potentially cause a solar intensity disturbance affecting PV field 302. When an approaching cloud is detected at time t1, controller 314 may preemptively cause power inverter 304 to begin ramping down power output 316. This allows power inverter 304 to ramp down power output 316 by limiting the energy generated by PV field 302 while the power output is still high, rather than requiring additional energy from a battery to perform the ramp down once the power output has dropped, [0100]; see also [0057], sending power to local grids or PV, therefore offline as going off grid, thereby disabling power delivery to the grids). Therefore, it would have been obvious to one of ordinary skill in the art during the time the invention was made to use the operational directive of Johnson in the invention of Swann. The motivation would have been to control the power output of the behind-the-meter power based on power availability (Johnson, abstract, [0004], [0007]).

Regarding claim 30, Swann lacks in the teaching of the method, further comprising: receiving an operational directive to reduce power consumption; and dynamically reducing power delivery to a subset of the one or more components of the climate control system, the irrigation system, and the lighting system. However, Swann does teach disabling power delivery to a lighting system (the LED lights 222 may be activated only at night. The LED lights 222 may be in communication with a timer that turns the LED lights 222 on and off at the appropriate time, or the LED lights 222 may automatically turn on when the lighting dims and be allowed to run until the additional power source runs out of power, [0052]). Johnson teaches receiving an operational directive to reduce power consumption; and dynamically reducing power delivery to a subset of the one or more components (In some embodiments, campus 1302 includes a central plant 1318. Central plant 1318 may include one or more subplants that consume resources from utilities (e.g., water, natural gas, electricity, etc.) to satisfy the loads of buildings 1316, [0191]. In some embodiments, frequency response controller 1312 uses power inverter 1306 and battery 1308 to perform load shifting for campus 1302. For example, controller 1312 may cause power inverter 1306 to store energy in battery 1308 when energy prices are low and retrieve energy from battery 1308 when energy prices are high in order to reduce the cost of electricity required to power campus 1302. Load shifting may also allow system 1300 reduce the demand charge incurred. Demand charge is an additional charge imposed by some utility providers based on the maximum power consumption during an applicable demand charge period. For example, a demand charge rate may be specified in terms of dollars per unit of power (e.g., $/kW) and may be multiplied by the peak power usage (e.g., kW) during a demand charge period to calculate the demand charge. Load shifting may allow system 1300 to smooth momentary spikes in the electric demand of campus 1302 by drawing energy from battery 1308 in order to reduce peak power draw from energy grid 1304, thereby decreasing the demand charge incurred, [0198]). Therefore, it would have been obvious to one of ordinary skill in the art during the time the invention was made to use the operational directive of reducing power of Johnson in the invention of Swann. The motivation would have been to control the power output of the system based on power availability and to create an efficient energy system (Johnson, abstract, [0004], [0007], [0198]).

Regarding claim 31, Swann lacks in the teaching of the method, further comprising: receiving an operational directive to reduce power consumption; and dynamically reducing power consumption to one or more components of the climate control system, the irrigation system, and the lighting system. However, Swann does teach disabling power delivery to a lighting system (the LED lights 222 may be activated only at night. The LED lights 222 may be in communication with a timer that turns the LED lights 222 on and off at the appropriate time, or the LED lights 222 may automatically turn on when the lighting dims and be allowed to run until the additional power source runs out of power, [0052]). Johnson teaches receiving an operational directive to reduce power consumption; and dynamically reducing power consumption to one or more components (In some embodiments, campus 1302 includes a central plant 1318. Central plant 1318 may include one or more subplants that consume resources from utilities (e.g., water, natural gas, electricity, etc.) to satisfy the loads of buildings 1316, [0191]. In some embodiments, frequency response controller 1312 uses power inverter 1306 and battery 1308 to perform load shifting for campus 1302. For example, controller 1312 may cause power inverter 1306 to store energy in battery 1308 when energy prices are low and retrieve energy from battery 1308 when energy prices are high in order to reduce the cost of electricity required to power campus 1302. Load shifting may also allow system 1300 reduce the demand charge incurred. Demand charge is an additional charge imposed by some utility providers based on the maximum power consumption during an applicable demand charge period. For example, a demand charge rate may be specified in terms of dollars per unit of power (e.g., $/kW) and may be multiplied by the peak power usage (e.g., kW) during a demand charge period to calculate the demand charge. Load shifting may allow system 1300 to smooth momentary spikes in the electric demand of campus 1302 by drawing energy from battery 1308 in order to reduce peak power draw from energy grid 1304, thereby decreasing the demand charge incurred, [0198]). Therefore, it would have been obvious to one of ordinary skill in the art during the time the invention was made to use the operational directive of reducing power of Johnson in the invention of Swann. The motivation would have been to control the power output of the system based on power availability and to create an efficient energy system (Johnson, abstract, [0004], [0007], [0198]).

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Regarding claim 33, Swann discloses the method, wherein unutilized behind-the-meter power availability comprises one or more of excess local power generation at a local station level, excess local power generation that a grid cannot receive, local power generation subject to economic curtailment, local power generation subject to reliability curtailment, local power generation subject to power factor correction, low local power generation, start up local power generation situations, transient local power generation situations, or testing local power generation situations where there is an economic advantage to using local behind-the-meter power generation (in some embodiments an additional power source (not shown) may also be in communication with growing or LED lights 222 that are disposed within the greenhouse 100. The additional power source may be the supplemental battery that was disclosed above or it may be a separate power source. The additional power source may be connected to photovoltaic panels that charge the power source during the day. The LED lights 222 may be activated only at night. The LED lights 222 may be in communication with a timer that turns the LED lights 222 on and off at the appropriate time, or the LED lights 222 may automatically turn on when the lighting dims and be allowed to run until the additional power source runs out of power, [0052]).

Regarding claim 34, Swann lacks in the teaching of the method, wherein the growcenter ramp-up condition is met if there is sufficient behind-the--meter power availability and there is no operational directive from a local station to go offline. Johnson teaches wherein the ramp-up condition is met if there is sufficient behind-the--meter power availability and there is no operational directive from a local station to go offline (still referring to FIG. 8, process 800 is shown to include detecting a ramp rate condition of the PV power output based on the upper and lower bounds (step 808). Step 808 may include determining whether the PV power output is currently ramping-up, ramping-down, or not ramping. Ramping-up may occur when the PV power output PPV is increasing at a rate that exceeds the ramp rate compliance limit. Ramping-down may occur when the PV power output PPV is decreasing at a rate that exceeds the ramp rate compliance limit. If the PV power output PPV is neither ramping-up nor ramping-down the PV power output may be considered to be not ramping (e.g., not changing or changing at a rate within the ramp rate compliance limit), [0143]. Referring now to FIG. 1, a photovoltaic energy system 100 is shown, according to an exemplary embodiment. In brief overview, system 100 converts solar energy into electricity using solar panels or other materials that exhibit the photovoltaic effect. The electricity generated by system 100 may be used locally by system 100 (e.g., used to power components of system 100), provided to a building or campus connected to system 100, supplied to a regional energy grid, and/or stored in a battery. System 100 may use battery storage to perform load shifting and/or ramp rate control. Battery storage can also be used to perform frequency regulation. A photovoltaic energy system 300 that uses battery storage to simultaneously perform both ramp rate control and frequency regulation is described in greater detail with reference to FIGS. 3A-8, [0052]. Further, the ramp rate is monitored to determine if the PV panels are ramping-up and controls the output power to the grid or building, [0066], [0069], [0084]. A load/rate predictor 1510 can also be used to control the ramp-up and load consumption detection and power distribution on a campus, [0218], [0219]). Therefore, it would have been obvious to one of ordinary skill in the art during the time the invention was made to use the ramped-up condition determination of Johnson in the invention of Swann. The motivation would have been to control the power output of the behind-the-meter power based on power availability (Johnson, abstract, [0004], [0007]).

Regarding claim 35, Swann lacks in the teaching of the method, wherein the growcenter ramp-down condition is met if there is insufficient behind-the-meter power availability or there is an operational directive from a local station to go offline. Johnson teaches wherein the ramp-down condition is met if there is insufficient behind-the-meter power availability or there is an operational directive from a local station to go offline (controller 314 is configured to predict when solar intensity disturbances will occur and may cause power inverter 304 to ramp down the power output 316 provided to energy grid 312 preemptively. Instead of reacting to solar intensity disturbances after they occur, controller 314 can actively predict solar intensity disturbances and preemptively ramp down power output 316 before the disturbances affect PV field 302. Advantageously, this allows system controller 314 to perform both ramp down control and ramp up control by using only a portion of the energy provided by PV field 302 to generate power output 316 while the power output of PV field 302 is still high, rather than relying on energy from a battery. The remainder of the energy generated by PV field 302 (i.e., the excess energy) may be stored in battery 306 and/or dissipated, [0089]. Notably, a significant portion of triangular region 1206 occurs between times t1 and t2, before the disturbance affects PV field 302. As such, the decreasing ramp rate control provided by system 300 is a preemptive process triggered by detecting an approaching cloud, prior to the cloud casting a shadow upon PV field 302. In some embodiments, controller 314 uses a predictive control technique (e.g., feedforward control, model predictive control, etc.) to perform ramp down control in system 300. For example, controller 314 may actively monitor the positions, sizes, velocities, and/or other attributes of clouds/shadows that could potentially cause a solar intensity disturbance affecting PV field 302. When an approaching cloud is detected at time t1, controller 314 may preemptively cause power inverter 304 to begin ramping down power output 316. This allows power inverter 304 to ramp down power output 316 by limiting the energy generated by PV field 302 while the power output is still high, rather than requiring additional energy from a battery to perform the ramp down once the power output has dropped, [0100]). Therefore, it would have been obvious to one of ordinary skill in the art during the time the invention was made to use the ramped-down condition determination of Johnson in the invention of Swann. The motivation would have been to control the power output of the behind-the-meter power based on power availability (Johnson, abstract, [0004], [0007]).

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Continuation of:

Claim 32 lacks an inventive step under PCT Article 33(3) as being obvious over Swann in view of Johnson Controls Technology Company (hereinafter Johnson) and Abb Technology Ag (hereinafter Abb).

Regarding claim 32, Swann lacks in the teaching of the method, further comprising: receiving an operational directive to provide power factor correction; and dynamically adjusting power delivery to a subset of the one or more components of the climate control system, the irrigation system, and the lighting system. However, Swann does teach disabling power delivery to a lighting system (the LED lights 222 may be activated only at night. The LED lights 222 may be in communication with a timer that turns the LED lights 222 on and off at the appropriate time, or the LED lights 222 may automatically turn on when the lighting dims and be allowed to run until the additional power source runs out of power, [0052]). Abb is in the field of control systems for electric distribution (abstract) including renewable energy systems ([0006]) and teaches receiving an operational directive to provide power factor correction; and dynamically adjusting power delivery to a subset of the one or more components (improved step-down AC/AC converters are needed for use in several applications, including applications involving grid-tie converters that are capable to supply active or reactive power free of harmonics, where a line-frequency transformer is needed to condition the voltage to that of a medium-voltage (MV) distribution system. The MV system in these applications is assumed to be a stiff voltage source compared with the grid-tie converter. Under these conditions, the step-down converter needs to be capable of stepping down the voltage from the distribution level to a level that the grid-tie converter can handle, and transferring active and reactive power free of harmonic, with the power factor controlled by the grid-tie converter, [0024]. The step-down converters described in detail below, an example of which is pictured in FIG. 1, allow for the stepping down of multi-phase (e.g., three-phase) voltage without the use of bulky line-frequency transformers or high/medium frequency transformers. These converters are based on a modified multi-phase AC chopper circuit, and can provide several benefits, including electric isolation from the distribution system in the event of a secondary fault condition, dynamic control of the secondary voltage for voltage regulation purposes, reduced secondary side common mode voltage, and high power-quality characteristics (i.e., low input current and output voltage total harmonic distortion, and near-unity power factor). These converters are suitable for use in varied applications, including energy storage systems, photovoltaic systems, wind generation systems, and fast electric vehicle charger systems, [0025]. Provided that in the low voltage side, the current is free of harmonics and the power factor is near unity, the converter also provides for high power-quality characteristics, as in low total harmonic distortion for input currents and output voltages, as well as near unity power factor, [0037]). Therefore, it would have been obvious to one of ordinary skill in the art during the time the invention was made to use the AC voltage power factor correction of Abb in the invention of Swann. The motivation would have been to provide varied output based on load and system capabilities (Abb, [0024], [0025]).

Claims 1-35 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.

Search History:

Limited Classification Search

The Patent Analyst performed a limited classification search within the following US, IPC, CPC, ECLA, or F-Term classification areas:

CPC Class/Subclass(es): A01G 9/16; A01G 9/14; A01G 9/24; H02S 10/40; H02S 20/30 (2018.02)

IPC (8) Class/Subclass(es): A01G 9/16; A01G 9/14; A01G 9/24; H02S 10/40; H02S 20/30 (2018.01)

U.S. Class/Subclass(es): 47/17; 47/66.7; 47/66.6

See Global Search Results.

Global Patent Literature Text Search

The Patent Analyst performed the following global text search, which was not limited by classification but may or may not have been limited by other criteria:

Questel Orbit: https://www.orbit.com

#	Search query	Results
1	((FLEX+ OR EXPAND+ OR ADAPT+ OR ADJUST+ OR CONFORM+ OR MODIF+) AND (GROW+ OR GREEN+ OR PLANT+ OR FOOD+ OR CROP+ OR NURSER+) AND (MOBIL+ OR TRANSPORT+ OR AUTOMOBIL+ OR VEHIC+) AND (CONTROL+ OR COMPUTER+ OR +COMPUTER OR +PROCESSOR OR PROCESS+ OR +CONTROLLER) AND (CLIMAT+ OR HUMID+ OR TEMPERATUR+ OR WEATHER+))/TI/AB/IW	1741
2	1 AND (BEHIND+ OR +METER OR BTM+ OR +BTM OR RENEW+ OR SOLAR+ OR WIND+ OR PHOTOVOLT+) AND (POWER+ OR DISTRIB+ OR GRID+ OR ALLOCAT+ OR CENTER+) AND (LIGHT+ OR ILLUMINAT+ OR LAMP+) AND (IRRIGAT+ OR DRAIN+ OR WATER+ OR SPRAY+ OR SPRINKL+ OR FLOOD+)	51
3	(US8720125 OR US20160324077 OR US20150223418 OR US20020088171 OR US7036270 OR US5031358 OR EP2725892 OR US9288948 OR US20130006401 OR WO2017103922 OR EP2866551 OR US20110252705 OR US20170035008)/PN	11
4	(US8649907 OR US20160212954 OR WO201019109 OR US20100088953 OR US7987632 OR WO201807334 OR US20170347547 OR US9288948 OR US20160143228 OR US20130006401 OR US20130019527 OR US5101593 OR US8707617 OR US20110252705 OR US20140137468 OR US8910419)/PN	15
5	..CITBF NOSOURCE SS 4 11-12 14 RANKED	61
6	..SIMILARITY SS 4 RANKED 11-12 14	125101
7	(5 OR 6) AND (GROW+ OR GREEN+ OR PLANT+ OR FOOD+ OR CROP+ OR NURSER+) AND (MOBIL+ OR TRANSPORT+ OR AUTOMOBIL+ OR VEHIC+ OR WHEEL+	1581

	OR PORTABL+) AND (CONTROL+ OR COMPUTER+ OR +COMPUTER OR +PROCESSOR OR PROCESS+ OR +CONTROLLER) AND (CLIMAT+ OR HUMID+ OR TEMPERATUR+ OR WEATHER+)	
8	7 AND (BEHIND+ OR +METER OR BTM+ OR +BTM OR RENEW+ OR SOLAR+ OR WIND+ OR PHOTOVOLT+) AND (POWER+ OR DISTRIB+ OR GRID+ OR ALLOCAT+ OR CENTER+) AND (LIGHT+ OR ILLUMINAT+ OR LAMP+) AND (IRRIGAT+ OR DRAIN+ OR WATER+ OR SPRAY+ OR SPRINKL+ OR FLOOD+)	208
9	8 AND (FLEX+ OR EXPAND+ OR ADAPT+ OR ADJUST+ OR CONFORM+ OR MODIF+)	119
10	..CITBF NOSOURCE SS 9 21 RANKED	0
11	..SIMILARITY SS 9 RANKED 21	27587
12	11 AND (GROW+ OR GREEN+ OR PLANT+ OR FOOD+ OR CROP+ OR NURSER+) AND (MOBIL+ OR TRANSPORT+ OR AUTOMOBIL+ OR VEHIC+ OR WHEEL+ OR PORTABL+) AND (CONTROL+ OR COMPUTER+ OR +COMPUTER OR +PROCESSOR OR PROCESS+ OR +CONTROLLER) AND (CLIMAT+ OR HUMID+ OR TEMPERATUR+ OR WEATHER+) AND (BEHIND+ OR +METER OR BTM+ OR +BTM OR RENEW+ OR SOLAR+ OR WIND+ OR PHOTOVOLT+) AND (POWER+ OR DISTRIB+ OR GRID+ OR ALLOCAT+ OR CENTER+) AND (LIGHT+ OR ILLUMINAT+ OR LAMP+) AND (IRRIGAT+ OR DRAIN+ OR WATER+ OR SPRAY+ OR SPRINKL+ OR FLOOD+)	171
13	12 AND (AC OR ALTERNAT+)	29
14	(047017000)/PCL	729
15	(047066600)/PCL	285
16	(047066700)/PCL	281
17	(14 OR 15 OR 16) AND (GROW+ OR GREEN+ OR PLANT+ OR FOOD+ OR CROP+ OR NURSER+) AND (MOBIL+ OR TRANSPORT+ OR AUTOMOBIL+ OR VEHIC+ OR WHEEL+ OR PORTABL+) AND (CONTROL+ OR COMPUTER+ OR +COMPUTER OR +PROCESSOR OR PROCESS+ OR +CONTROLLER) AND (CLIMAT+ OR HUMID+ OR TEMPERATUR+ OR WEATHER+) AND (BEHIND+ OR +METER OR BTM+ OR +BTM OR RENEW+ OR SOLAR+ OR WIND+ OR PHOTOVOLT+) AND (POWER+ OR DISTRIB+ OR GRID+ OR ALLOCAT+ OR CENTER+) AND (LIGHT+ OR ILLUMINAT+ OR LAMP+) AND (IRRIGAT+ OR DRAIN+ OR WATER+ OR SPRAY+ OR SPRINKL+ OR FLOOD+)	9
18	(A01G-009/14)/IPC	23159
19	(A01G-009/16)/IPC	4093
20	(A01G-009/24)/IPC	21677
21	(A01G-031/06)/IPC	3988

22	(H02S-010/40)/IPC	1322
23	(H02S-020/30)/IPC	5940
24	(18 OR 19 OR 20 OR 21 OR 22 OR 23) AND (GROW+ OR GREEN+ OR PLANT+ OR FOOD+ OR CROP+ OR NURSER+) AND (MOBIL+ OR TRANSPORT+ OR AUTOMOBIL+ OR VEHIC+ OR WHEEL+ OR PORTABL+) AND (CONTROL+ OR COMPUTER+ OR +COMPUTER OR +PROCESSOR OR PROCESS+ OR +CONTROLLER) AND (CLIMAT+ OR HUMID+ OR TEMPERATUR+ OR WEATHER+) AND (BEHIND+ OR +METER OR BTM+ OR +BTM OR RENEW+ OR SOLAR+ OR WIND+ OR PHOTOVOLT+) AND (POWER+ OR DISTRIB+ OR GRID+ OR ALLOCAT+ OR CENTER+) AND (LIGHT+ OR ILLUMINAT+ OR LAMP+) AND (IRRIGAT+ OR DRAIN+ OR WATER+ OR SPRAY+ OR SPRINKL+ OR FLOOD+)	171
25	24 AND (AC OR ALTERNAT+)	23
26	24 AND (SUN+ OR SOLAR+ OR WIND+ OR RENEWABL+)	154
27	24 AND (SOLAR+ OR WIND+)	134
28	27 AND RAMP+	2
29	27 AND (+PHASE OR PHAS+) AND VOLT+	3
30	(A01G-009/14)/CPC	6245
31	(A01G-009/16)/CPC	1565
32	(A01G-009/24)/CPC	6439
33	(A01G-031/06)/CPC	1436
34	(H02S-010/40)/CPC	806
35	(H02S-020/30)/CPC	1972
36	(A01G-009/14/07)/CPC	992
37	(A01G-025/16/7)/CPC	1311
38	(A01G-009/24/3)/CPC	716
39	(Y02A-040/254)/CPC	3445
40	(Y02A-040/266)/CPC	2561
41	(30 OR 31 OR 32 OR 33 OR 34 OR 35 OR 36 OR 37 OR 38 OR 39 OR 40) AND (GROW+ OR GREEN+ OR PLANT+ OR FOOD+ OR CROP+ OR NURSER+) AND (MOBIL+ OR TRANSPORT+ OR AUTOMOBIL+ OR VEHIC+ OR WHEEL+ OR PORTABL+) AND (CONTROL+ OR COMPUTER+ OR +COMPUTER OR +PROCESSOR OR PROCESS+ OR +CONTROLLER) AND (CLIMAT+ OR HUMID+ OR TEMPERATUR+ OR WEATHER+) AND (BEHIND+ OR +METER OR BTM+ OR +BTM OR RENEW+ OR SOLAR+ OR WIND+ OR PHOTOVOLT+) AND (POWER+ OR DISTRIB+ OR GRID+ OR ALLOCAT+ OR CENTER+) AND (LIGHT+ OR	118

16	(grow center OR nursery OR greenhouse) AND (Solar OR wind) AND ramp up condition for power	4,490
17	(grow center OR nursery OR greenhouse) AND (Solar OR wind) AND ramp up condition for power distribution	3,950
18	dynamic power delivery AND (grow center OR nursery OR greenhouse) AND (Solar OR wind OR behind the meter) AND ramp up condition for power distribution	4,170
19	dynamic power delivery AND (grow center OR nursery OR greenhouse) AND (Solar OR wind OR behind the meter) AND (full OR on OR ramp up) condition for power distribution	17,700
20	dynamic power delivery AND (grow center OR nursery OR greenhouse) AND (Solar OR wind OR behind the meter) AND power (allocation OR distribution OR availability OR conservation)	22,400
21	dynamic power delivery AND (grow center OR nursery OR greenhouse) AND (Solar OR wind OR behind the meter) AND power (allocation OR distribution OR availability OR conservation) AND three phase AC voltage	9,280
22	(grow center OR nursery OR greenhouse) AND (Solar OR wind OR behind the meter) AND power management	18,200
23	(grow center OR nursery OR greenhouse) AND (Solar OR wind) AND power management	10,900
24	(grow center OR nursery OR greenhouse) AND (solar OR photovoltaic) panel AND power (distribution OR management)	23,200
25	(grow center OR nursery OR greenhouse) AND (solar OR photovoltaic) panel AND power (distribution OR management) AND ramp up	3,420
26	(grow center OR nursery OR greenhouse) AND (solar OR photovoltaic) panel AND power (distribution OR management) AND load demand	15,600
27	(grow center OR nursery OR greenhouse) AND (solar OR photovoltaic) panel AND power (distribution OR management) AND power delivery based on available power	76,000
28	(grow center OR nursery OR greenhouse) AND power (distribution OR management) AND ramp up	13,000
29	(grow center OR nursery OR greenhouse) AND (Energy OR power) management AND (solar OR wind OR behind the meter)	19,600
30	(grow center OR nursery OR greenhouse) AND (Energy OR power) distribution based on availability AND (solar OR wind OR behind the meter)	29,900
31	(grow center OR nursery OR greenhouse OR plants) AND (Energy OR power) distribution based on availability AND (solar OR wind OR behind the meter)	33,400
32	(grow center OR nursery OR greenhouse OR plants) AND monitoring power availability AND (solar OR sun OR wind OR photovoltaic) AND (light OR irrigation OR temperature OR climate)	59,000
33	power availability control of (Greenhouse OR nursery OR growcenter) using (solar OR wind OR renewable) energy	14,600
34	power availability control of (Greenhouse OR nursery OR grow center) using (solar OR wind OR renewable) energy AND (light OR irrigation OR climate OR temperature)	11,100
35	controlling output power of solar panel in greenhouse AND ramp up AND agriculture	1,630

36	controlling output power of solar panel in greenhouse AND ramp up AND (mobile OR building OR portable)	2,630
37	ramp up condition of greenhouse using solar power	3,600
38	ramp up condition of (horticulture OR greenhouse OR plant grow) using solar power	5,440
39	ramp up condition for greenhouse to control power output of solar panels to (lighting OR irrigation OR temperature OR climate) system	3,380
40	(greenhouse OR nursery OR horticulture) AND three phase AC voltage AND step down transformer	13,400
41	(greenhouse OR nursery OR horticulture) AND three phase AC voltage AND ac to ac step down transformer to single phase	11,100

Computer Accessed Text Databases Searched

The Patent Analyst searched the following computer accessed text databases:

Proquest: http://www.proquest.com/

#	Search query	Results
1	ramp up condition of (horticulture OR greenhouse OR plant grow) using solar power	5,336
2	power availability control of (Greenhouse OR nursery OR grow center) using (solar OR wind OR renewable) energy AND (light OR irrigation OR climate OR temperature)	58,157
3	flexible and mobile grow center	41,735
4	(portable OR mobile) AND (grow center OR nursery OR plant OR greenhouse) AND (humidity OR temperature OR climate) AND (watering OR irrigation) AND light	18,716
5	(portable OR mobile) AND (grow center OR nursery OR plant OR greenhouse) AND (humidity OR temperature OR climate) AND (watering OR irrigation)	141,000
6	(grow center OR nursery OR plant OR greenhouse) AND (Solar OR wind) AND ramp up condition	20,064

Google Scholar: https://scholar.google.com/

#	Search query	Results
1	ramp up condition of (horticulture OR greenhouse OR plant grow) using solar power	22,000
2	power availability control of (Greenhouse OR nursery OR grow center) using (solar OR wind OR renewable) energy AND (light OR irrigation OR climate OR temperature)	248,000
3	flexible and mobile grow center	230,000
4	(portable OR mobile) AND (grow center OR nursery OR plant OR greenhouse) AND (humidity OR temperature OR climate) AND (watering OR irrigation) AND light	90,800
5	(portable OR mobile) AND (grow center OR nursery OR plant OR greenhouse) AND (humidity OR temperature OR climate) AND (watering OR irrigation)	141,000
6	(grow center OR nursery OR plant OR greenhouse) AND (Solar OR wind) AND ramp up condition	41,400

PATENT COOPERATION TREATY

From the INTERNATIONAL SEARCHING AUTHORITY

To: BASIL ANGELO
ANGELO MIKESKA PLLC
21 WATERWAY AVENUE, SUITE 300
THE WOODLANDS, TX 77380

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)

Applicant's or agent's file reference 01128-000002 PCT	Date of mailing *(day/month/year)* 31 MAY 2018 **FOR FURTHER ACTION** See paragraphs 1 and 4 below
International application No. PCT/US2018/017950	International filing date *(day/month/year)* 13 February 2018
Applicant LANCIUM LLC	

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 01128-000002 PCT	**FOR FURTHER ACTION**	see Form PCT/ISA/220 as well as, where applicable, item 5 below.
International application No. PCT/US2018/017950	International filing date *(day/month/year)* 13 February 2018	(Earliest) Priority Date *(day/month/year)* 11 January 2018
Applicant LANCIUM LLC		

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 4 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. 6

☒ 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.

Form PCT/ISA/210 (first sheet) (January 2015)

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US2018/017950

Box No. II Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:

2. ☐ Claims Nos.:
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:

3. ☐ Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box No. III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:
See extra sheet(s).

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.

2. ☐ As all searchable claims could be searched without effort justifying additional fees, this Authority did not invite payment of additional fees.

3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:

4. ☒ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:
1-24

Remark on Protest

☐ The additional search fees were accompanied by the applicant's protest and, where applicable, the payment of a protest fee.

☐ The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.

☐ No protest accompanied the payment of additional search fees.

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US2018/017950

A. CLASSIFICATION OF SUBJECT MATTER
IPC(8) - G06F 1/26; G06F 1/20; G06F 1/30; G06F 1/32 (2018.01)
CPC - G06F 1/26; H05K 7/1497; G06F 1/20; H05K 7/1485 (2018.05)

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 - 713/300; 361/679.46; 361/679.02 (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.
X --- Y	US 2008/0094797 A1 (COGLITORE et al) 24 April 2008 (24.04.2008) entire document	1, 7, 15-18, 20-22 --- 2-6, 8-14, 19, 23, 24
Y	US 2010/0211810 A1 (ZACHO) 19 August 2010 (19.08.2010) entire document	2, 19
Y	US 2008/0030078 A1 (WHITTED et al) 07 February 2008 (07.02.2008) entire document	3-6, 8-14, 23, 24
Y	US 2013/0063991 A1 (XIAO et al) 14 March 2013 (14.03.2013) entire document	12
Y	US 2015/0155712 A1 (INERTECH IP LLC) 04 June 2015 (04.06.2015) entire document	24
A	US 2010/0328849 A1 (EWING et al) 30 December 2010 (30.12.2010) entire document	1-24
A	US 2013/0306276 A1 (DUCHESNEAU) 21 November 2013 (21.11.2013) entire document	1-24
A	US 2012/0300524 A1 (FORNAGE et al) 29 November 2012 (29.11.2012) entire document	1-24

☐ 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
14 May 2018	31 MAY 2018
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)

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US2018/017950

Continued from Box No. III Observations where unity of invention is lacking

This application contains the following inventions or groups of inventions which are not so linked as to form a single general inventive concept under PCT Rule 13.1. In order for all inventions to be examined, the appropriate additional examination fees must be paid.

Group I, claims 1-24, are drawn to a flexible datacenter comprising: a mobile container; and a behind-the-meter power input system.

Group II, claims 25-34, are drawn to a method of dynamic power delivery to a flexible datacenter using unutilized behind-the meter power comprising: monitoring unutllized behind-the-meter power availability; and determining when a datacenter ramp-up condition is met.

The inventions listed as Groups I-II do not relate to a single general inventive concept under PCT Rule 13.1 because, under PCT Rule 13.2, they lack the same or corresponding special technical features for the following reasons: the special technical feature of the Group I invention: a flexible datacenter comprising: a mobile container; a behind-the-meter power input system; a power distribution system; a datacenter control system; and a climate control system, wherein the datacenter control system modulates power delivery to the plurality of computing systems as claimed therein is not present in the invention of Group II. The special technical feature of the Group II invention: monitoring unutllized behind-the-meter power availability; determining when a datacenter ramp-up condition is met; enabling behind-the-meter power delivery to one or more computing systems when the datacenter ramp-up condition is met; and directing the one or more computing systems to perform predetermined computational operations as claimed therein is not present in the invention of Group I.

Groups I and II lack unity of invention because even though the inventions of these groups require the technical feature of a flexible datacenter comprising one or more computing systems; and power delivery to the flexible datacenter using unutilized behind-the meter power availability, this technical feature is not a special technical feature as it does not make a contribution over the prior art.

Specifically, US 2010/0328849 to Ewing teaches a datacenter comprising one or more computing systems; and power delivery to the datacenter using power availability (if a server demands 500 watts and the PUE for the datacenter is 3.0, then the power from the utility grid needed to deliver 500 watts to the server is 1500 watts. The DCIE, in comparison, may provide a different aspect of this information, a DCIE value of 0.33 (equivalent to a PUE of 3.0) suggesting that the computing equipment consumes 33% of the power in the data center, para.0060). Further, US 2013/0306276 to Duchesneau teaches a flexible datacenter (supercomputing datacenter, Para. [0315. Maximum flexibility, para. 1500]); and using unutilized behind-the meter power availability (PERKS is hybrid energy system combining UPS with a peak-shaving system that directly captures excess or low-cost energy from a multiplicity of sources (when it is cheapest or most readily available) and stores it for later reuse, such as during peak periods, Para. [1456]. Note that excess energy is hereby "unutilized behind the meter power" as defined by applicant in Para [0041] of the specification of the present application).

Since none of the special technical features of the Group I or II inventions are found in more than one of the inventions, unity of invention is lacking.

Search History:

Limited Classification Search

The Patent Analyst performed a limited classification search within the following US, IPC, CPC, ECLA, or F-Term classification areas:

CPC Class/Subclass(es): G06F 1/26; H05K 7/1497; G06F 1/20; H05K 7/1485 (2018.05)

IPC (8) Class/Subclass(es): G06F 1/26; G06F 1/20; G06F 1/30; G06F 1/32 (2018.01)

U.S. Class/Subclass(es): 713/300; 361/679.46; 361/679.02

See Global Search Results.

Global Patent Literature Text Search

The Patent Analyst performed the following global text search, which was not limited by classification but may or may not have been limited by other criteria:

Questel Orbit: https://www.orbit.com

#	Search query	Results
1	((LANCIUM)/PA/OPA)	0
2	((HENSON 2D DAVID)/IN/OIN/INH/INV)	25
3	((MCNAMARA 2D MICHAEL)/IN/OIN/INH/INV)	98
4	((CLINE 2D RAYMOND)/IN/OIN/INH/INV)	0
5	2 OR 3	123
6	(US20080094797)/PN	1
7	5 AND (DATA W CENTER)	0
8	5 AND (DATACENTER)	0
9	((DATACENTER OR (DATA W CENTER)) AND (BEHIND 4D METER))/TX	44
10	((DATACENTER OR (DATA W CENTER)) S (MOBILE))/TX	9804
11	((DATACENTER OR (DATA W CENTER)) S (MOBILE))/TX AND (POWER 2D DISTRIBUT+)/TX	457
12	(G06F-001/20)/IPC	37030
13	(G06F-001/20)/CPC	10635
14	(H05K-007/1485)/CPC	94
15	(H05K-007/1497)/CPC	303
16	(US20100211810)/PN	1
17	(G06F-001/26)/IPC	33369
18	(G06F-001/26)/CPC	9420

19	(713300)/PCL	6605
20	(361679020)/PCL	1569
21	(361679460)/PCL	903
22	(G06F-001/30)/IPC	6761
23	(G06F-001/32)/IPC	28657
24	12 OR 13 OR 14 OR 15 OR 17 OR 18 OR 19 OR 20 OR 21 OR 22 OR 23	100164
25	24 AND ((DATACENTER OR (DATA W CENTER)) S (MOBILE))/TX	268
26	24 AND ((DATACENTER OR (DATA W CENTER)) S (MOBILE))/TX AND (POWER 2D DISTRIBUT+)/TX	98

Google Patents: https://patents.google.com

#	Search query	Results
1	METHOD AND SYSTEM FOR DYNAMIC POWER DELIVERY TO A FLEXIBLE DATACENTER USING UNUTILIZED ENERGY SOURCES	100+
2	mobile container data center three phase power climate control	100+
3	data centers power remotely controlled	100+
4	solar energy three phase inverter "step-up transformer"	100+
5	step down transformer three phase to nominal supervisory single phase	100+
6	datacenter ac to ac step down three phase	100+

Computer Accessed Text Databases Searched

The Patent Analyst searched the following computer accessed text databases:

Google Scholar: https://scholar.google.com/

#	Search query	Results
1	METHOD AND SYSTEM FOR DYNAMIC POWER DELIVERY TO A FLEXIBLE DATACENTER USING UNUTILIZED ENERGY SOURCES	100+
2	mobile container data center three phase power climate control	100+
3	data centers power remotely controlled	100+

Date search was completed: 14 May 2018

SV/CC

PATENT COOPERATION TREATY

From the
INTERNATIONAL SEARCHING AUTHORITY

To: BASIL ANGELO
ANGELO MIKESKA PLLC
21 WATERWAY AVENUE, SUITE 300
THE WOODLANDS, TX 77380

PCT

WRITTEN OPINION OF THE
INTERNATIONAL SEARCHING AUTHORITY

(PCT Rule 43*bis*.1)

Date of mailing *(day/month/year)*	31 MAY 2018
Applicant's or agent's file reference 01128-000002 PCT	**FOR FURTHER ACTION** See paragraph 2 below

International application No.	International filing date *(day/month/year)*	Priority date *(day/month/year)*
PCT/US2018/017950	13 February 2018	11 January 2018

International Patent Classification (IPC) or both national classification and IPC
IPC(8) - G06F 1/26; G06F 1/20; G06F 1/30; G06F 1/32 (2018.01)
CPC - G06F 1/26; H05K 7/1497; G06F 1/20; H05K 7/1485 (2018.05)

Applicant LANCIUM LLC

1. This opinion contains indications relating to the following items:

- ☒ 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
- ☒ 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
- ☐ 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	14 May 2018	Blaine R. Copenheaver PCT Helpdesk: 571-272-4300 PCT OSP: 571-272-7774

Form PCT/ISA/237 (cover sheet) (January 2015)

WRITTEN OPINION OF THE INTERNATIONAL SEARCHING AUTHORITY

International application No.
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Box No. I Basis of this opinion

1. With regard to the **language**, this opinion has been established on the basis of:
   - [X] 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

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Box No. IV Lack of unity of invention

1. ☒ In response to the invitation (Form PCT/ISA/206) to pay additional fees the applicant has, within the applicable time limit:

   ☐ paid additional fees.

   ☐ paid additional fees under protest and, where applicable, the protest fee.

   ☐ paid additional fees under protest but the applicable protest fee was not paid.

   ☒ not paid additional fees.

2. ☐ This Authority found that the requirement of unity of invention is not complied with and chose not to invite the applicant to pay additional fees.

3. This Authority considers that the requirement of unity of invention in accordance with Rule 13.1, 13.2 and 13.3 is

   ☐ complied with.

   ☒ not complied with for the following reasons:

This application contains the following inventions or groups of inventions which are not so linked as to form a single general inventive concept under PCT Rule 13.1. In order for all inventions to be examined, the appropriate additional examination fees must be paid.

Group I, claims 1-24, are drawn to a flexible datacenter comprising: a mobile container; and a behind-the-meter power input system.

Group II, claims 25-34, are drawn to a method of dynamic power delivery to a flexible datacenter using unutilized behind-the meter power comprising: monitoring unutllized behind-the-meter power availability; and determining when a datacenter ramp-up condition is met.

The inventions listed as Groups I-II do not relate to a single general inventive concept under PCT Rule 13.1 because, under PCT Rule 13.2, they lack the same or corresponding special technical features for the following reasons: the special technical feature of the Group I invention: a flexible datacenter comprising: a mobile container; a behind-the-meter power input system; a power distribution system; a datacenter control system; and a climate control system, wherein the datacenter control system modulates power delivery to the plurality of computing systems as claimed therein is not present in the invention of Group II. The special technical feature of the Group II invention: monitoring unutllized behind-the-meter power availability; determining when a datacenter ramp-up condition is met; enabling behind-the-meter power delivery to one or more computing systems when the datacenter ramp-up condition is met; and directing the one or more computing systems to perform predetermined computational operations as claimed therein is not present in the invention of Group I.

Groups I and II lack unity of invention because even though the inventions of these groups require the technical feature of a flexible datacenter comprising one or more computing systems; and power delivery to the flexible datacenter using unutilized behind-the meter power availability, this technical feature is not a special technical feature as it does not make a contribution over the prior art.

Specifically, US 2010/0328849 to Ewing teaches a datacenter comprising one or more computing systems; and power delivery to the datacenter using power availability (if a server demands 500 watts and the PUE for the datacenter is 3.0, then the power from the utility grid needed to deliver 500 watts to the server is 1500 watts. The DCIE, in comparison, may provide a different aspect of this information, a DCIE value of 0.33 (equivalent to a PUE of 3.0) suggesting that the computing equipment consumes 33% of the power in the data center, para.0060). Further, US 2013/0306276 to Duchesneau teaches a flexible datacenter (supercomputing datacenter, Para. [0315. Maximum flexibility, para. 1500]); and using unutilized behind-the meter power availability (PERKS is hybrid energy system combining UPS with a peak-shaving system that directly captures excess or low-cost energy from a multiplicity of sources (when it is cheapest or most readily available) and stores it for later reuse, such as during peak periods, Para. [1456]. Note that excess energy is hereby "unutilized behind the meter power" as defined by applicant in Para [0041] of the specification of the present application).

Since none of the special technical features of the Group I or II inventions are found in more than one of the inventions, unity of invention is lacking.

4. Consequently, this opinion has been established in respect of the following parts of the international application:

   ☐ all parts.

   ☒ the parts relating to claims Nos. 1-24

Form PCT/ISA/237 (Box No. IV) (January 2015)

WRITTEN OPINION OF THE INTERNATIONAL SEARCHING AUTHORITY

International application No.
PCT/US2018/017950

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	2-6, 8-14, 19, 23, 24	YES
	Claims	1, 7, 15-18, 20-22	NO
Inventive step (IS)	Claims	None	YES
	Claims	1-24	NO
Industrial applicability (IA)	Claims	1-24	YES
	Claims	None	NO

2. Citations and explanations:

Claims 1, 7, 15-18, and 20-22 lack novelty under PCT Article 33(2) as being anticipated by Coglitore et al. (hereinafter Coglitore).

Regarding Claim 1, Coglitore discloses a flexible datacenter (Container-based data center, Title; a canopy 700 is used to shade the container-based data center modules 100 contained inside the canopy 700 [flexible/modular datacenter], para 0062; also see Fig. 7) comprising: a mobile container (The data center module 100 may comprise a housing 102 which may be, for example, a standard or modified shipping container, para 0028); a behind-the-meter power input system (the primary power 901 for the data center 900 is provided by the biogas-fueled power-generation equipment ["behind-the-meter power system, see para 0041 of Applicants specs], para 0066; also see Fig. 9); a power distribution system (One or more power distribution units (PDU) may be housed in the data center module 100 for receiving the three-phase power., para 0032); a datacenter control system (The data center module 100 may include some or all of the components necessary for operating a data center. In particular, the data center module 100 may provide one or more the following services: power, cooling, network connectivity, and the physical structure for housing all of the equipment in the data center 100, required servers and networking equipment is included in the installed hardware, para 0030-0031; a workstation for an administrator is also provided, para. 0035); a plurality of computing systems (A plurality of computers 200 may be provided in the data center module 100 in a variety of configurations, para 0034); and a climate control system (a plurality of computers 200 mounted on rack assemblies 220, para 0046; air mover modules 230 are provided for drawing the air out of the exhaust region 214. The air mover modules 230 may comprise a fan assembly portion 232 and a cooling portion 234. The fan assembly portion 232may comprise a plurality of air movers (such as, e.g., fans 236; which are provided along the vertical length of the rack assembly 220, para 0041; also see Fig. 4), wherein the datacenter control system modulates power delivery to the plurality of computing systems based on unutilized behind-the-meter power availability or an operational directive (the primary power 901 may be operated to produce more power than is consumed by the data center. In this case, the excess power may be provided back to the utility company for utility credits or other compensation. In other embodiments, the primary power 901 is used for "peak shaving", in which the primary power 901 is utilized when energy costs are high, and the utility feed 903 is used when energy costs are low. In some cases, the use of biogas may provide Environmental Protection Agency Clean Air Credits, which may be sold to other companies if not needed by the data center operator, para 0066; a workstation is provided for an administrator, para. 0035 [thus providing control from a computing system on operational directive by the administrator]).

Regarding Claim 7, Coglitore discloses the flexible datacenter of claim 1, wherein the behind-the-meter power input system provides three-phases of the three-phase nominal AC voltage to the power distribution system (The power can be supplied using one or more utility feeds providing, e.g., 100A [nominal value] three-phase power. One or more power distribution units (PDU) may be housed in the data center module 100 for receiving the three-phase power., para 0032).

Regarding Claim 15, Coglitore discloses the flexible datacenter of claim 1, wherein unutilized behind-the-meter power availability comprises one or more of excess local power generation at a local station level, excess local power generation that a grid cannot receive, local power generation subject to economic curtailment, local power generation subject to reliability curtailment, local power generation subject to power factor correction, low local power generation, start up local power generation situations, transient local power generation situations, or testing local power generation situations where there is an economic advantage to using local behind-the-meter power generation to power the flexible datacenter (the primary power 901 for the data center 900 is provided by the biogas-fueled power-generation equipment. In some cases, the primary power 901 may be operated to produce more power than is consumed by the data center. In this case, the excess power may be provided back to the utility company for utility credits or other compensation. In other embodiments, the primary power 901 is used for "peak shaving", in which the primary power 901 is utilized when energy costs are high, and the utility feed 903 is used when energy costs are low. In some cases, the use of biogas may provide Environmental Protection Agency Clean Air Credits, which may be sold to other companies if not needed by the data center operator., para 0066).

Regarding Claim 16, Coglitore discloses the flexible datacenter of claim 1, wherein an operational directive comprises one or more of a local station directive, a remote master control directive, or a grid directive (the primary power 901 for the data center 900 is provided by the biogas-fueled power-generation equipment... the primary power 901 is used for "peak shaving", in which the primary power 901 is utilized when energy costs are high, and the utility feed 903 is used when energy costs are low [local directive], para 0066).

Regarding Claim 17, Coglitore discloses the flexible datacenter of claim 1, wherein an operational directive comprises one or more of a dispatchability directive or a forecast directive (the primary power 901 for the data center 900 is provided by the biogas-fueled power-generation equipment... the primary power 901 is used for "peak shaving", in which the primary power 901 is utilized when energy costs are high, and the utility feed 903 is used when energy costs are low [dispatchability directive, to change the source based on market needs and costs], para 0066).

WRITTEN OPINION OF THE INTERNATIONAL SEARCHING AUTHORITY

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Supplemental Box

In case **the space in any of the preceding boxes is not sufficient.**
Continuation of:

Regarding Claim 18, Coglitore discloses the flexible datacenter of claim 1, wherein an operational directive comprises a workload directive based on actual behind-the-meter power availability or projected behind-themeter power availability (the biogas-based primary power 901 provides all of the power utilized by the datacenter during normal operation. In the event of a failure in the power system, the data center may then utilize the utility feed 903 as an instantaneous uninterruptable power supply (UPS) [based on actual behind-the-meter power availability], para 0067).

Regarding Claim 20, Coglitore discloses the flexible datacenter of claim 1, wherein the climate control system comprises a computer room air conditioner system, a computer room air handler system, an evaporative cooling system, a refrigerant cooling system, an immersive cooling system, or any other suitable heat extraction system configured to operate the plurality of computing systems within their operational temperature range (FIG. 4 shows a cooling system that may be used in accordance with example embodiments. In the embodiment shown, the cooling portion 234 comprises a radiator 236 which receives a heat transfer medium, such as a liquid coolant (e.g., water), from intake line 410, and expels the heat transfer medium via outlet line 420. Each radiator 236 may be connected to the intake line 410 via a valve 412 and outlet line 420 via valve 422. The valves 412, 422 may be provided to enable rapid replacement of failed radiators. The heat transfer medium (e.g., cooled water) passes through the radiator 236, where heat from the exhaust air drawn through the air mover modules 230 is absorbed by the heat transfer medium, thereby cooling the exhaust air. The cooled exhaust air is emitted into the central aisle 212, where it is again drawn into the front sides of the computers 200. The heat transfer medium is routed to a cooling system 450 via the outlet line 420. The cooling system 450 removes the heat from the heat transfer medium and returns the heat transfer medium to the intake line 410. A condensation collector and drain may be provided at the bottom of each radiator 236 in order to collect and remove any condensation that may be formed in the air mover modules 230, para 0042; also see Fig. 4).

Regarding Claim 21, Coglitore discloses the flexible datacenter of claim 1, wherein the mobile container comprises a storage container configured for placement on a ground surface (FIG. 3A is a perspective view of the data center module 100 with the walls of the housing 102 shown as semi-transparent for clarity, para 0034; also see Fig. 3A).

Regarding Claim 22, Coglitore discloses the flexible datacenter of claim 1, wherein the mobile container comprises a storage trailer on wheels (see Fig. 7 [shipping containers can be transported using wheels and attaching to a truck]).

Claims 2 and 19 lack an inventive step under PCT Article 33(3) as being obvious over Coglitore et al. (hereinafter Coglitore) in view of Zacho.

Regarding Claim 2, Coglitore fails to disclose the flexible datacenter of claim 1, further comprising: a remote master control system. Zacho is in the field of power supply and data center control (para 0003) and teaches a remote master control system (data center controller 310 can be located within one or more data centers 200, or remotely located external to data centers 200, para 0036). It would have been obvious to one of ordinary skill in the art at the time of the invention to modify Coglitore with the teaching of Zacho for the purpose of being able to remotely monitor a plurality of datacenter from a centralized facility (see Zacho, para 0063).

Regarding Claim 19, modified Coglitore fails to disclose the flexible datacenter of claim 2, wherein the remote master control system dynamically adjusts power delivery to the flexible datacenter based on a remote master control directive. Zacho teaches wherein the remote master control system dynamically adjusts power delivery to the flexible datacenter based on a remote master control directive (data center controller 310 controls power distribution within one or more data centers 200 by allocating virtual servers based on power supplies and requirements, and distributing power as appropriate to, for example, balance load distribution or regulate data center temperature, para 0097; data center controller 310 can be located within one or more data centers 200, or remotely located external to data centers 200, para 0036). It would have been obvious to one of ordinary skill in the art at the time of the invention to modify Coglitore with the teaching of Zacho for the purpose of remotely balancing load distribution (see Zacho, paras 0063 and 0036).

Claims 3-6, 8-11, 13, 14, and 23 lack an inventive step under PCT Article 33(3) as being obvious over Coglitore et al. (hereinafter Coglitore) in view of Whitted et al. (hereinafter Whitted).

Regarding Claim 3, Coglitore fails to disclose the flexible datacenter of claim 1, wherein the behind-the-meter power input system comprises an input configured to receive three-phase behind-the-meter AC voltage and a supervisory AC-to-AC step-down transformer configured to step down the three-phase behind-the-meter AC voltage to a single-phase supervisory nominal AC voltage or an input configured to receive single-phase supervisory nominal AC voltage from a local station or metered source. Whitted is in the field of a power distribution architecture for data centers (para 0002) and teaches wherein the behind-the-meter power input system comprises an input configured to receive three-phase behind-the-meter AC voltage and a supervisory AC-to-AC step-down transformer configured to step down the three-phase behind-the-meter AC voltage to a single-phase supervisory nominal AC voltage (The AC input voltage signal can be originated from one or more electric generator types selected from the group consisting of: a generator in an electric utility plant; a gas turbine; a steam turbine; a wind turbine; a water turbine; a solar cell; an electronic circuit; a flywheel; and, a fuel-powered motor-generator. The AC input voltage signal can include a phase voltage signal and a neutral signal from a three phase AC system., para 0011; In the data center 105, individual phase voltages (e.g., 208 V line-to-neutral) are routed to the individual racks 125A-125C. Suitable AC-to-AC transformers (not shown) may be employed, as necessary, to deliver the AC power at a specified AC voltage. For example, step-down transformers may transform AC power from high voltage levels suitable for transmission to levels that can be substantially directly applied to the UPS 115 [nominal value], para 0038; The operations may further be performed under the control, supervision, and/or monitoring of one or more of the processors, para 0077). It would have been obvious to one of ordinary skill in the art at the time of the invention to modify Coglitore with the teaching of Whitted for the purpose of being able to route any practical number of phases to provide operating power to individual computer trays of the datacenter (see Whitted, para 0031)

WRITTEN OPINION OF THE INTERNATIONAL SEARCHING AUTHORITY

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Supplemental Box

In case **the space in any of the preceding boxes is not sufficient.**
Continuation of:

Regarding Claim 4, modified Coglitore fails to disclose the flexible datacenter of claim 3, wherein the behind-the-meter power input system provides the single-phase supervisory nominal AC voltage to the datacenter control system. Whitted teaches wherein the behind-the-meter power input system provides the single-phase supervisory nominal AC voltage to the datacenter control system (one phase voltage and a neutral line are distributed to each rack 125. The racks 125 and trays 110 may be configured in to form a substantially balanced load, para 0040; also see Fig. 3 [phase voltage sent to control system of UPS]). It would have been obvious to one of ordinary skill in the art at the time of the invention to modify Coglitore with the teaching of Whitted for the purpose of controlling the application of the practical number of phases to provide operating power to individual computer trays of the datacenter (see Whitted, paras 0031 and 0077).

Regarding Claim 5, Coglitore fails to disclose the flexible datacenter of claim 1, wherein the behind-the-meter power input system comprises an input configured to receive three-phase behind-the-meter AC voltage and an operational AC-to-AC step-down transformer configured to controllably step down the three-phase behind-the-meter AC voltage to three-phase nominal AC voltage. Whitted teaches wherein the behind-the-meter power input system comprises an input configured to receive three-phase behind-the-meter AC voltage and an operational AC-to-AC step-down transformer configured to controllably step down the three-phase behind-the-meter AC voltage to three-phase nominal AC voltage (The racks 125A-125C may be powered by three phase AC power line voltages that are delivered to the data center 105... Suitable AC-to-AC transformers (not shown) may be employed, as necessary, to deliver the AC power at a specified AC voltage. For example, step-down transformers may transform AC power from high voltage levels suitable for transmission to levels that can be substantially directly applied to the UPS 115, para 0038). It would have been obvious to one of ordinary skill in the art at the time of the invention to modify Coglitore with the teaching of Whitted for the purpose of poviding the AC power at the suitable voltage level for application to the devices (see Whitted, para 0038).

Regarding Claim 6, modified Coglitore fails to disclose the flexible datacenter of claim 5, wherein the datacenter control system controllably enables or disables generation of the three-phase nominal AC voltage by the operational AC-to-AC step-down transformer. Whitted teaches wherein the datacenter control system controllably enables or disables generation of voltage by a converter (When switching from AC input operation to battery operation, the UPS 115 may, in some embodiments, disable operation of the AC-to-DC converter before, substantially during, or after the battery 185is connected across the DC bus 175. If all the converter 175 output current passes through a series diode, for example, then the converter 175 may be disabled by simply disabling operation of the DC-to-DC switching, para 0099). It would have been obvious to one of ordinary skill in the art at the time of the invention to modify Coglitore with the teaching of Whitted for the purpose of switching between different modes of operation based on available power (see Whitted, para 0099).

Regarding Claim 8, Coglitore fails to disclose the flexible datacenter of claim 7, wherein the power distribution system controllably provides a single phase of the three-phase nominal AC voltage to each computing system of the plurality of computing systems. Whitted teaches wherein the power distribution system controllably provides a single phase of the three-phase nominal AC voltage to each computing system of the plurality of computing systems (In the data center 105, individual phase voltages (e.g., 208 V line-to-neutral) are routed to the individual racks 125A-125C, para 0038; In the depicted example, one phase voltage and a neutral line are distributed to each rack 125. The racks 125 and trays 110 may be configured in to form a substantially balanced load. , para 0040). It would have been obvious to one of ordinary skill in the art at the time of the invention to modify Coglitore with the teaching of Whitted for the purpose of controlling the application of the practical number of phases to provide operating power to individual computer trays of the datacenter (see Whitted, paras 0031 and 0077).

Regarding Claim 9, Coglitore fails to disclose the flexible data center of claim 7, wherein the datacenter control system controllably selects which phase of the three-phase nominal AC voltage the power distribution system provides to each computing system of the plurality of computing systems. Whitted teaches wherein the datacenter control system controllably selects which phase of the three-phase nominal AC voltage the power distribution system provides to each computing system of the plurality of computing systems (In the data center 105, individual phase voltages (e.g., 208 V line-to-neutral) are routed to the individual racks 125A-125C, para 0038; In the depicted example, one phase voltage and a neutral line are distributed to each rack 125. The racks 125 and trays 110 may be configured in to form a substantially balanced load... As an example, the exemplary tray 110 (shown in magnified detail) in the rack 125A receives a phase A voltage and the neutral line, para 0040). It would have been obvious to one of ordinary skill in the art at the time of the invention to modify Coglitore with the teaching of Whitted for the purpose of controlling the application of the practical number of phases to provide operating power to individual computer trays of the datacenter (see Whitted, paras 0031 and 0077).

Regarding Claim 10, Coglitore fails to disclose the flexible datacenter of claim 7, wherein the datacenter control system modulates a power factor correction factor by controllably adjusting which phase of the three-phase nominal AC voltage each computing system of the plurality of computing systems receive. Whitted teaches wherein the datacenter control system modulates a power factor correction factor by controllably adjusting which phase of the three-phase nominal AC voltage each computing system of the plurality of computing systems receive (In the data center 105, individual phase voltages (e.g., 208 V line-to-neutral) are routed to the individual racks 125A-125C, para 0038; In the depicted example, one phase voltage and a neutral line are distributed to each rack 125. The racks 125 and trays 110 may be configured in to form a substantially balanced load... As an example, the exemplary tray 110 (shown in magnified detail) in the rack 125A receives a phase A voltage and the neutral line, para 0040; , the converter 170 may incorporate hardware, software, or a combination thereof, to provide power factor correction [with balanced load by adjusting which phase goes to which rack], para 0096). It would have been obvious to one of ordinary skill in the art at the time of the invention to modify Coglitore with the teaching of Whitted for the purpose of controlling the application of the practical number of phases to provide operating power to individual computer trays of the datacenter in order to obtain a balanced load and improve power factor corrections (see Whitted, paras 0040 and 0096).

WRITTEN OPINION OF THE INTERNATIONAL SEARCHING AUTHORITY

International application No.
PCT/US2018/017950

Supplemental Box

In case the space in any of the preceding boxes is not sufficient.
Continuation of:

Regarding Claim 11, modified Coglitore fails to explicitly disclose the flexible datacenter of claim 5, wherein the three-phase behind-the-meter AC voltage comprises a three-phase wind-generated AC voltage output by one or more wind turbines prior to an AC-to-AC step-up transformer that steps up the three-phase wind-generated AC voltage to a three-phase grid AC voltage. Whitted teaches wherein the three-phase behind-the-meter AC voltage comprises a three-phase wind-generated AC voltage output by one or more wind turbines prior to an AC-to-AC step-up transformer that steps up the three-phase wind-generated AC voltage to a three-phase grid AC voltage (The AC input voltage signal can be... a wind turbine, para 0011; Suitable AC-to-AC transformers (not shown) may be employed, as necessary, to deliver the AC power at a specified AC voltage, para 0038; Wind or solar generated energy, such as that provided by a wind farm or a solar farm, respectively, may serve as sources of energy to generate a substantially sinusoidal AC voltage in an electric utility grid. In such implementations, the generated substantially sinusoidal signal is transmitted through the utility grid to an input, para 0051; If the battery voltage is above the set-point voltage, then the charger may include a step-up and/or buck-boost type converter circuit., para 0089). It would have been obvious to one of ordinary skill in the art at the time of the invention to modify Coglitore with the teaching of Whitted for the purpose of using a renewable source such as wind, and obtaining the required voltage for the UPS system of the datacenter (see Whitted, paras 0051 and 0089).

Regarding Claim 13, Coglitore discloses the flexible datacenter of claim 5, wherein the three-phase behind-the-meter AC voltage comprises a three-phase gas-generated AC voltage output by a generator that inputs combustible gas diverted from a flare or venting system (Methane forms in a landfill site when organic waste decomposes in the absence of oxygen. The biogas can be collected [venting system] and used as fuel for microturbine energy systems, which can provide power for the data center, para 0064; the biogas is used to fuel a cogeneration system, or combined heat and power (CHP) system. This CHP system may be used to simultaneously generate both heat and electricity. The electricity is used to directly power the computers and other equipment in the data center [AC voltage output by generator], para 0065).

Regarding Claim 14, modified Coglitore discloses the flexible datacenter of claim 5, wherein the three-phase behind-the-meter AC voltage is a three-phase metered AC voltage (the primary power 901 may be operated to produce more power than is consumed by the data center. In this case, the excess power may be provided back to the utility company for utility credits or other compensation.... the use of biogas may provide Environmental Protection Agency Clean Air Credits, which may be sold to other companies if not needed by the data center operator [metered power], para 0066)

Regarding Claim 23, modified Coglitore fails to disclose the flexible datacenter of claim 5, further comprising a battery system configured to convert the three-phase nominal AC voltage to DC nominal voltage and store power in a plurality of storage cells. Whitted teaches a battery system configured to convert the three-phase nominal AC voltage to DC nominal voltage and store power in a plurality of storage cells (The UPS 115 includes an AC-to-DC converter 170 that converts the AC input voltage signal to a regulated DC voltage, para 0046; the battery 185 is charged using power received from the DC bus 175, para 0098; the AC-to-DC converter may regulate to a set point voltage that is within 50, 100, 200, 250, 400, 500, . . . , 1000 mV of the battery's nominal fully charged voltage, para 0089; The battery 185 may be a single cell, or a combination of cells arranged in series and/or parallel. , para 0093). It would have been obvious to one of ordinary skill in the art at the time of the invention to modify Coglitore with the teaching of Whitted for the purpose of using a backup source during a fault condition in which an AC input voltage signal falls outside of a normal operating range (see Whitted, para 0020).

Claim 12 lacks an inventive step under PCT Article 33(3) as being obvious over Coglitore et al. (hereinafter Coglitore) in view of Whitted et al. (hereinafter Whitted) and Xiao et al. (hereinafter Xiao).

Regarding Claim 12, modified Coglitore fails to disclose the flexible datacenter of claim 5, wherein the three-phase behind-the-meter AC voltage comprises a three-phase solar-generated AC voltage output by a DC-to-AC inverter that inputs solar-generated DC voltage from one or more solar panels and prior to an AC-toAC step-up transformer that steps up the three-phase solar-generated AC voltage to a three-phase grid AC voltage. Xiao is in the field of photovoltaic power conversion systems (para 0002) and teaches a three-phase solar-generated AC voltage output by a DC-to-AC inverter that inputs solar-generated DC voltage from one or more solar panels (The current source inverters 14 may operate to convert the direct current (DC) power generated by the solar cells 12 into alternating current (AC) power. In some embodiments, the current source inverters 14 may be specific control rectifier current source inverters 14, specifically three phase specific control rectifier current source inverters 14 capable of generating three phase AC power and transmitting this power (e.g., electricity) along path 20, para 0015; also see Fig. 1) and prior to an AC-toAC step-up transformer that steps up the three-phase solar-generated AC voltage to a three-phase grid AC voltage (The power transmitted along path 20 is received by the transformer 18. The transformer 18 may be a step-up transformer that takes source voltage of a first voltage (e.g., 100-600 V, which can vary based on the number of solar cells 12 connected in series and can be selected to match the current source inverters 14/transformer 18 to a medium grid) and converts it to a higher voltage (e.g., medium voltage, for example, 2400 kV, 3300 kV, or another medium voltage value), para 0017; also see Fig. 1). It would have been obvious to one of ordinary skill in the art at the time of the invention to modify Coglitore with the teaching of Xiao for the purpose of using environmentally friendly solar panels, converting the electricity generated by solar cells into power directly usable by consumers or transmittable along a voltage power grid; and allowing for low voltage stress on the solar cells, which may allow for increased lifespan of the solar cells (see Xiao, paras 0003 and 0017).

WRITTEN OPINION OF THE INTERNATIONAL SEARCHING AUTHORITY

International application No.
PCT/US2018/017950

Supplemental Box

In case **the space in any of the preceding boxes is not sufficient.**
Continuation of:

Claim 24 lacks an inventive step under PCT Article 33(3) as being obvious over Coglitore et al. (hereinafter Coglitore) in view of Whitted et al. (hereinafter Whitted) and Inertech Ip Llc (hereinafter Inertech).

Regarding Claim 24, modified Coglitore fails to explicitly disclose the flexible datacenter of claim 23, wherein the DC nominal voltage from the plurality of storage cells are converted via a DC-to-AC inverter to three-phase nominal AC voltage for flexible datacenter use. Inertech is in the field of power control for data center loads (para 0002) and teaches wherein the DC nominal voltage from the plurality of storage cells are converted via a DC-to-AC inverter to three-phase nominal AC voltage for flexible datacenter use (FIG. 6 shows inverter 268 which may be used to convert the DC voltage output V2 from the converter 262 to three-phase AC voltage V3, para 0063; where load... is a data center load, para 0017). It would have been obvious to one of ordinary skill in the art at the time of the invention to modify Coglitore with the teaching of Inertech for the purpose of being able to use stored battery power to provide uninterrupted power supply to the datacenter (see Inertech, Abstract and para 0002).

Claims 1-24 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 Patent Application Fee Transmittal

Application Number:	
Filing Date:	
Title of Invention:	Method and System for Dynamic Power Delivery to a Flexible Datacenter Using Unutilized Energy Sources
First Named Inventor/Applicant Name:	David Henson
Filer:	Alexander D. Georges/Carol Neth
Attorney Docket Number:	18-874-WO1-US

Filed as Small Entity

Filing Fees for U.S. National Stage under 35 USC 371

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Basic Filing:				
BASIC NATIONAL STAGE FEE	2631	1	150	150
NATL STAGE SEARCH FEE - REPORT PROVIDED	2642	1	260	260
NATL STAGE EXAM FEE - ALL OTHER CASES	2633	1	380	380
Pages:				
Claims:				
CLAIMS IN EXCESS OF 20	2615	10	50	500
Miscellaneous-Filing:				
Petition:				

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Patent-Appeals-and-Interference:				
Post-Allowance-and-Post-Issuance:				
Extension-of-Time:				
Miscellaneous:				
		Total in USD ($)		**1290**

Electronic Acknowledgement Receipt	
EFS ID:	36742858
Application Number:	16482495
International Application Number:	PCT/US2018/017950
Confirmation Number:	7727
Title of Invention:	Method and System for Dynamic Power Delivery to a Flexible Datacenter Using Unutilized Energy Sources
First Named Inventor/Applicant Name:	David Henson
Customer Number:	20306
Filer:	Alexander D. Georges
Filer Authorized By:	
Attorney Docket Number:	18-874-WO1-US
Receipt Date:	31-JUL-2019
Filing Date:	
Time Stamp:	15:06:27
Application Type:	U.S. National Stage under 35 USC 371

Payment information:

Submitted with Payment	yes
Payment Type	CARD
Payment was successfully received in RAM	$1290
RAM confirmation Number	E20197UF07381144
Deposit Account	132490
Authorized User	Alexander Georges
The Director of the USPTO is hereby authorized to charge indicated fees and credit any overpayment as follows: 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)

37 CFR 1.492 (National application filing, search, and examination fees)

37 CFR 1.492(a) (Basic national fee only)

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Transmittal of New Application	18-874-WO1-US_371_Transmittal.pdf	276183 280a54c1660b6872e54c2d1a9b184925baf8a200	no	4
Warnings:					
Information:					
2	Application Data Sheet	18-874-WO1-US_ADS.pdf	1256408 af6fbc3ba26e7eeae7edc4bc33583b806c7ba431	no	9
Warnings:					
Information:					
3	Oath or Declaration filed	18-874-WO1-US_Declaration_Cline.pdf	152785 bf9661692a83906c1814dd7bb81adcc6c17dd5d3	no	2
Warnings:					
Information:					
4	Oath or Declaration filed	18-874-WO1-US_Declaration_Henson.pdf	399287 295a180b93982c4fedb1428f62bd22675d6ff5f1	no	1
Warnings:					
Information:					
5	Oath or Declaration filed	18-874-WO1-US_Declaration_McNamara.pdf	186863 85fcefd8a01d5ed5fa068c0a6ab715c0066adcd5	no	2
Warnings:					
Information:					
6		18-874-WO1-US_WO2019139632_PubAppln.pdf	3198554 5877f4c30d740ebc6fe94d90349431d24ebf470e	yes	44
	Multipart Description/PDF files in .zip description				
	Document Description		**Start**	**End**	

	Abstract		1	2	
	Specification		3	28	
	Claims		29	33	
	Drawings-only black and white line drawings		34	41	
	Documents submitted with 371 Applications		42	44	
Warnings:					
Information:					
7		18-874-WO1-US_PrelimAmendment.pdf	135034 84303899691ac82e786ddb15360730eebec9ca88	yes	10
	Multipart Description/PDF files in .zip description				
	Document Description		**Start**	**End**	
	Preliminary Amendment		1	1	
	Specification		2	2	
	Claims		3	9	
	Applicant Arguments/Remarks Made in an Amendment		10	10	
Warnings:					
Information:					
8	Information Disclosure Statement (IDS) Form (SB08)	18-874-WO1-US_IDS.pdf	1055747 c087f84fd5ed176a81a2c9e3c88b2d7f411d3719	no	9
Warnings:					
Information:					
9	Foreign Reference	CN103163904_EngAbstract.pdf	1124284 d952b77c23abb0938632b955ce0c1e92efcc2fae	no	15
Warnings:					
Information:					

10	Foreign Reference	WO2015199629_Reference.pdf	805686 55d206d86234158197fbd884b67fc87751d49b20	no	21
Warnings:					
Information:					
11	Non Patent Literature	Bird_NREL_reference.pdf	714271 29857ab70719d105b3c19094aba544837df981ea	no	58
Warnings:					
Information:					
12	Non Patent Literature	EpexSpot_website_basics_of_the_power_ma.pdf	124729 97d0f012c419bca00946d2718f2ce7412d75b01d	no	2
Warnings:					
Information:					
13	Other Reference-Patent/App/Search documents	PCTUS2018017955_ISR_WO_30APR2018.pdf	1970040 286b83f98b0b37d42cd9b7c20e6474e0a1e4ecf7	no	22
Warnings:					
Information:					
14	Other Reference-Patent/App/Search documents	PCTUS2018017950_ISR_WO_31MAY2018.pdf	936713 2b5764d9a8d0a9b22a9f160fce9e8fd47192ee89	no	15
Warnings:					
Information:					
15	Other Reference-Patent/App/Search documents	NOA_US16245532_29Jul2019_EFS.pdf	6619818 234eea06d2b38318e1aa39cf8572505b3263aebc	no	13
Warnings:					
Information:					
16	Other Reference-Patent/App/Search documents	NOA_US16175335_02Apr2019_EFS.pdf	6479843 898ea3c5ea78ab0a25137b9c7f7248a576415d60	no	12
Warnings:					
Information:					

17	Non Patent Literature	Soluna_reference.pdf	3663447 55622ea8c3723171a3fe45365f75903f632d10e6	no	29
Warnings:					
Information:					
18	Fee Worksheet (SB06)	fee-info.pdf	37477 2c3b9c1354e2f3dedef73048013d1fffabbcfb6a	no	2
Warnings:					
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		Total Files Size (in bytes):	29137169		

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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-1390 (01-18)
Approved for use through 8/31/2019. OMB 0651-0021
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
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TRANSMITTAL LETTER TO THE UNITED STATES DESIGNATED/ELECTED OFFICE (DO/EO/US) CONCERNING A SUBMISSION UNDER 35 U.S.C. 371

Attorney Docket No.	
18-874-WO1-US	
U.S. Application No. (if known, see 37 CFR 1.5)	

International Application No.	International Filing Date	Priority Date Claimed
PCT/US2018/017950	February 13, 2018	January 11, 2018

Title of Invention
Method and System for Dynamic Power Delivery to a Flexible Datacenter Using Unutilized Energy Sources

First Named Inventor
David Henson

Applicant herewith submits to the United States Designated/Elected Office (DO/EO/US) the following items and other information.

1. ☐ This is an express request to begin national examination procedures (35 U.S.C. 371(f)). NOTE: The express request under 35 U.S.C. 371(f) will not be effective unless the requirements under 35 U.S.C. 371(c)(1), (2), and (4) for payment of the basic national fee, copy of the International Application and English translation thereof (if required), and the oath or declaration of the inventor(s) have been received.
2. ■ A copy of the International Application (35 U.S.C. 371(c)(2)) is attached hereto (not required if the International Application was previously communicated by the International Bureau or was filed in the United States Receiving Office (RO/US)).
3. An English language translation of the International Application (35 U.S.C. 371(c)(2))
   a. ☐ is attached hereto.
   b. ☐ has been previously submitted under 35 U.S.C. 154(d)(4).
4. An oath or declaration of the inventor(s) (35 U.S.C. 371(c)(4))
   a. ■ is attached.
   b. ☐ was previously filed in the international phase under PCT Rule 4.17(iv).

Items 5 to 8 below concern amendments made in the international phase.

PCT Article 19 and 34 amendments

5. ☐ Amendments to the claims under PCT Article 19 are attached (not required if communicated by the International Bureau) (35 U.S.C. 371(c)(3)).
6. ☐ English translation of the PCT Article 19 amendment is attached (35 U.S.C. 371(c)(3)).
7. ☐ English translation of annexes (Article 19 and/or 34 amendments only) of the International Preliminary Examination Report is attached (35 U.S.C. 371(c)(5)).

Cancellation of amendments made in the international phase

8a. ☐ Do not enter the amendment made in the international phase under PCT Article 19.

8b. ☐ Do not enter the amendment made in the international phase under PCT Article 34.

NOTE: A proper amendment made in English under Article 19 or 34 will be entered in the U.S. national phase application absent a clear instruction from applicant not to enter the amendment(s).

The following items 9 to 17 concern a document(s) or information included.

9. ■ An Information Disclosure Statement under 37 CFR 1.97 and 1.98.
10. ■ A preliminary amendment.
11. ■ An Application Data Sheet under 37 CFR 1.76.
12. ☐ A substitute specification. NOTE: A substitute specification cannot include claims. See 37 CFR 1.125(b).
13. ☐ A power of attorney and/or change of address letter.
14. ☐ A computer-readable form of the sequence listing in accordance with PCT Rule 13*ter*.3 and 37 CFR 1.821-1.825 (not required if sequence listing in text format was indicated on the PCT Request as part of the International Application and the sequence listing was published as part of the international application).
15. ☐ Assignment papers *(cover sheet and document(s))*. Name of Assignee: _____
16. ☐ 37 CFR 3.73(c) Statement *(when there is an Assignee)*.

This collection of information is required by 37 CFR 1.414 and 1.491-1.492. 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 15 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.

U.S. APPLN. No. (if known – see 37 CFR 1.5)	INTERNATIONAL APPLICATION No.	ATTORNEY DOCKET No.
	PCT/US2018/017950	18-874-WO1-US

17. ☐ Other items or information:

The following fees have been submitted.	CALCULATIONS
18. ■ Basic national fee (37 CFR 1.492(a)) **$300**	$ 300.00
19. ■ Examination fee (37 CFR 1.492(c)) • If the written opinion prepared by ISA/US or the international preliminary examination report prepared by IPEA/US indicates all claims satisfy provisions of PCT Article 33(1)-(4)..... **$0** • All other situations **$760**	$ 760.00
20. ■ Search fee (37 CFR 1.492(b)) • If the written opinion prepared by ISA/US or the international preliminary examination report prepared by IPEA/US indicates all claims satisfy provisions of PCT Article 33(1)-(4)..... **$0** • Search fee (37 CFR 1.445(a)(2)) has been paid on the international application to the USPTO as an International Searching Authority .....**$140** • International Search Report prepared by an ISA other than the US and provided to the Office or previously communicated to the US by the IB.....**$520** • All other situations **$660**	520.00 $
TOTAL OF 18, 19, and 20 =	$ 1580.00
☐ Additional fee for specification and drawings filed in paper over 100 sheets (excluding sequence listing in compliance with 37 CFR 1.821(c) or (e) in an electronic medium or computer program listing in an electronic medium) (37 CFR 1.492(j)). Fee for each additional 50 sheets of paper or fraction thereof **$400**	

Total Sheets	Extra Sheets	Number of each additional 50 or fraction thereof (round **up** to a whole number)	RATE	
- 100 =	/ 50 =		x **$400**	$

Surcharge for furnishing any of the search fee, examination fee, or the oath or declaration after the date of commencement of the national stage (37 CFR 1.492(h))..... **$140**	$

CLAIMS	NUMBER FILED	NUMBER EXTRA	RATE	
Total claims	30 - 20 =	10	x **$100**	$ 1000.00
Independent claims	3 - 3 =	0	x **$460**	$
MULTIPLE DEPENDENT CLAIM(S) (if applicable)			**+ $820**	$

Fee for submission of Sequence Listing text file of 300 MB to 800 MB (37 CFR 1.21(o)(1))..... **$1,000**	$
Fee for submission of Sequence Listing text file of more than 800 MB (37 CFR 1.21(o)(2))..... **$10,000**	$
Processing fee for furnishing the English translation later than 30 months from the earliest claimed priority date (37 CFR 1.492(i))..... **$140 +**	$
TOTAL OF ABOVE CALCULATIONS =	$ 2580.00
■ **Applicant asserts small entity status.** See 37 CFR 1.27. Fees above are reduced by ½.	
☐ **Applicant certifies micro entity status.** See 37 CFR 1.29. Fees above are reduced by ¾. Applicant must attach form PTO/SB/15A or B or equivalent.	
TOTAL NATIONAL FEE =	$ 1290.00
Fee for recording the enclosed assignment (37 CFR 1.21(h)). The assignment must be accompanied by an appropriate cover sheet (37 CFR 3.28, 3.31)..... **$50.00** per property **+**	$
TOTAL FEES ENCLOSED =	$ 1290.00

a. ☐ A check in the amount of $_____ to cover the above fees is enclosed.

b. ☐ Please charge my Deposit Account No. _____ in the amount of $_____ to cover the above fees.

c. ☒ The Director is hereby authorized to charge additional fees which may be required, or credit any overpayment, to Deposit Account No. 13-2490 as follows:

i. ☒ any required fee.

ii. ☐ any required fee except for excess claims fees required under 37 CFR 1.492(d) and (e) and multiple dependent claim fee required under 37 CFR 1.492(f).

d. ☒ Fees are to be charged to a credit card. **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. The PTO-2038 should only be mailed or faxed to the USPTO. However, when paying the basic national fee, the PTO-2038 may NOT be faxed to the USPTO.

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NOTE: Where an appropriate time limit under 37 CFR 1.495 has not been met, a petition to revive (37 CFR 1.137(a) or (b)) must be filed and granted to restore the International Application to pending status.

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.

NOTE 1: By providing this statement under 37 CFR 1.55 or 1.78, **this application, with a filing date on or after March 16, 2013, will be examined under the first inventor to file provisions of the AIA**.

NOTE 2: A U.S. national stage application may not claim priority to the international application of which it is the national phase. The filing date of a U.S. national stage application is the international filing date. See 35 U.S.C. 363.

Correspondence Address

☒ The address associated with Customer Number: 20306 **OR** ☐ Correspondence address below

Name					
Address					
City		State		Zip Code	
Country			Telephone		
Email					

Signature	/Alexander D. Georges/	Date	July 31, 2019
Name (Print/Type)	Alexander D. Georges	Registration No. (Attorney/Agent)	70,534

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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Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it contains a valid OMB control number.

Application Data Sheet 37 CFR 1.76	Attorney Docket Number	18-874-WO1-US
	Application Number	
Title of Invention	Method and System for Dynamic Power Delivery to a Flexible Datacenter Using Unutilized Energy Sources	

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
	David		Henson	

Residence Information (Select One) ● US Residency ○ Non US Residency ○ Active US Military Service

City	State/Province	Country of Residence
The Woodlands	TX	US

Mailing Address of Inventor:

Address 1	Lancium LLC, c/o Angelo Mikeska PLLC
Address 2	21 Waterway Avenue

City	State/Province	Postal Code	Country
The Woodlands	TX	77380	US

Inventor 2 — Remove

Legal Name

Prefix	Given Name	Middle Name	Family Name	Suffix
	Michael		McNamara	

Residence Information (Select One) ◉ US Residency ○ Non US Residency ○ Active US Military Service

City	State/Province	Country of Residence
The Woodlands	TX	US

Mailing Address of Inventor:

Address 1	Lancium LLC, c/o Angelo Mikeska PLLC
Address 2	21 Waterway Avenue

City	State/Province	Postal Code	Country
The Woodlands	TX	77380	US

Inventor 3 — Remove

Legal Name

Prefix	Given Name	Middle Name	Family Name	Suffix
	Raymond		Cline	

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	18-874-WO1-US
	Application Number	
Title of Invention	Method and System for Dynamic Power Delivery to a Flexible Datacenter Using Unutilized Energy Sources	

City	The Woodlands	State/Province	TX	Country of Residence	US

Mailing Address of Inventor:

Address 1	Lancium LLC, c/o Angelo Mikeska PLLC		
Address 2	21 Waterway Avenue		
City	The Woodlands	**State/Province**	TX
Postal Code	77380	**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	20306		
Email Address	docketing@mbhb.com	Add Email	Remove Email

Application Information:

Title of the Invention	Method and System for Dynamic Power Delivery to a Flexible Datacenter Using Unutilized Energy Sources		
Attorney Docket Number	18-874-WO1-US	**Small Entity Status Claimed**	☒
Application Type	Nonprovisional		
Subject Matter	Utility		
Total Number of Drawing Sheets (if any)	8	**Suggested Figure for Publication (if any)**	

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	18-874-WO1-US
	Application Number	
Title of Invention	Method and System for Dynamic Power Delivery to a Flexible Datacenter Using Unutilized Energy Sources	

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	20306		

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)
	a 371 of international	PCT/US2018/017950	2018-02-13
Prior Application Status	Expired		Remove
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
PCT/US2018/017950	Claims benefit of provisional	62/616348	2018-01-11

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	18-874-WO1-US
	Application Number	
Title of Invention	Method and System for Dynamic Power Delivery to a Flexible Datacenter Using Unutilized Energy Sources	

Application Number	Country[i]	Filing Date (YYYY-MM-DD)	Access Code[i] (if applicable)

Remove

Additional Foreign Priority Data may be generated within this form by selecting the **Add** button. Add

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.
NOTE: By providing this statement under 37 CFR 1.55 or 1.78, this application, with a filing date on or after March 16, 2013, will be examined under the first inventor to file provisions of the AIA.

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Application Data Sheet 37 CFR 1.76	Attorney Docket Number	18-874-WO1-US
	Application Number	
Title of Invention	Method and System for Dynamic Power Delivery to a Flexible Datacenter Using Unutilized Energy Sources	

Authorization or Opt-Out of Authorization to Permit Access:

When this Application Data Sheet is properly signed and filed with the application, applicant has provided written authority to permit a participating foreign intellectual property (IP) office access to the instant application-as-filed (see paragraph A in subsection 1 below) and the European Patent Office (EPO) access to any search results from the instant application (see paragraph B in subsection 1 below).

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.

NOTE: This section of the Application Data Sheet is **ONLY** reviewed and processed with the **INITIAL** filing of an application. After the initial filing of an application, an Application Data Sheet cannot be used to provide or rescind authorization for access by a foreign IP office(s). Instead, Form PTO/SB/39 or PTO/SB/69 must be used as appropriate.

1. Authorization to Permit Access by a Foreign Intellectual Property Office(s)

A. Priority Document Exchange (PDX) - Unless box A in subsection 2 (opt-out of authorization) is checked, the undersigned hereby **grants the USPTO authority** to provide the European Patent Office (EPO), the Japan Patent Office (JPO), the Korean Intellectual Property Office (KIPO), the State Intellectual Property Office of the People's Republic of China (SIPO), the World Intellectual Property Organization (WIPO), and any other foreign intellectual property office participating with the USPTO in a bilateral or multilateral priority document exchange agreement in which a foreign application claiming priority to the instant patent application is filed, access to: (1) the instant patent application-as-filed and its related bibliographic data, (2) any foreign or domestic application to which priority or benefit is claimed by the instant application and its related bibliographic data, and (3) the date of filing of this Authorization. See 37 CFR 1.14(h)(1).

B. Search Results from U.S. Application to EPO - Unless box B in subsection 2 (opt-out of authorization) is checked, the undersigned hereby **grants the USPTO authority** to provide the EPO access to the bibliographic data and search results from the instant patent application when a European patent application claiming priority to the instant patent application is filed. See 37 CFR 1.14(h)(2).

The applicant is reminded that the EPO's Rule 141(1) EPC (European Patent Convention) requires applicants to submit a copy of search results from the instant application without delay in a European patent application that claims priority to the instant application.

2. Opt-Out of Authorizations to Permit Access by a Foreign Intellectual Property Office(s)

☐ A. Applicant **DOES NOT** authorize the USPTO to permit a participating foreign IP office access to the instant application-as-filed. If this box is checked, the USPTO will not be providing a participating foreign IP office with any documents and information identified in subsection 1A above.

☐ B. Applicant **DOES NOT** authorize the USPTO to transmit to the EPO any search results from the instant patent application. If this box is checked, the USPTO will not be providing the EPO with search results from the instant application.

NOTE: Once the application has published or is otherwise publicly available, the USPTO may provide access to the application in accordance with 37 CFR 1.14.

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Application Data Sheet 37 CFR 1.76	Attorney Docket Number	18-874-WO1-US
	Application Number	
Title of Invention	Method and System for Dynamic Power Delivery to a Flexible Datacenter Using Unutilized Energy Sources	

Applicant Information:

Providing assignment information in this section does not substitute for compliance with any requirement of part 3 of Title 37 of CFR to have an assignment recorded by the Office.

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.

Clear

● 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. ☒

Organization Name	Lancium LLC		
Mailing Address Information For Applicant:			
Address 1	c/o Angelo Mikska PLLC		
Address 2	21 Waterway Avenue, Suite 300		
City	The Woodlands	**State/Province**	TX
Country	US	Postal Code	77380
Phone Number		Fax Number	
Email Address			

Additional Applicant Data may be generated within this form by selecting the Add button. Add

Assignee Information including Non-Applicant Assignee Information:

Providing assignment information in this section does not substitute for compliance with any requirement of part 3 of Title 37 of CFR to have an assignment recorded by the Office.

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Application Data Sheet 37 CFR 1.76	Attorney Docket Number	18-874-WO1-US
	Application Number	
Title of Invention	Method and System for Dynamic Power Delivery to a Flexible Datacenter Using Unutilized Energy Sources	

Assignee 1

Complete this section if assignee information, including non-applicant assignee information, is desired to be included on the patent application publication. An assignee-applicant identified in the "Applicant Information" section will appear on the patent application publication as an applicant. For an assignee-applicant, complete this section only if identification as an assignee is also desired on the patent application publication.

Remove

If the Assignee or Non-Applicant Assignee is an Organization check here. ☐

Prefix	**Given Name**	Middle Name	**Family Name**	Suffix

Mailing Address Information For Assignee including Non-Applicant Assignee:

Address 1			
Address 2			
City		**State/Province**	
Country i		Postal Code	
Phone Number		Fax Number	
Email Address			

Additional Assignee or Non-Applicant Assignee Data may be generated within this form by selecting the Add button. Add

Signature:

Remove

NOTE: This Application Data Sheet must be signed in accordance with 37 CFR 1.33(b). **However, if this Application Data Sheet is submitted with the INITIAL filing of the application and either box A or B is not checked in subsection 2 of the "Authorization or Opt-Out of Authorization to Permit Access" section, then this form must also be signed in accordance with 37 CFR 1.14(c).**

This Application Data Sheet **must** be signed by a patent practitioner if one or more of the applicants is a **juristic entity** (e.g., corporation or association). If the applicant is two or more joint inventors, this form must be signed by a patent practitioner, **all** joint inventors who are the applicant, or one or more joint inventor-applicants who have been given power of attorney (e.g., see USPTO Form PTO/AIA/81) on behalf of **all** joint inventor-applicants.

See 37 CFR 1.4(d) for the manner of making signatures and certifications.

Signature	/Alexander D. Georges/			Date (YYYY-MM-DD)	2019-07-31
First Name	Alexander D.	Last Name	Georges	Registration Number	70,534

Additional Signature may be generated within this form by selecting the Add button. Add

PTO/AIA/14 (02-18)
Approved for use through 11/30/2020. OMB 0651-0032
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
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Application Data Sheet 37 CFR 1.76	Attorney Docket Number	18-874-WO1-US
	Application Number	
Title of Invention	Method and System for Dynamic Power Delivery to a Flexible Datacenter Using Unutilized Energy Sources	

This collection of information is required by 37 CFR 1.76. 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 23 minutes to complete, including gathering, preparing, and submitting the completed application data sheet 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.**

Privacy Act Statement

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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 the Freedom of Information Act requires disclosure of these records.

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 CooperationTreaty.

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 inspections 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	METHOD AND SYSTEM FOR DYNAMIC POWER DELIVERY TO A FLEXIBLE DATACENTER USING UNUTILZED ENERGY SOURCES

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: Raymond Cline Date (Optional): 7/8/2019

Signature: _____

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.

PTO/AIA/01 (06-12)
Approved for use through 01/31/2014. 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.

DECLARATION (37 CFR 1.63) FOR UTILITY OR DESIGN APPLICATION USING AN APPLICATION DATA SHEET (37 CFR 1.76)

Title of Invention	METHOD AND SYSTEM FOR DYNAMIC POWER DELIVERY TO A FLEXIBLE DATACENTER USING UNUTILZED ENERGY SOURCES

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: David Henson Date (Optional) _____

Signature: _____

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.**

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PTO/AIA/01 (06-12)
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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	METHOD AND SYSTEM FOR DYNAMIC POWER DELIVERY TO A FLEXIBLE DATACENTER USING UNUTILZED ENERGY SOURCES

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.

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LEGAL NAME OF INVENTOR

Inventor: Michael McNamara Date (Optional): July 8, 2019

Signature: _____

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.**

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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)).
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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.

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US2018/017950

A. CLASSIFICATION OF SUBJECT MATTER
IPC(8) - G06F 1/26; G06F 1/20; G06F 1/30; G06F 1/32 (2018.01)
CPC - G06F 1/26; H05K 7/1497; G06F 1/20; H05K 7/1485 (2018.05)

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 - 713/300; 361/679.46; 361/679.02 (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.
X --- Y	US 2008/0094797 A1 (COGLITORE et al) 24 April 2008 (24.04.2008) entire document	1, 7, 15-18, 20-22 --- 2-6, 8-14, 19, 23, 24
Y	US 2010/0211810 A1 (ZACHO) 19 August 2010 (19.08.2010) entire document	2, 19
Y	US 2008/0030078 A1 (WHITTED et al) 07 February 2008 (07.02.2008) entire document	3-6, 8-14, 23, 24
Y	US 2013/0063991 A1 (XIAO et al) 14 March 2013 (14.03.2013) entire document	12
Y	US 2015/0155712 A1 (INERTECH IP LLC) 04 June 2015 (04.06.2015) entire document	24
A	US 2010/0328849 A1 (EWING et al) 30 December 2010 (30.12.2010) entire document	1-24
A	US 2013/0306276 A1 (DUCHESNEAU) 21 November 2013 (21.11.2013) entire document	1-24
A	US 2012/0300524 A1 (FORNAGE et al) 29 November 2012 (29.11.2012) entire document	1-24

☐ 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
14 May 2018	31 MAY 2018
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)

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US2018/017950

Box No. II Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:

2. ☐ Claims Nos.:
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:

3. ☐ Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box No. III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:
See extra sheet(s).

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.

2. ☐ As all searchable claims could be searched without effort justifying additional fees, this Authority did not invite payment of additional fees.

3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:

4. ☒ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:
1-24

Remark on Protest

☐ The additional search fees were accompanied by the applicant's protest and, where applicable, the payment of a protest fee.

☐ The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.

☐ No protest accompanied the payment of additional search fees.

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US2018/017950

Continued from Box No. III Observations where unity of invention is lacking

This application contains the following inventions or groups of inventions which are not so linked as to form a single general inventive concept under PCT Rule 13.1. In order for all inventions to be examined, the appropriate additional examination fees must be paid.

Group I, claims 1-24, are drawn to a flexible datacenter comprising: a mobile container; and a behind-the-meter power input system.

Group II, claims 25-34, are drawn to a method of dynamic power delivery to a flexible datacenter using unutilized behind-the meter power comprising: monitoring unutllized behind-the-meter power availability; and determining when a datacenter ramp-up condition is met.

The inventions listed as Groups I-II do not relate to a single general inventive concept under PCT Rule 13.1 because, under PCT Rule 13.2, they lack the same or corresponding special technical features for the following reasons: the special technical feature of the Group I invention: a flexible datacenter comprising: a mobile container; a behind-the-meter power input system; a power distribution system; a datacenter control system; and a climate control system, wherein the datacenter control system modulates power delivery to the plurality of computing systems as claimed therein is not present in the invention of Group II. The special technical feature of the Group II invention: monitoring unutllized behind-the-meter power availability; determining when a datacenter ramp-up condition is met; enabling behind-the-meter power delivery to one or more computing systems when the datacenter ramp-up condition is met; and directing the one or more computing systems to perform predetermined computational operations as claimed therein is not present in the invention of Group I.

Groups I and II lack unity of invention because even though the inventions of these groups require the technical feature of a flexible datacenter comprising one or more computing systems; and power delivery to the flexible datacenter using unutilized behind-the meter power availability, this technical feature is not a special technical feature as it does not make a contribution over the prior art.

Specifically, US 2010/0328849 to Ewing teaches a datacenter comprising one or more computing systems; and power delivery to the datacenter using power availability (if a server demands 500 watts and the PUE for the datacenter is 3.0, then the power from the utility grid needed to deliver 500 watts to the server is 1500 watts. The DCIE, in comparison, may provide a different aspect of this information, a DCIE value of 0.33 (equivalent to a PUE of 3.0) suggesting that the computing equipment consumes 33% of the power in the data center, para.0060). Further, US 2013/0306276 to Duchesneau teaches a flexible datacenter (supercomputing datacenter, Para. [0315. Maximum flexibility, para. 1500]); and using unutilized behind-the meter power availability (PERKS is hybrid energy system combining UPS with a peak-shaving system that directly captures excess or low-cost energy from a multiplicity of sources (when it is cheapest or most readily available) and stores it for later reuse, such as during peak periods, Para. [1456]. Note that excess energy is hereby "unutilized behind the meter power" as defined by applicant in Para [0041] of the specification of the present application).

Since none of the special technical features of the Group I or II inventions are found in more than one of the inventions, unity of invention is lacking.

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE
(Docket No. 18-874-WO1-US)

In re Application of: David Henson et al	)	
	)	**Examiner: TBD**
US Application No: TBD	)	
	)	
Filing Date: Herewith	)	**Art Unit: TBD**
	)	
Title: Method and System for Dynamic Power Delivery to a Flexible Datacenter Using Unutilized Energy Sources	)	**Confirmation No.: TBD**

PRELIMINARY AMENDMENT

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

Please consider the following amendments and remarks before examination on the merits.

Amendments to the Specification begin on page 2 of this paper.

Amendments to the Claims begin on page 3 of this paper.

Remarks begin on page 10 of this paper.

AMENDMENTS TO THE SPECIFICATION

Please amend the specification by adding the following as the first paragraph of the specification, immediately after the title:

--CROSS-REFERENCE TO RELATED APPLICATIONS

This application is a U.S. national phase application under 35 USC 371 of International Patent Application no. PCT/US2018/017950, filed February 13, 2018, which claims the benefit of U.S. Patent Application no. 62/616348, filed January 1, 2018.--

AMENDMENTS TO THE CLAIMS

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

Listing of claims:

1 – 34. (Canceled)

35. (New) A flexible datacenter comprising:

a behind-the-meter (BTM) power input system, wherein the BTM power input system is configured to receive power from a power generation station prior to the power undergoing step-up transformation for transmission to a power grid;

a power distribution system;

a plurality of computing systems; and

a datacenter control system configured to modulate power delivery to the plurality of computing systems based on an operational directive.

36. (New) The flexible datacenter of claim 35, wherein the datacenter control system is configured to receive the operational directive from a remote master control system.

37. (New) The flexible datacenter of claim 36, wherein the operational directive depends on BTM power availability at the flexible datacenter.

38. (New) The flexible datacenter of claim 37, wherein the remote master control system is positioned remotely from the flexible datacenter.

39. (New) The flexible datacenter of claim 35, wherein the datacenter control system is further configured to modulate power delivery to the plurality computing systems based on BTM power availability at the BTM power input system.

40. (New) The flexible datacenter of claim 35, wherein the BTM power input system comprises:

an input configured to receive three-phase BTM AC voltage from the power generation station.

41. (New) The flexible datacenter of claim 40, wherein the BTM power input system is configured to provide a single-phase AC voltage to the datacenter control system.

42. (New) The flexible datacenter of claim 35, wherein the datacenter control system controllably enables or disables power delivery to respective computing systems of the plurality of computing systems.

43. (New) The flexible datacenter of claim 35, wherein the datacenter control system is positioned remotely from the plurality of computing systems.

44. (New) The flexible datacenter of claim 37, wherein BTM power availability comprises:

one or more of excess local power generation at a local station level, local power generation subject to economic curtailment, local power generation subject to reliability curtailment, local power generation subject to power factor correction, low local power generation, start up local power generation situations, transient local power generation

situations, or testing local power generation situations where there is an economic advantage to using local BTM power generation to power the flexible datacenter.

45. (New) The flexible datacenter of claim 37, wherein BTM power availability comprises:

excess local power generation at a local station level.

46. (New) The flexible datacenter of claim 37, wherein BTM power availability comprises:

local power generation subject to economic curtailment.

47. (New) The flexible datacenter of claim 37, wherein BTM power availability comprises:

local power generation subject to reliability curtailment.

48. (New) The flexible datacenter of claim 37, wherein BTM power availability comprises:

local power generation subject to power factor correction.

49. (New) The flexible datacenter of claim 37, wherein BTM power availability comprises:

low local power generation.

50. (New) The flexible datacenter of claim 37, wherein BTM power availability comprises:

start up local power generation situations.

51. (New) The flexible datacenter of claim 37, wherein BTM power availability comprises:

transient local power generation situations.

52. (New) The flexible datacenter of claim 37, wherein BTM power availability comprises:

testing local power generation situations where there is an economic advantage to using local BTM power generation to power the flexible datacenter.

53. (New) The flexible datacenter of claim 35, wherein the operational directive is a workload directive based on a current BTM power availability and a projected BTM power availability at the flexible datacenter.

54. (New) The flexible datacenter of claim 35, wherein the datacenter control system is collocated with the plurality of computing systems.

55. (New) The flexible datacenter of claim 35, wherein the datacenter control system is further configured to transfer a workload from the plurality of computing systems to a second plurality of computing systems, and wherein the second plurality of computing systems is positioned at a second flexible datacenter.

56. (New) The flexible datacenter of claim 55, wherein the flexible datacenter is coupled to a first power generation station such that the plurality of computing systems operates using BTM power from the first power generation station; and

wherein the second flexible datacenter is coupled to a second power generation station such that the second plurality of computing systems operates using BTM power from the second power generation station.

57. (New) The flexible datacenter of claim 56, wherein the datacenter control system is configured to transfer the workload from the plurality of computing systems to the second plurality of computing systems in response to detecting a change in BTM power availability at the plurality of computing systems.

58. (New) The flexible datacenter of claim 57, wherein the datacenter control system is a remote master control system that is positioned remotely from the flexible datacenter and the second flexible datacenter.

59. (New) A system comprising:

a first flexible datacenter that comprises:

a behind-the-meter (BTM) power input system, wherein the BTM power input system is configured to receive power from a power generation station prior to the power undergoing step-up transformation for transmission to a power grid;

a power distribution system; and

a plurality of computing systems configured to receive power from the BTM power input system via the power distribution system;

a second flexible datacenter; and

a routing control system configured to modulate power delivery to the first flexible datacenter and the second flexible datacenter.

60. (New) The system of claim 59, wherein the routing control system is configured to transfer a workload from the plurality of computing systems to a second plurality of computing systems at the second flexible datacenter in response to detecting a change in BTM power availability at the first flexible datacenter.

61. (New) The system of claim 59, wherein the routing control system is positioned remotely from the first flexible datacenter and the second flexible datacenter, and wherein the routing control system is configured to modulate power delivery to the first flexible datacenter and the second flexible datacenter based on BTM power availability at the first flexible datacenter and the second flexible datacenter.

62. (New) A method of dynamic power delivery to a flexible datacenter using behind-the-meter (BTM) power comprising:

monitoring, by a control system, BTM power availability at the flexible datacenter, wherein the flexible datacenter includes a BTM power input system configured to receive power from a power generation station prior to the power undergoing step-up transformation for transmission to a power grid;

determining that a ramp-up condition is met, wherein the ramp-up condition depends on BTM power availability at the flexible datacenter; and

based on determining that the ramp-up condition is met, providing an operational directive to a datacenter control system at the flexible datacenter, wherein the operational

directive instructs the datacenter control system to enable BTM power delivery to one or more computing systems at the flexible datacenter.

63. (New) The method of claim 62, further comprising:

determining that a ramp-down condition is met, wherein the ramp-down condition depends on BTM power availability at the flexible datacenter; and

based on determining that the ramp-down condition is met, providing a second operational directive to the datacenter control system at the flexible datacenter, wherein the second operational directive instructs the datacenter control system to disable BTM power delivery to one or more computing systems at the flexible datacenter.

64. (New) The method of claim 62, wherein the control system is positioned remotely from the flexible datacenter.

REMARKS

No new matter has been introduced into the present application as a result of the above amendments.

Prompt consideration and entry of this amendment prior to examination is respectfully requested. If there are any questions or comments regarding this amendment or application, the Examiner is encouraged to contact the undersigned attorney as indicated below.

Respectfully submitted,

Date: July 31, 2019

/Alexander D. Georges/
Alexander D. Georges
Registration No. 70,534

McDonnell Boehnen Hulbert & Berghoff LLP
300 South Wacker Drive
Chicago, Illinois 60606

Telephone: 312-913-0001
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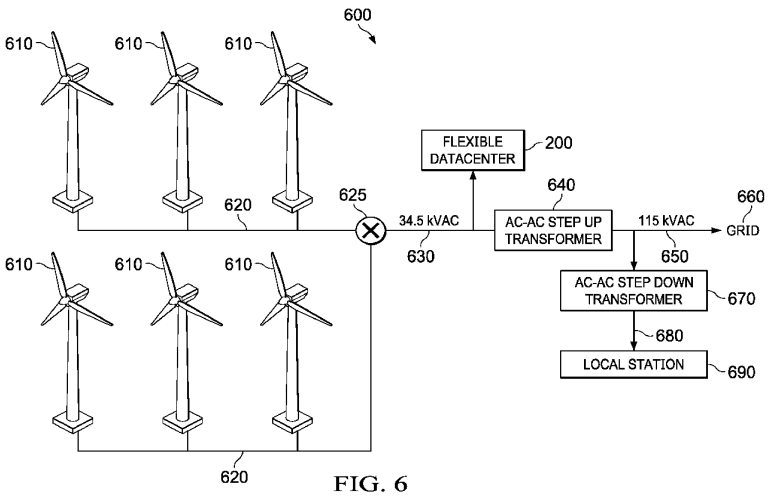


FIG. 6

(57) Abstract: A flexible datacenter includes a mobile container, a behind-the-meter power input system, a power distribution system, a datacenter control system, a plurality of computing systems, and a climate control system. The datacenter control system modulates power delivery to the plurality of computing systems based on unutilized behind-the-meter power availability or an operational directive. A method of dynamic power delivery to a flexible datacenter using unutilized behind-the-meter power includes monitoring unutilized behind-the-meter power availability, determining when a datacenter ramp-up condition is met, enabling behind-the-meter power delivery to one or more computing systems when the datacenter ramp-up condition is met, and directing the one or more computing systems to perform predetermined computational operations.

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METHOD AND SYSTEM FOR DYNAMIC POWER DELIVERY TO A FLEXIBLE DATACENTER USING UNUTILIZED ENERGY SOURCES

BACKGROUND OF THE INVENTION

[0001] Blockchain technology was originally conceived of as an open and distributed system for securely conducting transactions with cryptographic currency. However, the foundational principle of blockchain technology is the ability to securely transact information of any type or kind between anonymous parties without intermediaries or a centralized trust authority. As such, blockchain technology finds application outside the realm of cryptocurrency and is widely considered one of the more robust and secure means of transacting information in the computer sciences.

[0002] In typical blockchain implementations, each participating party creates a digital identity, or wallet, which includes a pair of cryptographic keys used to transact information securely and anonymously with the blockchain. The blockchain may be thought of as a constantly growing database of all prior transaction information that is securely and coherently replicated across all nodes of a peer-to-peer blockchain network. The blockchain includes a sequence of blocks, where each block includes a bundle of transactions and other data including a hash of the prior block in the chain. As such, each block in the blockchain is mathematically related to the prior block, protecting the integrity of the blockchain from the most recently added block to the genesis block in the chain. Because anyone may participate in the curation of the blockchain, once a block is added, it becomes a permanent and immutable part of the blockchain. Thus, the blockchain stores transactions in a manner that prevents the transactions from being altered or otherwise corrupted, unless all subsequent blocks in the blockchain are also altered. The immutability of the blockchain makes the malicious alteration of a block exceptionally difficult, if not impossible, and at the very least makes it easy to detect and deter any such attempt before being accepted and replicated across the blockchain network.

[0003] Each transacting party of the blockchain uses a pair of cryptographic keys to anonymously transact information. The private key is a random number maintained in secrecy by the party holder that is used to derive a public key and sign information. The private key and the public key are mathematically related such that anyone holding the public key may verify that information signed with the private key originated from the holder of the private key. When an initiating party wishes to

transact information, the information is signed with the initiating party's private key and broadcast to the blockchain network. A blockchain miner uses the initiating party's public key to verify that the initiating party initiated, or signed, the transaction. Once the initiating party's signature is validated, the transaction is validated, added to the next block in the blockchain, and replicated across all nodes.

[0004] The computational overhead of the blockchain is largely due to hashing functions used by blockchain miners to discover new blocks. While computationally intensive, the work performed by miners is critically important to the functionality of the blockchain. When an initiating party's transaction request has been lodged and the signatures validated, the transaction request is pooled in the blockchain network. Blockchain miners validate transactions and compete to discover a new block to be added to the blockchain. In order to add a newly discovered block to the blockchain, the blockchain miner must provide a cryptographic proof of the discovered block. To create the proof, the miner inputs the hash value of the prior block in the blockchain, the candidate block to be added, and a random number, commonly referred to as the nonce, to a hash function. The hash function takes input of any length and outputs an alphanumeric string of fixed length, commonly referred to as a hash, which uniquely identifies the input. However, the blockchain algorithm requires that the hash start with a certain number of leading zeros as determined by the current level of prescribed difficulty. The blockchain network modulates the level of difficulty for block discovery, by varying the number of leading zeros required in the calculated hash, based on the amount of computing power in the blockchain network.

[0005] As more computational capacity has come online, the hash rate has increased dramatically. In an effort to keep the block discovery time constant, the blockchain network modulates difficulty every 2016 blocks discovered. If the blockchain network hash rate is too high and the amount of time taken to discover a new block is less than 10 minutes, the difficulty is increased proportionally to increase the block discovery time to 10 minutes. Similarly, if the blockchain hash rate is too low and the amount of time taken to discover a new block is more than 10 minutes, the difficulty is increased proportionally to reduce the block discovery time to 10 minutes. Because there is no way to predict what hash value a given set of input data will generate, miners often have to execute the hash function a substantial number of times, each time inputting a new nonce, to generate a new hash value.

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When a miner is the first to obtain a hash value having the correct number of leading zeros, they broadcast the newly discovered block to the blockchain network and the blockchain is replicated across all nodes.

BRIEF SUMMARY OF THE INVENTION

[0006] According to one aspect of one or more embodiments of the present invention, a flexible datacenter includes a mobile container, a behind-the-meter power input system, a power distribution system, a datacenter control system, a plurality of computing systems, and a climate control system. The datacenter control system modulates power delivery to the plurality of computing systems based on unutilized behind-the-meter power availability or an operational directive.

[0007] According to one aspect of one or more embodiments of the present invention, a method of dynamic power delivery to a flexible datacenter using unutilized behind-the-meter power includes monitoring unutilized behind-the-meter power availability, determining when a datacenter ramp-up condition is met, enabling behind-the-meter power delivery to one or more computing systems when the datacenter ramp-up condition is met, and directing the one or more computing systems to perform predetermined computational operations.

[0008] Other aspects of the present invention will be apparent from the following description and claims.

BRIEF DESCRIPTION OF THE DRAWINGS

[0009] Figure **1** shows a computing system in accordance with one or more embodiments of the present invention.

[0010] Figure **2** shows a flexible datacenter in accordance with one or more embodiments of the present invention.

[0011] Figure **3** shows a three-phase power distribution of a flexible datacenter in accordance with one or more embodiments of the present invention.

[0012] Figure **4** shows a control distribution scheme of a flexible datacenter in accordance with one or more embodiments of the present invention.

[0013] Figure **5** shows a control distribution scheme of a fleet of flexible datacenters in accordance with one or more embodiments of the present invention.

[0014] Figure **6** shows a flexible datacenter powered by one or more wind turbines in accordance with one or more embodiments of the present invention.

[0015] Figure 7 shows a flexible datacenter powered by one or more solar panels in accordance with one or more embodiments of the present invention.

[0016] Figure 8 shows a flexible datacenter powered by flare gas in accordance with one or more embodiments of the present invention.

[0017] Figure 9 shows a method of dynamic power delivery to a flexible datacenter using unutilized behind-the-meter power in accordance with one or more embodiments of the present invention.

DETAILED DESCRIPTION OF THE INVENTION

[0018] One or more embodiments of the present invention are described in detail with reference to the accompanying figures. For consistency, like elements in the various figures are denoted by like reference numerals. In the following detailed description of the present invention, specific details are set forth in order to provide a thorough understanding of the present invention. In other instances, well-known features to one having ordinary skill in the art are not described to avoid obscuring the description of the present invention.

[0019] Blockchain miners are typically compensated for their efforts through either a discovery fee or a fee paid by one or more of the transacting parties. Consequently, more and more computing resources are coming online to compete for these fees. As the number of computing resources increases, the blockchain network modulates the difficulty level, requiring hash values with more leading zeros. In essence, the increased difficulty means more hashing operations are required to find a valid hash. As such, there is an increasing number of computing resources executing an increasing number of hash functions that do not result in the discovery of a valid hash, yet still consume a substantial amount of power.

[0020] The intensive computational demand of blockchain applications makes the widespread adoption of blockchain technology inefficient and unsustainable from an energy and environmental perspective. In certain blockchain applications, with limited participation, roughly 5 quintillion 256-bit cryptographic hashes are created each and every second of every day. While it is difficult to determine how much energy is required for that computational task, it is estimated to be in excess of 500 megawatts, the vast majority of which is sourced from fossil fuels. The majority of blockchain mining operations are currently being conducted in the People's Republic of China and powered by coal-fired energy. As blockchain technology

proliferates, there is concern that the energy required to sustain such blockchain applications could exceed that of a developed country.

[0021] While future versions of blockchain technology may improve power consumption for various blockchain operations, including hashing functions, industry efforts have focused on the development of central processing units ("CPUs"), graphics processing units ("GPUs"), and application specific integrated circuits ("ASICs") that are specifically designed to perform blockchain operations in a more efficient manner. While such efforts are beneficial, the issue remains, the widespread adoption of blockchain technology will require substantially more power than is economically and environmentally feasible.

[0022] Accordingly, in one or more embodiments of the present invention, a method and system for dynamic power delivery to a flexible datacenter uses unutilized behind-the-meter power sources without transmission and distribution costs. The flexible datacenter may be configured to modulate power delivery to one or more computing systems based on the availability of unutilized behind-the-meter power or an operational directive. For example, the flexible datacenter may ramp-up to a fully online status, ramp-down to a fully offline status, or dynamically reduce power consumption, act a load balancer, or adjust the power factor. Advantageously, the flexible datacenter may perform computational operations, such as blockchain hashing operations, with little to no energy costs, using clean and renewable energy that would otherwise be wasted.

[0023] Figure **1** shows a computing system **100** in accordance with one or more embodiments of the present invention. Computing system **100** may include one or more central processing units (singular "CPU" or plural "CPUs") **105**, host bridge **110**, input/output ("IO") bridge **115**, graphics processing units (singular "GPU" or plural "GPUs") **125**, and/or application-specific integrated circuits (singular "ASIC or plural "ASICs") (not shown) disposed on one or more printed circuit boards (not shown) that are configured to perform computational operations. Each of the one or more CPUs **105**, GPUs **125**, or ASICs (not shown) may be a single-core (not independently illustrated) device or a multi-core (not independently illustrated) device. Multi-core devices typically include a plurality of cores (not shown) disposed on the same physical die (not shown) or a plurality of cores (not shown) disposed on multiple die (not shown) that are collectively disposed within the same mechanical package (not shown).

[0024] CPU **105** may be a general purpose computational device typically configured to execute software instructions. CPU **105** may include an interface **108** to host bridge **110**, an interface **118** to system memory **120**, and an interface **123** to one or more IO devices, such as, for example, one or more GPUs **125**. GPU **125** may serve as a specialized computational device typically configured to perform graphics functions related to frame buffer manipulation. However, one of ordinary skill in the art will recognize that GPU **125** may be used to perform non-graphics related functions that are computationally intensive. In certain embodiments, GPU **125** may interface **123** directly with CPU **125** (and interface **118** with system memory **120** through CPU **105**). In other embodiments, GPU **125** may interface **121** with host bridge **110** (and interface **116** or **118** with system memory **120** through host bridge **110** or CPU **105** depending on the application or design). In still other embodiments, GPU **125** may interface **133** with IO bridge **115** (and interface **116** or **118** with system memory **120** through host bridge **110** or CPU **105** depending on the application or design). The functionality of GPU **125** may be integrated, in whole or in part, with CPU **105**.

[0025] Host bridge **110** may be an interface device configured to interface between the one or more computational devices and IO bridge **115** and, in some embodiments, system memory **120**. Host bridge **110** may include an interface **108** to CPU **105**, an interface **113** to IO bridge **115**, for embodiments where CPU **105** does not include an interface **118** to system memory **120**, an interface **116** to system memory **120**, and for embodiments where CPU **105** does not include an integrated GPU **125** or an interface **123** to GPU **125**, an interface **121** to GPU **125**. The functionality of host bridge **110** may be integrated, in whole or in part, with CPU **105**. IO bridge **115** may be an interface device configured to interface between the one or more computational devices and various IO devices (*e.g.*, **140**, **145**) and IO expansion, or add-on, devices (not independently illustrated). IO bridge **115** may include an interface **113** to host bridge **110**, one or more interfaces **133** to one or more IO expansion devices **135**, an interface **138** to keyboard **140**, an interface **143** to mouse **145**, an interface **148** to one or more local storage devices **150**, and an interface **153** to one or more network interface devices **155**. The functionality of IO bridge **115** may be integrated, in whole or in part, with CPU **105** or host bridge **110**. Each local storage device **150**, if any, may be a solid-state memory device, a solid-state memory device array, a hard disk drive, a hard disk drive array, or any other

non-transitory computer readable medium. Network interface device **155** may provide one or more network interfaces including any network protocol suitable to facilitate networked communications.

[0026] Computing system **100** may include one or more network-attached storage devices **160** in addition to, or instead of, one or more local storage devices **150**. Each network-attached storage device **160**, if any, may be a solid-state memory device, a solid-state memory device array, a hard disk drive, a hard disk drive array, or any other non-transitory computer readable medium. Network-attached storage device **160** may or may not be collocated with computing system **100** and may be accessible to computing system **100** via one or more network interfaces provided by one or more network interface devices **155**.

[0027] One of ordinary skill in the art will recognize that computing system **100** may be a conventional computing system or an application-specific computing system. In certain embodiments, an application-specific computing system may include one or more ASICs (not shown) that are configured to perform one or more functions, such as hashing, in a more efficient manner. The one or more ASICs (not shown) may interface directly with CPU **105**, host bridge **110**, or GPU **125** or interface through IO bridge **115**. Alternatively, in other embodiments, an application-specific computing system may be reduced to only those components necessary to perform a desired function in an effort to reduce one or more of chip count, printed circuit board footprint, thermal design power, and power consumption. The one or more ASICs (not shown) may be used instead of one or more of CPU **105**, host bridge **110**, IO bridge **115**, or GPU **125**. In such systems, the one or more ASICs may incorporate sufficient functionality to perform certain network and computational functions in a minimal footprint with substantially fewer component devices.

[0028] As such, one of ordinary skill in the art will recognize that CPU **105**, host bridge **110**, IO bridge **115**, GPU **125**, or ASIC (not shown) or a subset, superset, or combination of functions or features thereof, may be integrated, distributed, or excluded, in whole or in part, based on an application, design, or form factor in accordance with one or more embodiments of the present invention. Thus, the description of computing system **100** is merely exemplary and not intended to limit the type, kind, or configuration of component devices that constitute a computing system **100** suitable for performing computing operations in accordance with one or more embodiments of the present invention.

[0029] One of ordinary skill in the art will recognize that computing system **100** may be a stand alone, laptop, desktop, server, blade, or rack mountable system and may vary based on an application or design.

[0030] Figure **2** shows a flexible datacenter **200** in accordance with one or more embodiments of the present invention. Flexible datacenter **200** may include a mobile container **205**, a behind-the-meter power input system **210**, a power distribution system **215**, a climate control system (*e.g.*, **250**, **260**, **270**, **280**, and/or **290**), a datacenter control system **220**, and a plurality of computing systems **100** disposed in one or more racks **240**. Datacenter control system **220** may be a computing system (*e.g.*, **100** of Figure **1**) configured to dynamically modulate power delivery to one or more computing systems **100** disposed within flexible datacenter **200** based on unutilized behind-the-meter power availability or an operational directive from a local station control system (not shown), a remote master control system (not shown), or a grid operator (not shown).

[0031] In certain embodiments, mobile container **205** may be a storage trailer disposed on wheels and configured for rapid deployment. In other embodiments, mobile container **205** may be a storage container (not shown) configured for placement on the ground and potentially stacked in a vertical manner (not shown). In still other embodiments, mobile container **205** may be an inflatable container, a floating container, or any other type or kind of container suitable for housing a mobile datacenter **200**.

[0032] Flexible datacenter **200** may be rapidly deployed on site near a source of unutilized behind-the-meter power generation. Behind-the-meter power input system **210** may be configured to input power to flexible datacenter **200**. Behind-the-meter power input system **210** may include a first input (not independently illustrated) configured to receive three-phase behind-the-meter alternating current ("AC") voltage. In certain embodiments, behind-the-meter power input system **210** may include a supervisory AC-to-AC step-down transformer (not shown) configured to step down three-phase behind-the-meter AC voltage to single-phase supervisory nominal AC voltage or a second input (not independently illustrated) configured to receive single-phase supervisory nominal AC voltage from the local station (not shown) or a metered source (not shown). Behind-the-meter power input system **210** may provide single-phase supervisory nominal AC voltage to datacenter control system **220**, which may remain powered at almost all times to control the

operation of flexible datacenter **200**. The first input (not independently illustrated) or a third input (not independently illustrated) of behind-the-meter power input system **210** may direct three-phase behind-the-meter AC voltage to an operational AC-to-AC step-down transformer (not shown) configured to controllably step down three-phase behind-the-meter AC voltage to three-phase nominal AC voltage. Datacenter control system **220** may controllably enable or disable generation or provision of three-phase nominal AC voltage by the operational AC-to-AC step-down transformer (not shown).

[0033] Behind-the-meter power input system **210** may provide three phases of three-phase nominal AC voltage to power distribution system **215**. Power distribution system **215** may controllably provide a single phase of three-phase nominal AC voltage to each computing system **100** or group **240** of computing systems **100** disposed within flexible datacenter **200**. Datacenter control system **220** may controllably select which phase of three-phase nominal AC voltage that power distribution system **215** provides to each computing system **100** or group **240** of computing systems **100**. In this way, datacenter control system **220** may modulate power delivery by either ramping-up flexible datacenter **200** to fully operational status, ramping-down flexible datacenter **200** to offline status (where only datacenter control system **220** remains powered), reducing power consumption by withdrawing power delivery from, or reducing power to, one or more computing systems **100** or groups **240** of computing systems **100**, or modulating a power factor correction factor for the local station by controllably adjusting which phases of three-phase nominal AC voltage are used by one or more computing systems **100** or groups **240** of computing systems **100**.

[0034] Flexible datacenter **200** may include a climate control system (*e.g.*, **250**, **260**, **270**, **280**, **290**) configured to maintain the plurality of computing systems **100** within their operational temperature range. In certain embodiments, the climate control system may include an air intake **250**, an evaporative cooling system **270**, a fan **280**, and an air outtake **260**. In other embodiments, the climate control system may include an air intake **250**, an air conditioner or refrigerant cooling system **290**, and an air outtake **260**. In still other embodiments, the climate control system may include a computer room air conditioner system (not shown), a computer room air handler system (not shown), or an immersive cooling system (not shown). One of ordinary skill in the art will recognize that any suitable heat extraction system (not

shown) configured to maintain the operation of the plurality of computing systems **100** within their operational temperature range may be used in accordance with one or more embodiments of the present invention.

[0035] Flexible datacenter **200** may include a battery system (not shown) configured to convert three-phase nominal AC voltage to nominal DC voltage and store power in a plurality of storage cells. The battery system (not shown) may include a DC-to-AC inverter configured to convert nominal DC voltage to three-phase nominal AC voltage for flexible datacenter **200** use. Alternatively, the battery system (not shown) may include a DC-to-AC inverter configured to convert nominal DC voltage to single-phase nominal AC voltage to power datacenter control system **220**.

[0036] One of ordinary skill in the art will recognize that a voltage level of three-phase behind-the-meter AC voltage may vary based on an application or design and the type or kind of local power generation. As such, a type, kind, or configuration of the operational AC-to-AC step down transformer (not shown) may vary based on the application or design. In addition, the frequency and voltage level of three-phase nominal AC voltage, single-phase nominal AC voltage, and nominal DC voltage may vary based on the application or design in accordance with one or more embodiments of the present invention.

[0037] Figure **3** shows a three-phase power distribution of a flexible datacenter **200** in accordance with one or more embodiments of the present invention. Flexible datacenter **200** may include a plurality of racks **240**, each of which may include one or more computing systems **100** disposed therein. As discussed above, the behind-the-meter power input system (**210** of Figure **2**) may provide three phases of three-phase nominal AC voltage to the power distribution system (**215** of Figure **2**). The power distribution system (**215** of Figure **2**) may controllably provide a single phase of three-phase nominal AC voltage to each computing system **100** or group **240** of computing systems **100** disposed within flexible datacenter **200**. For example, a flexible datacenter **200** may include eighteen racks **240**, each of which may include eighteen computing systems **100**. The power distribution system (**215** of Figure **2**) may control which phase of three-phase nominal AC voltage is provided to one or more computing systems **100**, a rack **240** of computing systems **100**, or a group (*e.g.*, **310**, **320**, or **330**) of racks **240** of computing systems **100**.

[0038] In the figure, for purposes of illustration only, eighteen racks **240** are divided into a first group of six racks **310**, a second group of six racks **320**, and a third group

of six racks **330**, where each rack contains eighteen computing systems **100**. The power distribution system (**215** of Figure **2**) may, for example, provide a first phase of three-phase nominal AC voltage to the first group of six racks **310**, a second phase of three-phase nominal AC voltage to the second group of six racks **320**, and a third phase of three-phase nominal AC voltage to the third group of six racks **330**. If the flexible datacenter (**200** of Figure **2**) receives an operational directive from the local station (not shown) to provide power factor correction, the datacenter control system (**220** of Figure **2**) may direct the power distribution system (**215** of Figure **2**) to adjust which phase or phases of three-phase nominal AC voltage are used to provide the power factor correction required by the local station (not shown) or grid operator (not shown). One of ordinary skill in the art will recognize that, in addition to the power distribution, the load may be varied by adjusting the number of computing systems **100** operatively powered. As such, the flexible datacenter (**200** of Figure **2**) may be configured to act as a capacitive or inductive load to provide the appropriate reactance necessary to achieve the power factor correction required by the local station (not shown).

[0039] Figure **4** shows a control distribution scheme of a flexible datacenter **200** in accordance with one or more embodiments of the present invention. Datacenter control system **220** may independently, or cooperatively with one or more of local station control system **410**, remote master control system **420**, and grid operator **440**, modulate power delivery to flexible datacenter **200**. Specifically, power delivery may be dynamically adjusted based on conditions or operational directives.

[0040] Local station control system **410** may be a computing system (*e.g.*, **100** of Figure **1**) that is configured to control various aspects of the local station (not independently illustrated) that generates power and sometimes generates unutilized behind-the-meter power. Local station control system **410** may communicate with remote master control system **420** over a networked connection **430** and with datacenter control system **220** over a networked or hardwired connection **415**. Remote master control system **420** may be a computing system (*e.g.*, **100** of Figure **1**) that is located offsite, but connected via a network connection **425** to datacenter control system **220**, that is configured to provide supervisory or override control of flexible datacenter **200** or a fleet (not shown) of flexible datacenters **200**. Grid operator **440** may be a computing system (*e.g.*, **100** of Figure **1**) that is configured to control various aspects of the grid (not independently illustrated) that receives

power from the local station (not independently illustrated). Grid operator **440** may communicate with local station control system **440** over a networked or hardwired connection **445**.

[0041] Datacenter control system **220** may monitor unutilized behind-the-meter power availability at the local station (not independently illustrated) and determine when a datacenter ramp-up condition is met. Unutilized behind-the-meter power availability may include one or more of excess local power generation, excess local power generation that the grid cannot accept, local power generation that is subject to economic curtailment, local power generation that is subject to reliability curtailment, local power generation that is subject to power factor correction, situations where local power generation is prohibitively low, start up situations, transient situations, or testing situations where there is an economic advantage to using locally generated behind-the-meter power generation, specifically power available at little to no cost and with no associated transmission or distribution costs.

[0042] The datacenter ramp-up condition may be met if there is sufficient behind-the-meter power availability and there is no operational directive from local station control system **410**, remote master control system **420**, or grid operator **440** to go offline or reduce power. As such, datacenter control system **220** may enable **435** behind-the-meter power input system **210** to provide three-phase nominal AC voltage to the power distribution system (**215** of Figure **2**) to power the plurality of computing systems (**100** of Figure **2**) or a subset thereof. Datacenter control system **220** may optionally direct one or more computing systems (**100** of Figure **2**) to perform predetermined computational operations. For example, if the one or more computing systems (**100** of Figure **2**) are configured to perform blockchain hashing operations, datacenter control system **220** may direct them to perform blockchain hashing operations for a specific blockchain application, such as, for example, Bitcoin, Litecoin, or Ethereum. Alternatively, one or more computing systems (**100** of Figure **2**) may be configured to independently receive a computational directive from a network connection (not shown) to a peer-to-peer blockchain network (not shown) such as, for example, a network for a specific blockchain application, to perform predetermined computational operations.

[0043] Remote master control system **420** may specify to datacenter control system **220** what sufficient behind-the-meter power availability constitutes, or datacenter

control system **220** may be programmed with a predetermined preference or criteria on which to make the determination independently. For example, in certain circumstances, sufficient behind-the-meter power availability may be less than that required to fully power the entire flexible datacenter **200**. In such circumstances, datacenter control system **220** may provide power to only a subset of computing systems (**100** of Figure **2**), or operate the plurality of computing systems (**100** of Figure **2**) in a lower power mode, that is within the sufficient, but less than full, range of power that is available.

[0044] While flexible datacenter **200** is online and operational, a datacenter ramp-down condition may be met when there is insufficient, or anticipated to be insufficient, behind-the-meter power availability or there is an operational directive from local station control system **410**, remote master control system **420**, or grid operator **440**. Datacenter control system **220** may monitor and determine when there is insufficient, or anticipated to be insufficient, behind-the-meter power availability. As noted above, sufficiency may be specified by remote master control system **420** or datacenter control system **220** may be programmed with a predetermined preference or criteria on which to make the determination independently. An operational directive may be based on current dispatchability, forward looking forecasts for when unutilized behind-the-meter power is, or is expected to be, available, economic considerations, reliability considerations, operational considerations, or the discretion of the local station **410**, remote master control **420**, or grid operator **440**. For example, local station control system **410**, remote master control system **420**, or grid operator **440** may issue an operational directive to flexible datacenter **200** to go offline and power down. When the datacenter ramp-down condition is met, datacenter control system **220** may disable power delivery to the plurality of computing systems (**100** of Figure **2**). Datacenter control system **220** may disable **435** behind-the-meter power input system **210** from providing three-phase nominal AC voltage to the power distribution system (**215** of Figure **2**) to power down the plurality of computing systems (**100** of Figure **2**), while datacenter control system **220** remains powered and is capable of rebooting flexible datacenter **200** when unutilized behind-the-meter power becomes available again.

[0045] While flexible datacenter **200** is online and operational, changed conditions or an operational directive may cause datacenter control system **220** to modulate power consumption by flexible datacenter **200**. Datacenter control system **220** may

determine, or local station control system **410**, remote master control system **420**, or grid operator **440** may communicate, that a change in local conditions may result in less power generation, availability, or economic feasibility, than would be necessary to fully power flexible datacenter **200**. In such situations, datacenter control system **220** may take steps to reduce or stop power consumption by flexible datacenter **200** (other than that required to maintain operation of datacenter control system **220**). Alternatively, local station control system **410**, remote master control system **420**, or grid operator **440**, may issue an operational directive to reduce power consumption for any reason, the cause of which may be unknown. In response, datacenter control system **220** may dynamically reduce or withdraw power delivery to one or more computing systems (**100** of Figure **2**) to meet the dictate. Datacenter control system **220** may controllably provide three-phase nominal AC voltage to a smaller subset of computing systems (**100** of Figure **2**) to reduce power consumption. Datacenter control system **220** may dynamically reduce the power consumption of one or more computing systems (**100** of Figure **2**) by reducing their operating frequency or forcing them into a lower power mode through a network directive.

[0046] One of ordinary skill in the art will recognize that datacenter control system **220** may be configured to have a number of different configurations, such as a number or type or kind of computing systems (**100** of Figure **2**) that may be powered, and in what operating mode, that correspond to a number of different ranges of sufficient and available unutilized behind-the-meter power availability. As such, datacenter control system **220** may modulate power delivery over a variety of ranges of sufficient and available unutilized behind-the-meter power availability.

[0047] Figure **5** shows a control distribution of a fleet **500** of flexible datacenters **200** in accordance with one or more embodiments of the present invention. The control distribution of a flexible datacenter **200** shown and described with respect to Figure **4** may be extended to a fleet **500** of flexible datacenters **200**. For example, a first local station (not independently illustrated), such as, for example, a wind farm (not shown), may include a first plurality **510** of flexible datacenters **200*a*** through **200*d***, which may be collocated or distributed across the local station (not shown). A second local station (not independently illustrated), such as, for example, another wind farm or a solar farm (not shown), may include a second plurality **520** of flexible datacenters **200*e*** through **200*h***, which may be collocated or distributed

across the local station (not shown). One of ordinary skill in the art will recognize that the number of flexible datacenters **200** deployed at a given station and the number of stations within the fleet may vary based on an application or design in accordance with one or more embodiments of the present invention.

[0048] Remote master control system **420** may provide supervisory control over fleet **500** of flexible datacenters **200** in a similar manner to that shown and described with respect to Figure **4**, with the added flexibility to make high level decisions with respect to fleet **500** that may be counterintuitive to a given station. Remote master control system **420** may make decisions regarding the issuance of operational directives to a given local station based on, for example, the status of each local station where flexible datacenters **200** are deployed, the workload distributed across fleet **500**, and the expected computational demand required for the expected workload. In addition, remote master control system **420** may shift workloads from a first plurality **510** of flexible datacenters **200** to a second plurality **520** of flexible datacenters **200** for any reason, including, for example, a loss of unutilized behind-the-meter power availability at one local station and the availability of unutilized behind-the-meter power at another local station.

[0049] Figure **6** shows a flexible datacenter **200** powered by one or more wind turbines **610** in accordance with one or more embodiments of the present invention. A wind farm **600** typically includes a plurality of wind turbines **610**, each of which intermittently generates a wind-generated AC voltage. The wind-generated AC voltage may vary based on a type, kind, or configuration of farm **600**, turbine **610**, and incident wind speed. The wind-generated AC voltage is typically input into a turbine AC-to-AC step-up transformer (not shown) that is disposed within the nacelle (not independently illustrated) or at the base of the mast (not independently illustrated) of turbine **610**. The turbine AC-to-AC step up transformer (not shown) outputs three-phase wind-generated AC voltage **620**. Three-phase wind-generated AC voltage **620** produced by the plurality of wind turbines **610** is collected **625** and provided **630** to another AC-to-AC step-up transformer **640** that steps up three-phase wind-generated AC voltage **620** to three-phase grid AC voltage **650** suitable for delivery to grid **660**. Three-phase grid AC voltage **650** may be stepped down with an AC-to-AC step-down transformer **670** configured to produce three-phase local station AC voltage **680** provided to local station **690**. One of ordinary skill in the art will recognize that the actual voltage levels may vary based on the type, kind,

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or number of wind turbines **610**, the configuration or design of wind farm **600**, and grid **660** that it feeds into.

[0050] The output side of AC-to-AC step-up transformer **640** that connects to grid **660** may be metered and is typically subject to transmission and distribution costs. In contrast, power consumed on the input side of AC-to-AC step-up transformer **640** may be considered behind-the-meter and is typically not subject to transmission and distribution costs. As such, one or more flexible datacenters **200** may be powered by three-phase wind-generated AC voltage **620**. Specifically, in wind farm **600** applications, the three-phase behind-the-meter AC voltage used to power flexible datacenter **200** may be three-phase wind-generated AC voltage **620**. As such, flexible datacenter **200** may reside behind-the-meter, avoid transmission and distribution costs, and may be dynamically powered when unutilized behind-the-meter power is available.

[0051] Unutilized behind-the-meter power availability may occur when there is excess local power generation. In high wind conditions, wind farm **600** may generate more power than, for example, AC-to-AC step-up transformer **640** is rated for. In such situations, wind farm **600** may have to take steps to protect its equipment from damage, which may include taking one or more turbines **610** offline or shunting their voltage to dummy loads or ground. Advantageously, one or more flexible datacenters **200** may be used to consume power on the input side of AC-to-AC step-up transformer **640**, thereby allowing wind farm **600** to operate equipment within operating ranges while flexible datacenter **200** receives behind-the-meter power without transmission or distribution costs. The local station control system (not independently illustrated) of local station **690** may issue an operational directive to the one or more flexible datacenters **200** or to the remote master control system (**420** of Figure **4**) to ramp-up to the desired power consumption level. When the operational directive requires the cooperative action of multiple flexible datacenters **200**, the remote mater control system (**420** of Figure **4**) may determine how to power each individual flexible datacenter **200** in accordance with the operational directive or provide an override to each flexible datacenter **200**.

[0052] Another example of unutilized behind-the-meter power availability is when grid **660** cannot, for whatever reason, take the power being produced by wind farm **600**. In such situations, wind farm **600** may have to take one or more turbines **610** offline or shunt their voltage to dummy loads or ground. Advantageously, one or

more flexible datacenters **200** may be used to consume power on the input side of AC-to-AC step-up transformer **640**, thereby allowing wind farm **600** to either produce power to grid **660** at a lower level or shut down transformer **640** entirely while flexible datacenter **200** receives behind-the-meter power without transmission or distribution costs. The local station control system (not independently illustrated) of local station **690** or the grid operator (not independently illustrated) of grid **660** may issue an operational directive to the one or more flexible datacenters **200** or to the remote master control system (**420** of Figure **4**) to ramp-up to the desired power consumption level. When the operational directive requires the cooperative action of multiple flexible datacenters **200**, the remote master control system (**420** of Figure **4**) may determine how to power each individual flexible datacenter **200** in accordance with the operational directive or provide an override to each flexible datacenter **200**.

[0053] Another example of unutilized behind-the-meter power availability is when wind farm **600** is selling power to grid **660** at a negative price that is offset by a production tax credit. In certain circumstances, the value of the production tax credit may exceed the price wind farm **600** would have to pay to grid **660** to offload their generated power. Advantageously, one or more flexible datacenters **200** may be used to consume power behind-the-meter, thereby allowing wind farm **600** to produce and obtain the production tax credit, but sell less power to grid **660** at the negative price. The local station control system (not independently illustrated) of local station **690** may issue an operational directive to the one or more flexible datacenters **200** or to the remote master control system (**420** of Figure **4**) to ramp-up to the desired power consumption level. When the operational directive requires the cooperative action of multiple flexible datacenter **200**, the remote master control system (**420** of Figure **4**) may determine how to power each individual flexible datacenter **200** in accordance with the operational directive or provide an override to each flexible datacenter **200**.

[0054] Another example of unutilized behind-the-meter power availability is when wind farm **600** is selling power to grid **660** at a negative price because grid **660** is oversupplied or is instructed to stand down and stop producing altogether. The grid operator (not independently illustrated) may select certain power generation stations to go offline and stop producing power to grid **660**. Advantageously, one or more flexible datacenters **200** may be used to consume power behind-the-meter, thereby

allowing wind farm **600** to stop producing power to grid **660**, but making productive use of the power generated behind-the-meter without transmission or distribution costs. The local station control system (not independently illustrated) of the local station **690** or the grid operator (not independently illustrated) of grid **660** may issue an operational directive to the one or more flexible datacenters **200** or to the remote master control system (**420** of Figure **4**) to ramp-up to the desired power consumption level. When the operational directive requires the cooperative action of multiple flexible datacenters **200**, the remote master control system (**420** of Figure **4**) may determine how to power each individual flexible datacenter **200** in accordance with the operational directive or provide an override to each flexible datacenter **200**.

[0055] Another example of unutilized behind-the-meter power availability is when wind farm **600** is producing power to grid **660** that is unstable, out of phase, or at the wrong frequency, or grid **660** is already unstable, out of phase, or at the wrong frequency for whatever reason. The grid operator (not independently illustrated) may select certain power generation stations to go offline and stop producing power to grid **660**. Advantageously, one or more flexible datacenters **200** may be used to consume power behind-the-meter, thereby allowing wind farm **600** to stop producing power to grid **660**, but make productive use of the power generated behind-the-meter without transmission or distribution costs. The local station control system (not independently illustrated) of local station **690** may issue an operational directive to the one or more flexible datacenters **200** or to the remote master control system (**420** of Figure **4**) to ramp-up to the desired power consumption level. When the operational directive requires the cooperative action of multiple flexible datacenters **200**, the remote master control system (**420** of Figure **4**) may determine how to power each individual flexible datacenter **200** in accordance with the operational directive or provide an override to each flexible datacenter **200**.

[0056] Further examples of unutilized behind-the-meter power availability is when wind farm **600** experiences low wind conditions that make it not economically feasible to power up certain components, such as, for example, the local station (not independently illustrated), but there may be sufficient behind-the-meter power availability to power one or more flexible datacenters **200**. Similarly, unutilized behind-the-meter power availability may occur when wind farm **600** is starting up,

or testing, one or more turbines **610**. Turbines **610** are frequently offline for installation, maintenance, and service and must be tested prior to coming online as part of the array. One or more flexible datacenters **200** may be powered by one or more turbines **610** that are offline from farm **600**. The above-noted examples of when unutilized behind-the-meter power is available are merely exemplary and are not intended to limit the scope of what one of ordinary skill in the art would recognize as unutilized behind-the-meter power availability. Unutilized behind-the-meter power availability may occur anytime there is power available and accessible behind-the-meter that is not subject to transmission and distribution costs and there is an economic advantage to using it.

[0057] One of ordinary skill in the art will recognize that wind farm **600** and wind turbine **610** may vary based on an application or design in accordance with one or more embodiments of the present invention.

[0058] Figure 7 shows a flexible datacenter **200** powered by one or more solar panels **710** in accordance with one or more embodiments of the present invention. A solar farm **700** typically includes a plurality of solar panels **710**, each of which intermittently generates a solar-generated DC voltage **720**. Solar-generated DC voltage **720** may vary based on a type, kind, or configuration of farm **700**, panel **710**, and incident sunlight. Solar-generated DC voltage **720** produced by the plurality of solar panels **710** is collected **725** and provided **730** to a DC-to-AC inverter that converts solar-generated DC voltage into three-phase solar-generated AC voltage **750**. Three-phase solar-generated AC voltage **750** is provided to an AC-to-AC step-up transformer **760** that steps up three-phase solar-generated AC voltage to three-phase grid AC voltage **790**. Three-phase grid AC voltage **790** may be stepped down with an AC-to-AC step-down transformer **785** configured to produce three-phase local station AC voltage **777** provided to local station **775**. One of ordinary skill in the art will recognize that the actual voltage levels may vary based on the type, kind, or number of solar panels **710**, the configuration or design of solar farm **700**, and grid **790** that it feeds into.

[0059] The output side of AC-to-AC step-up transformer **760** that connects to grid **790** may be metered and is typically subject to transmission and distribution costs. In contrast, power consumed on the input side of AC-to-AC step-up transformer **760** may be considered behind-the-meter and is typically not subject to transmission and distribution costs. As such, one or more flexible datacenters **200** may be powered by

three-phase solar-generated AC voltage **750**. Specifically, in solar farm **700** applications, the three-phase behind-the-meter AC voltage used to power flexible datacenter **200** may be three-phase solar-generated AC voltage **750**. As such, flexible datacenter **200** may reside behind-the-meter, avoid transmission and distribution costs, and may be dynamically powered when unutilized behind-the-meter power is available.

[0060] Unutilized behind-the-meter power availability may occur when there is excess local power generation. In high incident sunlight situations, solar farm **700** may generate more power than, for example, AC-to-AC step-up transformer **760** is rated for. In such situations, solar farm **700** may have to take steps to protect its equipment from damage, which may include taking one or more panels **710** offline or shunting their voltage to dummy loads or ground. Advantageously, one or more flexible datacenters **200** may be used to consume power on the input side of AC-to-AC step-up transformer **760**, thereby allowing solar farm **700** to operate equipment within operating ranges while flexible datacenter **200** receives behind-the-meter power without transmission or distribution costs. The local station control system (not independently illustrated) of local station **775** may issue an operational directive to the one or more flexible datacenters **200** or to the remote master control system (**420** of Figure **4**) to ramp-up to the desired power consumption level. When the operational directive requires the cooperative action of multiple flexible datacenters **200**, the remote mater control system (**420** of Figure **4**) may determine how to power each individual flexible datacenter **200** in accordance with the operational directive or provide an override to each flexible datacenter **200**.

[0061] Another example of unutilized behind-the-meter power availability is when grid **790** cannot, for whatever reason, take the power being produced by solar farm **700**. In such situations, solar farm **700** may have to take one or more panels **710** offline or shunt their voltage to dummy loads or ground. Advantageously, one or more flexible datacenters **200** may be used to consume power on the input side of AC-to-AC step-up transformer **760**, thereby allowing solar farm **700** to either produce power to grid **790** at a lower level or shut down transformer **760** entirely while flexible datacenter **200** receives behind-the-meter power without transmission or distribution costs. The local station control system (not independently illustrated) of local station **775** or the grid operator (not independently illustrated) of grid **790** may issue an operational directive to the one or more flexible datacenters **200** or to

the remote master control system (**420** of Figure **4**) to ramp-up to the desired power consumption level. When the operational directive requires the cooperative action of multiple flexible datacenters **200**, the remote master control system (**420** of Figure **4**) may determine how to power each individual flexible datacenter **200** in accordance with the operational directive or provide an override to each flexible datacenter **200**.

[0062] Another example of unutilized behind-the-meter power availability is when solar farm **700** is selling power to grid **790** at a negative price that is offset by a production tax credit. In certain circumstances, the value of the production tax credit may exceed the price solar farm **700** would have to pay to grid **790** to offload their generated power. Advantageously, one or more flexible datacenters **200** may be used to consume power behind-the-meter, thereby allowing solar farm **700** to produce and obtain the production tax credit, but sell less power to grid **790** at the negative price. The local station control system (not independently illustrated) of local station **775** may issue an operational directive to the one or more flexible datacenters **200** or to the remote master control system (**420** of Figure **4**) to ramp-up to the desired power consumption level. When the operational directive requires the cooperative action of multiple flexible datacenter **200**, the remote master control system (**420** of Figure **4**) may determine how to power each individual flexible datacenter **200** in accordance with the operational directive or provide an override to each flexible datacenter **200**.

[0063] Another example of unutilized behind-the-meter power availability is when solar farm **700** is selling power to grid **790** at a negative price because grid **790** is oversupplied or is instructed to stand down and stop producing altogether. The grid operator (not independently illustrated) may select certain power generation stations to go offline and stop producing power to grid **790**. Advantageously, one or more flexible datacenters **200** may be used to consume power behind-the-meter, thereby allowing solar farm **700** to stop producing power to grid **790**, but making productive use of the power generated behind-the-meter without transmission or distribution costs. The local station control system (not independently illustrated) of the local station **775** or the grid operator (not independently illustrated) of grid **790** may issue an operational directive to the one or more flexible datacenters **200** or to the remote master control system (**420** of Figure **4**) to ramp-up to the desired power consumption level. When the operational directive requires the cooperative action of

multiple flexible datacenters **200**, the remote master control system (**420** of Figure **4**) may determine how to power each individual flexible datacenter **200** in accordance with the operational directive or provide an override to each flexible datacenter **200**.

[0064] Another example of unutilized behind-the-meter power availability is when solar farm **700** is producing power to grid **790** that is unstable, out of phase, or at the wrong frequency, or grid **790** is already unstable, out of phase, or at the wrong frequency for whatever reason. The grid operator (not independently illustrated) may select certain power generation stations to go offline and stop producing power to grid **790**. Advantageously, one or more flexible datacenters **200** may be used to consume power behind-the-meter, thereby allowing solar farm **700** to stop producing power to grid **790**, but make productive use of the power generated behind-the-meter without transmission or distribution costs. The local station control system (not independently illustrated) of local station **775** may issue an operational directive to the one or more flexible datacenters **200** or to the remote master control system (**420** of Figure **4**) to ramp-up to the desired power consumption level. When the operational directive requires the cooperative action of multiple flexible datacenters **200**, the remote master control system (**420** of Figure **4**) may determine how to power each individual flexible datacenter **200** in accordance with the operational directive or provide an override to each flexible datacenter **200**.

[0065] Further examples of unutilized behind-the-meter power availability is when solar farm **700** experiences intermittent cloud cover such that it is not economically feasible to power up certain components, such as, for example local station 775, but there may be sufficient behind-the-meter power availability to power one or more flexible datacenters **200**. Similarly, unutilized behind-the-meter power availability may occur when solar farm **700** is starting up, or testing, one or more panels **710**. Panels **710** are frequently offline for installation, maintenance, and service and must be tested prior to coming online as part of the array. One or more flexible datacenters **200** may be powered by one or more panels **710** that are offline from farm **700**. The above-noted examples of when unutilized behind-the-meter power is available are merely exemplary and are not intended to limit the scope of what one of ordinary skill in the art would recognize as unutilized behind-the-meter power availability. Behind-the-meter power availability may occur anytime there is power

available and accessible behind-the-meter that is not subject to transmission and distribution costs and there is an economic advantage to using it.

[0066] One of ordinary skill in the art will recognize that solar farm **700** and solar panel **710** may vary based on an application or design in accordance with one or more embodiments of the present invention.

[0067] Figure **8** shows a flexible datacenter **200** powered by flare gas **800** in accordance with one or more embodiments of the present invention. Flare gas **800** is combustible gas produced as a product or by-product of petroleum refineries, chemical plants, natural gas processing plants, oil and gas drilling rigs, and oil and gas production facilities. Flare gas **800** is typically burned off through a flare stack (not shown) or vented into the air. In one or more embodiments of the present invention, flare gas **800** may be diverted **812** to a gas-powered generator that produces three-phase gas-generated AC voltage **822**. This power may be considered behind-the-meter and is not subject to transmission and distribution costs. As such, one or more flexible datacenters **200** may be powered by three-phase gas-generated AC voltage. Specifically, the three-phase behind-the-meter AC voltage used to power flexible datacenter **200** may be three-phase gas-generated AC voltage **822**. Accordingly, flexible datacenter **200** may reside behind-the-meter, avoid transmission and distribution costs, and may be dynamically powered when unutilized behind-the-meter power is available.

[0068] Figure **9** shows a method of dynamic power delivery to a flexible datacenter (**200** of Figure **2**) using unutilized behind-the-meter power **900** in accordance with one or more embodiments of the present invention. In step **910**, the datacenter control system (**220** of Figure **4**), or the remote master control system (**420** of Figure **4**), may monitor unutilized behind-the-meter power availability. In certain embodiments, monitoring may include receiving information or an operational directive from the local station control system (**410** of Figure **4**) or the grid operator (**440** of Figure **4**) corresponding to unutilized behind-the-meter power availability.

[0069] In step **920**, the datacenter control system (**220** of Figure **4**), or the remote master control system (**420** of Figure **4**), may determine when a datacenter ramp-up condition is met. In certain embodiments, the datacenter ramp-up condition may be met when there is sufficient behind-the-meter power availability and there is no operational directive from the local station to go offline or reduce power. In step **930**, the datacenter control system (**220** of Figure **4**) may enable behind-the-meter

power delivery to one or more computing systems (**100** of Figure **2**). In step **940**, once ramped-up, the datacenter control system (**220** of Figure **4**) or the remote master control system (**420** of Figure **4**) may direct one or more computing systems (**100** of Figure **2**) to perform predetermined computational operations. In certain embodiments, the predetermined computational operations may include the execution of one or more hashing functions.

[0070] While operational, the datacenter control system (**220** of Figure **4**), or the remote master control system (**420** of Figure **4**), may receive an operational directive to modulate power consumption. In certain embodiments, the operational directive may be a directive to reduce power consumption. In such embodiments, the datacenter control system (**220** of Figure **4**) or the remote master control system (**420** of Figure **4**) may dynamically reduce power delivery to one or more computing systems (**100** of Figure **2**) or dynamically reduce power consumption of one or more computing systems. In other embodiments, the operational directive may be a directive to provide a power factor correction factor. In such embodiments, the datacenter control system (**220** of Figure **4**) or the remote master control system (**420** of Figure **4**) may dynamically adjust power delivery to one or more computing systems (**100** of Figure **2**) to achieve a desired power factor correction factor. In still other embodiments, the operational directive may be a directive to go offline or power down. In such embodiments, the datacenter control system (**220** of Figure **4**) may disable power delivery to one or more computing systems (**100** of Figure **2**).

[0071] The datacenter control system (**220** of Figure **4**), or the remote master control system (**420** of Figure **4**), may determine when a datacenter ramp-down condition is met. In certain embodiments, the datacenter ramp-down condition may be met if there is insufficient or anticipated to be insufficient behind-the-meter power availability or there is an operational directive from the local station to go offline or reduce power. The datacenter control system (**220** of Figure **4**) may disable behind-the-meter power delivery to one or more computing systems (**100** of Figure **2**). Once ramped-down, the datacenter control system (**220** of Figure **4**) remains powered and in communication with the remote master control system (**420** of Figure **4**) so that it may dynamically power the flexible datacenter (**200** of Figure **2**) when conditions change.

[0072] One of ordinary skill in the art will recognize that a datacenter control system (**220** of Figure **4**) may dynamically modulate power delivery to one or more

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computing systems (**100** of Figure **2**) of a flexible datacenter (**200** of Figure **2**) based on unutilized behind-the-meter power availability or an operational directive. The flexible datacenter (**200** of Figure **2**) may transition between a fully powered down state (while the datacenter control system remains powered), a fully powered up state, and various intermediate states in between. In addition, flexible datacenter (**200** of Figure **2**) may have a blackout state, where all power consumption, including that of the datacenter control system (**220** of Figure **4**) is halted. However, once the flexible datacenter (**200** of Figure **2**) enters the blackout state, it will have to be manually rebooted to restore power to datacenter control system (**220** of Figure **4**). Local station conditions or operational directives may cause flexible datacenter (**200** of Figure **2**) to ramp-up, reduce power consumption, change power factor, or ramp-down.

[0073] Advantages of one or more embodiments of the present invention may include one or more of the following:

[0074] In one or more embodiments of the present invention, a method and system for dynamic power delivery to a flexible datacenter using unutilized energy sources provides a green solution to two prominent problems: the exponential increase in power required for growing blockchain operations and the unutilized and typically wasted energy generated from renewable energy sources.

[0075] In one or more embodiments of the present invention, a method and system for dynamic power delivery to a flexible datacenter using unutilized energy sources allows for the rapid deployment of mobile datacenters to local stations. The mobile datacenters may be deployed on site, near the source of power generation, and receive unutilized behind-the-meter power when it is available.

[0076] In one or more embodiments of the present invention, a method and system for dynamic power delivery to a flexible datacenter using unutilized energy sources allows for the power delivery to the datacenter to be modulated based on conditions or an operational directive received from the local station or the grid operator.

[0077] In one or more embodiments of the present invention, a method and system for dynamic power delivery to a flexible datacenter using unutilized energy sources may dynamically adjust power consumption by ramping-up, ramping-down, or adjusting the power consumption of one or more computing systems within the flexible datacenter.

[0078] In one or more embodiments of the present invention, a method and system for dynamic power delivery to a flexible datacenter using unutilized energy sources may be powered by unutilized behind-the-meter power that is free from transmission and distribution costs. As such, the flexible datacenter may perform computational operations, such as hashing function operations, with little to no energy cost.

[0079] In one or more embodiments of the present invention, a method and system for dynamic power delivery to a flexible datacenter using unutilized energy sources provides a number of benefits to the hosting local station. The local station may use the flexible datacenter to adjust a load, provide a power factor correction, to offload power, or operate in a manner that invokes a production tax credit.

[0080] While the present invention has been described with respect to the above-noted embodiments, those skilled in the art, having the benefit of this disclosure, will recognize that other embodiments may be devised that are within the scope of the invention as disclosed herein. Accordingly, the scope of the invention should be limited only by the appended claims.

CLAIMS

What is claimed is:

1. A flexible datacenter comprising:
   a mobile container;
   a behind-the-meter power input system;
   a power distribution system;
   a datacenter control system;
   a plurality of computing systems; and
   a climate control system,
   wherein the datacenter control system modulates power delivery to the plurality of computing systems based on unutilized behind-the-meter power availability or an operational directive.

2. The flexible datacenter of claim 1, further comprising:
   a remote master control system.

3. The flexible datacenter of claim 1, wherein the behind-the-meter power input system comprises an input configured to receive three-phase behind-the-meter AC voltage and a supervisory AC-to-AC step-down transformer configured to step down the three-phase behind-the-meter AC voltage to a single-phase supervisory nominal AC voltage or an input configured to receive single-phase supervisory nominal AC voltage from a local station or metered source.

4. The flexible datacenter of claim 3, wherein the behind-the-meter power input system provides the single-phase supervisory nominal AC voltage to the datacenter control system.

5. The flexible datacenter of claim 1, wherein the behind-the-meter power input system comprises an input configured to receive three-phase behind-the-meter AC voltage and an operational AC-to-AC step-down transformer configured to controllably step down the three-phase behind-the-meter AC voltage to three-phase nominal AC voltage.

6. The flexible datacenter of claim 5, wherein the datacenter control system controllably enables or disables generation of the three-phase nominal AC voltage by the operational AC-to-AC step-down transformer.

7. The flexible datacenter of claim 1, wherein the behind-the-meter power input system provides three-phases of the three-phase nominal AC voltage to the power distribution system.

8. The flexible datacenter of claim 7, wherein the power distribution system controllably provides a single phase of the three-phase nominal AC voltage to each computing system of the plurality of computing systems.

9. The flexible data center of claim 7, wherein the datacenter control system controllably selects which phase of the three-phase nominal AC voltage the power distribution system provides to each computing system of the plurality of computing systems.

10. The flexible datacenter of claim 7, wherein the datacenter control system modulates a power factor correction factor by controllably adjusting which phase of the three-phase nominal AC voltage each computing system of the plurality of computing systems receive.

11. The flexible datacenter of claim 5, wherein the three-phase behind-the-meter AC voltage comprises a three-phase wind-generated AC voltage output by one or more wind turbines prior to an AC-to-AC step-up transformer that steps up the three-phase wind-generated AC voltage to a three-phase grid AC voltage.

12. The flexible datacenter of claim 5, wherein the three-phase behind-the-meter AC voltage comprises a three-phase solar-generated AC voltage output by a DC-to-AC inverter that inputs solar-generated DC voltage from one or more solar panels and prior to an AC-to-AC step-up transformer that steps up the three-phase solar-generated AC voltage to a three-phase grid AC voltage.

13. The flexible datacenter of claim 5, wherein the three-phase behind-the-meter AC voltage comprises a three-phase gas-generated AC voltage output by a generator that inputs combustible gas diverted from a flare or venting system.

14. The flexible datacenter of claim 5, wherein the three-phase behind-the-meter AC voltage is a three-phase metered AC voltage.

15. The flexible datacenter of claim 1, wherein unutilized behind-the-meter power availability comprises one or more of excess local power generation at a local station level, excess local power generation that a grid cannot receive, local power generation subject to economic curtailment, local power generation subject to reliability curtailment, local power generation subject to power factor correction, low local power generation, start up local power generation situations, transient local power generation situations, or testing local power generation situations where there is an economic advantage to using local behind-the-meter power generation to power the flexible datacenter.

16. The flexible datacenter of claim 1, wherein an operational directive comprises one or more of a local station directive, a remote master control directive, or a grid directive.

17. The flexible datacenter of claim 1, wherein an operational directive comprises one or more of a dispatchability directive or a forecast directive.

18. The flexible datacenter of claim 1, wherein an operational directive comprises a workload directive based on actual behind-the-meter power availability or projected behind-the-meter power availability.

19. The flexible datacenter of claim 2, wherein the remote master control system dynamically adjusts power delivery to the flexible datacenter based on a remote master control directive.

20. The flexible datacenter of claim 1, wherein the climate control system comprises a computer room air conditioner system, a computer room air handler system, an evaporative cooling system, a refrigerant cooling system, an immersive cooling system,

or any other suitable heat extraction system configured to operate the plurality of computing systems within their operational temperature range.

21. The flexible datacenter of claim 1, wherein the mobile container comprises a storage container configured for placement on a ground surface.

22. The flexible datacenter of claim 1, wherein the mobile container comprises a storage trailer on wheels.

23. The flexible datacenter of claim 5, further comprising a battery system configured to convert the three-phase nominal AC voltage to DC nominal voltage and store power in a plurality of storage cells.

24. The flexible datacenter of claim 23, wherein the DC nominal voltage from the plurality of storage cells are converted via a DC-to-AC inverter to three-phase nominal AC voltage for flexible datacenter use.

25. A method of dynamic power delivery to a flexible datacenter using unutilized behind-the-meter power comprising:

monitoring unutilized behind-the-meter power availability;

determining when a datacenter ramp-up condition is met;

enabling behind-the-meter power delivery to one or more computing systems when the datacenter ramp-up condition is met; and

directing the one or more computing systems to perform predetermined computational operations.

26. The method of claim 25, further comprising:

determining when a datacenter ramp-down condition is met; and

disabling power delivery to one or more computing systems when the datacenter ramp-down condition is met.

27. The method of claim 25, further comprising:

receiving an operational directive to go offline; and

disabling power delivery to the one or more computing systems.

28. The method of claim 25, further comprising:

receiving an operational directive to reduce power consumption; and

dynamically reducing power delivery to a subset of the one or more computing systems.

29. The method of claim 25, further comprising:

receiving an operational directive to reduce power consumption; and

dynamically reducing power consumption of the one or more computing systems.

30. The method of claim 25, further comprising:

receiving an operational directive to provide power factor correction; and

dynamically adjusting power delivery to a subset of the one or more computing systems to achieve a desired power factor correction factor.

31. The method of claim 25, wherein unutilized behind-the-meter power availability comprises one or more of excess local power generation at a local station level, excess local power generation that a grid cannot receive, local power generation subject to economic curtailment, local power generation subject to reliability curtailment, local power generation subject to power factor correction, low local power generation, start up local power generation situations, transient local power generation situations, or testing local power generation situations where there is an economic advantage to using local behind-the-meter power generation.

32. The method of claim 25, wherein the datacenter ramp-up condition is met if there is sufficient behind-the-meter power availability and there is no operational directive from a local station to go offline.

33. The method of claim 25, wherein the datacenter ramp-down condition is met if there is insufficient behind-the-meter power availability or there is an operational directive from a local station to go offline.

34. The method of claim 25, wherein the predetermined computational operations comprise execution of one or more hashing functions.

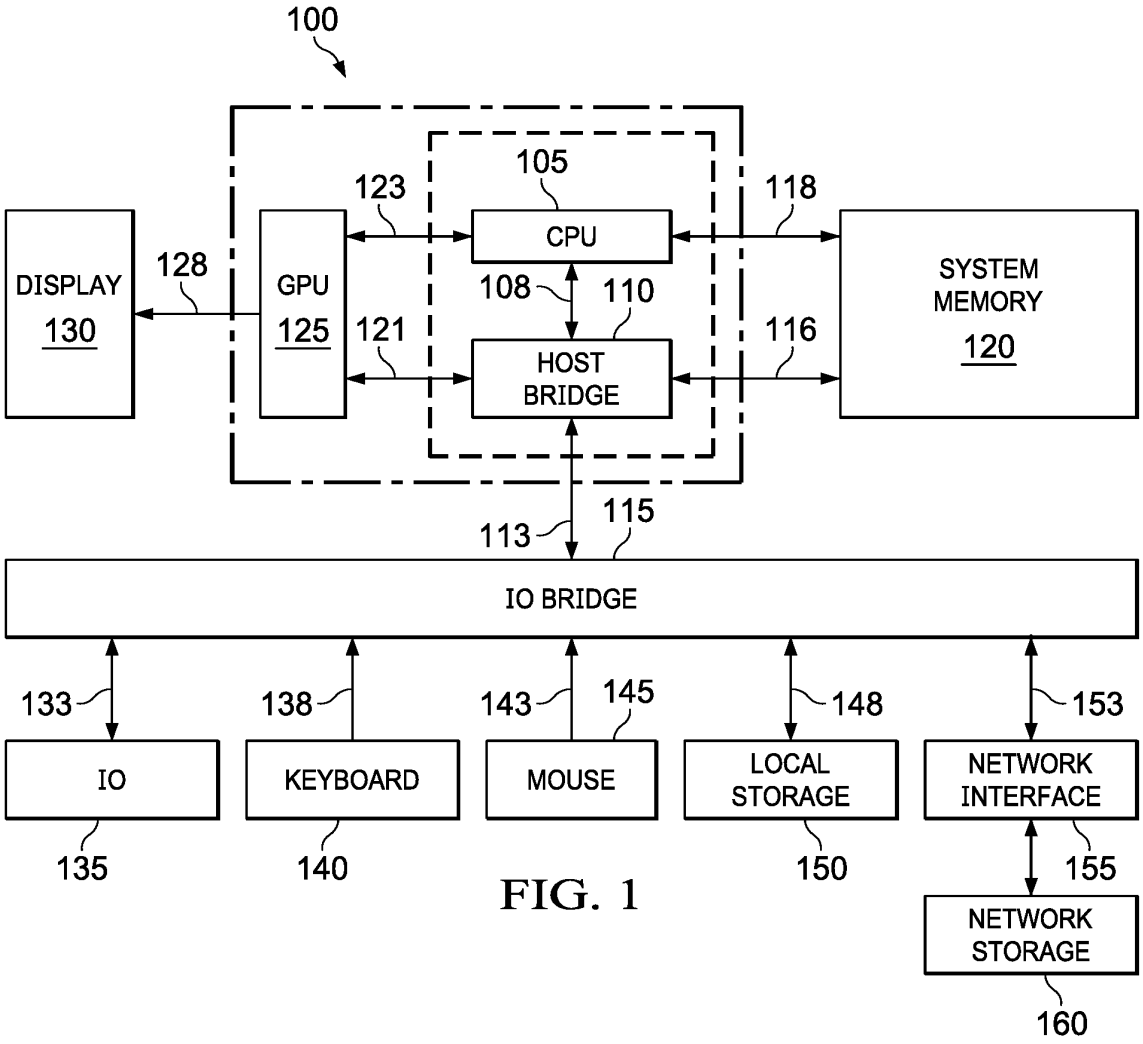

100
105
123
118
CPU
DISPLAY
130
128
GPU
125
121
108
110
HOST
BRIDGE
116
SYSTEM
MEMORY
120
113
115
IO BRIDGE
133
138
143
145
148
153
IO
KEYBOARD
MOUSE
LOCAL
STORAGE
NETWORK
INTERFACE
135
140
150
155
NETWORK
STORAGE
160

FIG. 1

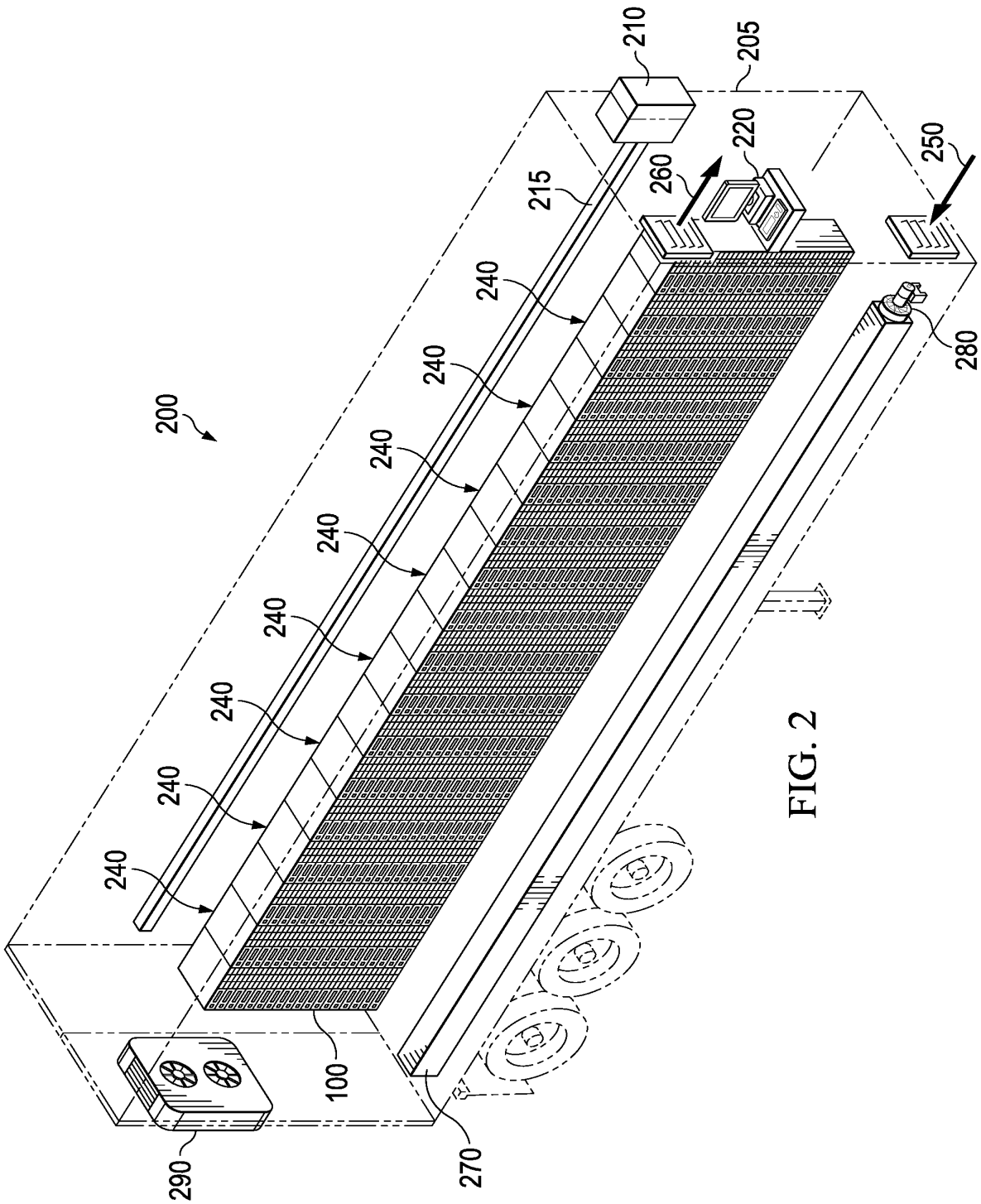

210
205
220
250
260
215
240
240
240
240
240
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240
200
280
100
290
270

FIG. 2

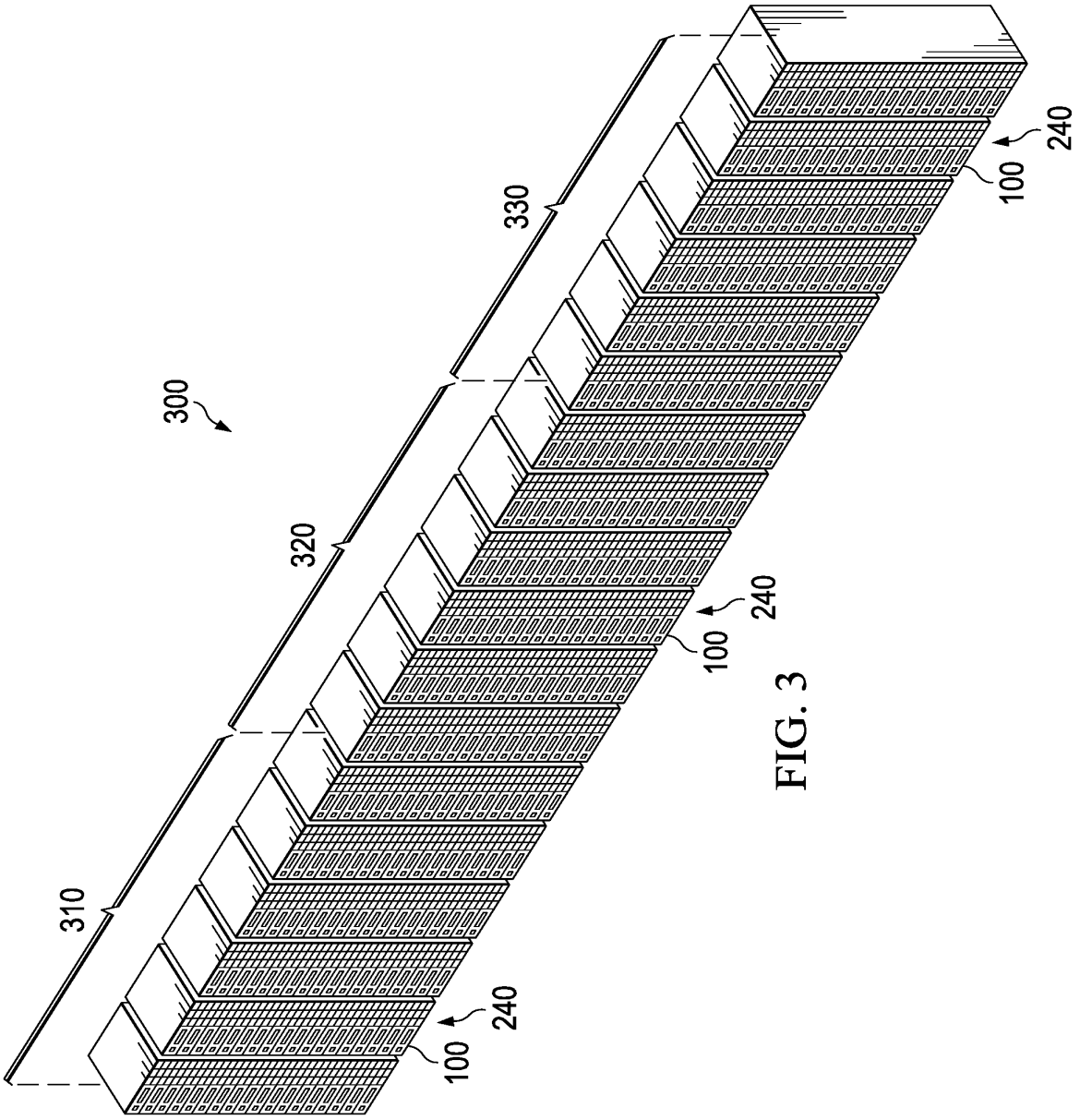


FIG. 3

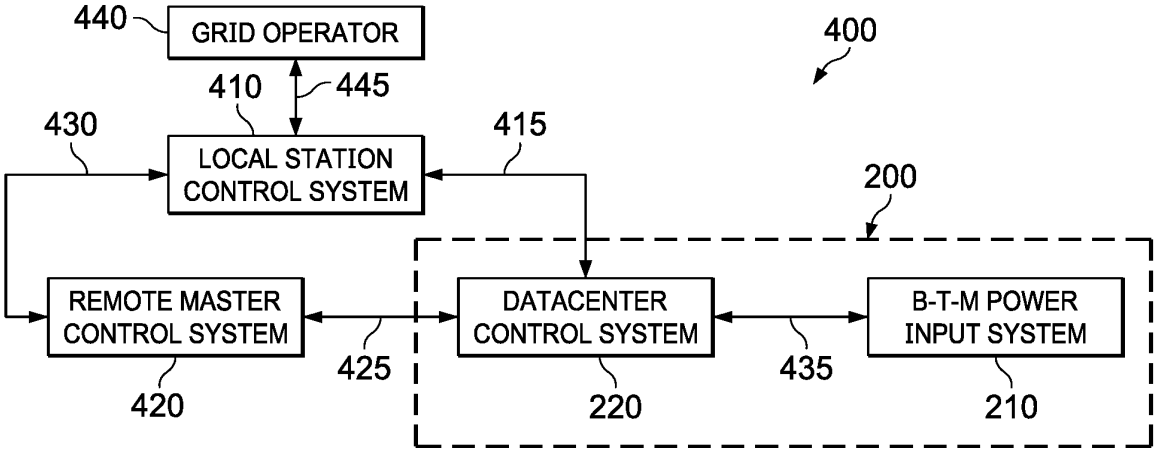

440
GRID OPERATOR
400
410
445
430
415
LOCAL STATION CONTROL SYSTEM
200
REMOTE MASTER CONTROL SYSTEM
DATACENTER CONTROL SYSTEM
B-T-M POWER INPUT SYSTEM
425
435
420
220
210

FIG. 4

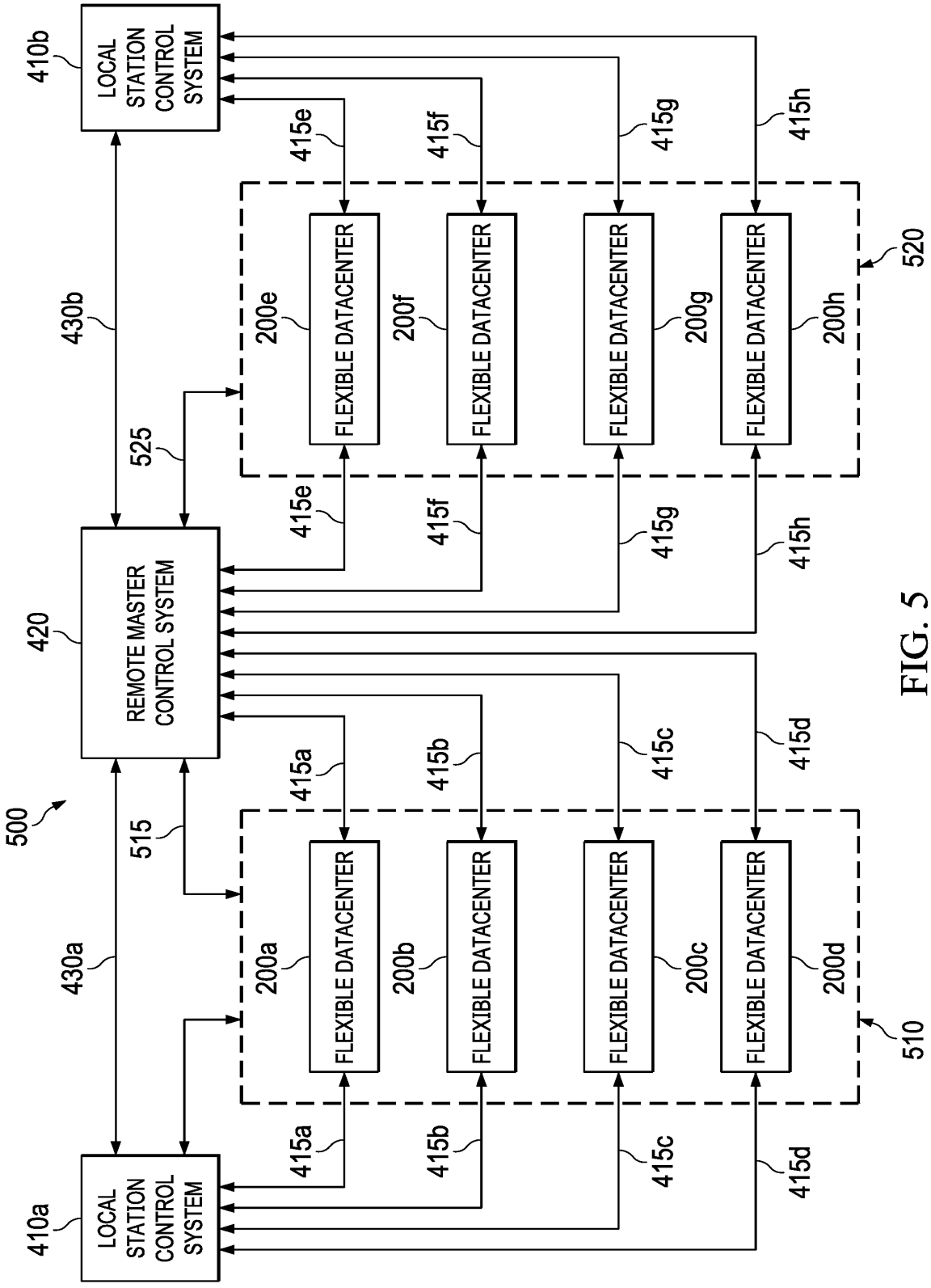

410b
LOCAL STATION CONTROL SYSTEM
415e
415f
415g
415h
520
200e
FLEXIBLE DATACENTER
200f
FLEXIBLE DATACENTER
200g
FLEXIBLE DATACENTER
200h
FLEXIBLE DATACENTER
430b
525
420
REMOTE MASTER CONTROL SYSTEM
500
515
415a
415b
415c
415d
200a
FLEXIBLE DATACENTER
200b
FLEXIBLE DATACENTER
200c
FLEXIBLE DATACENTER
200d
FLEXIBLE DATACENTER
510
430a
410a
LOCAL STATION CONTROL SYSTEM

FIG. 5

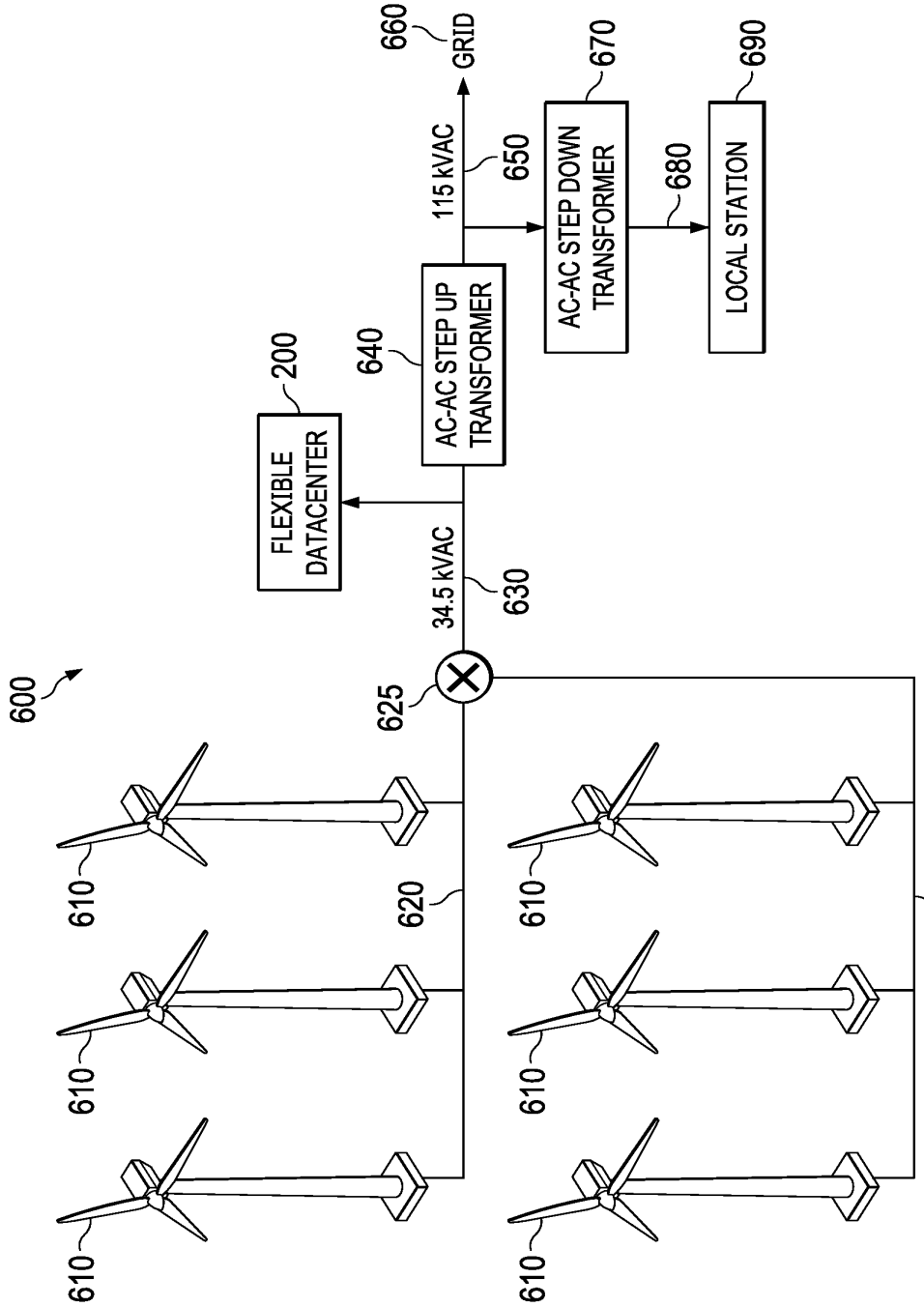

600
610
610
610
610
610
610
620
620
625
630
34.5 kVAC
640
AC-AC STEP UP TRANSFORMER
200
FLEXIBLE DATACENTER
650
115 kVAC
660
GRID
670
AC-AC STEP DOWN TRANSFORMER
680
690
LOCAL STATION

FIG. 6

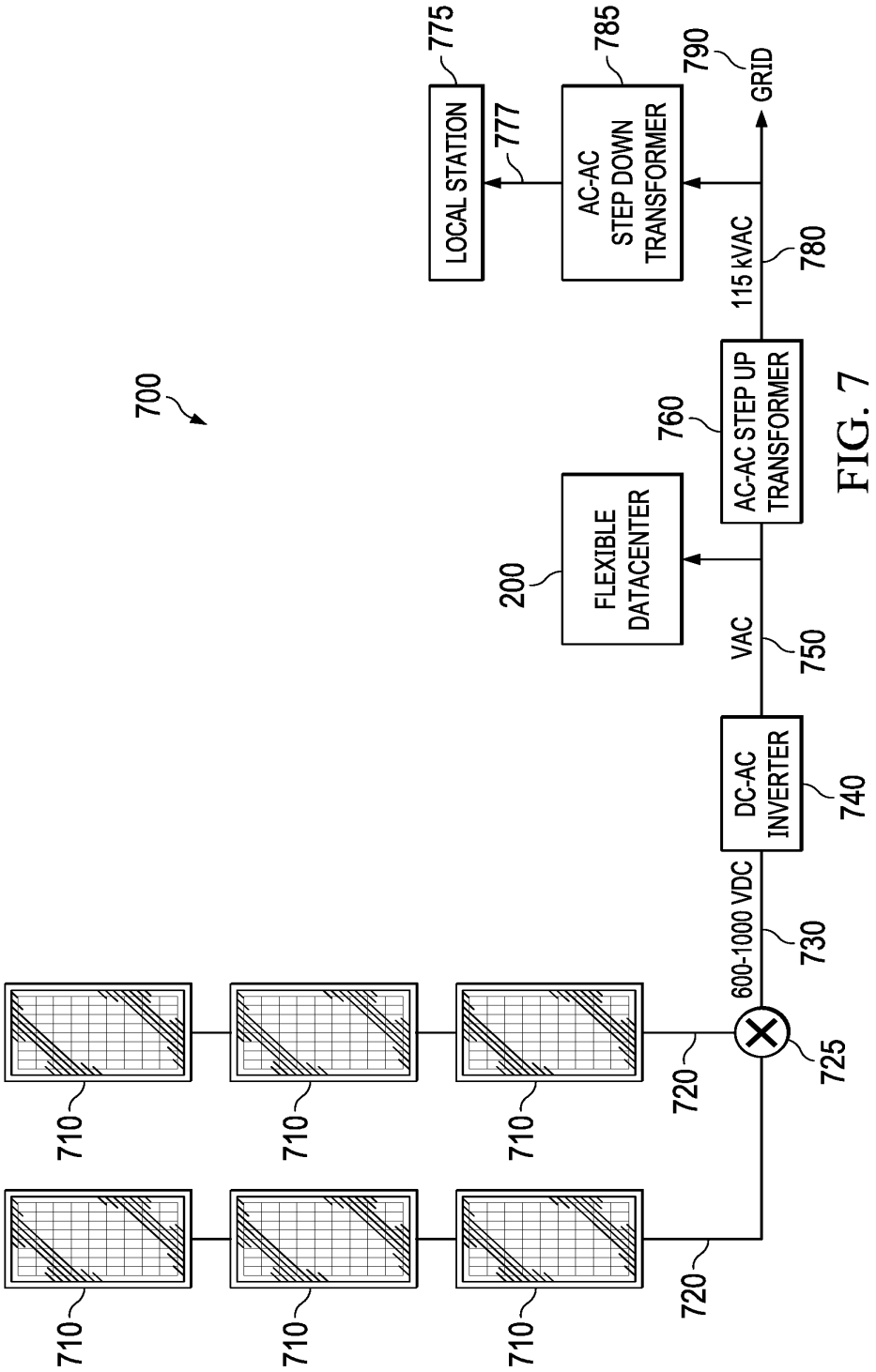

700
710
710
710
710
710
710
720
720
725
600-1000 VDC
730
DC-AC INVERTER
740
VAC
750
FLEXIBLE DATACENTER
200
AC-AC STEP UP TRANSFORMER
760
115 kVAC
780
AC-AC STEP DOWN TRANSFORMER
785
790
GRID
LOCAL STATION
775
777

FIG. 7

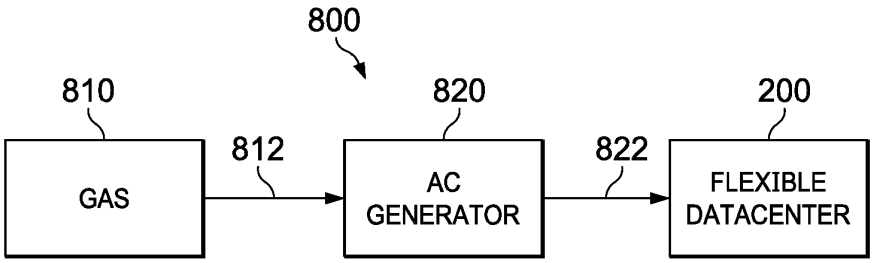

800
810
820
200
812
822
GAS
AC GENERATOR
FLEXIBLE DATACENTER

FIG. 8

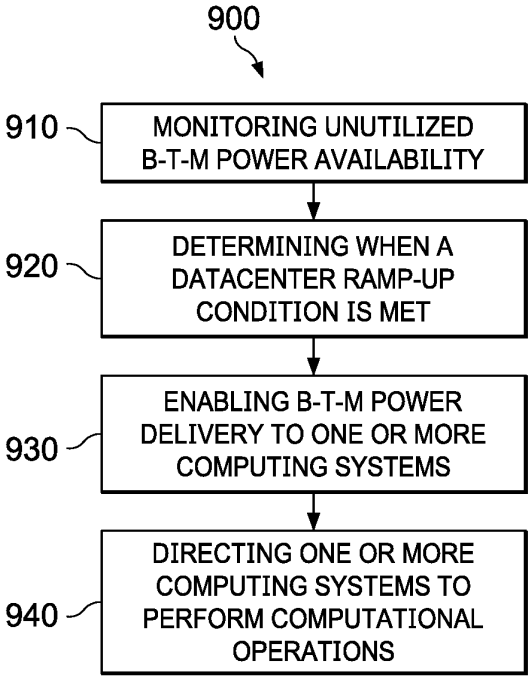

900
910
MONITORING UNUTILIZED B-T-M POWER AVAILABILITY
920
DETERMINING WHEN A DATACENTER RAMP-UP CONDITION IS MET
930
ENABLING B-T-M POWER DELIVERY TO ONE OR MORE COMPUTING SYSTEMS
940
DIRECTING ONE OR MORE COMPUTING SYSTEMS TO PERFORM COMPUTATIONAL OPERATIONS

FIG. 9