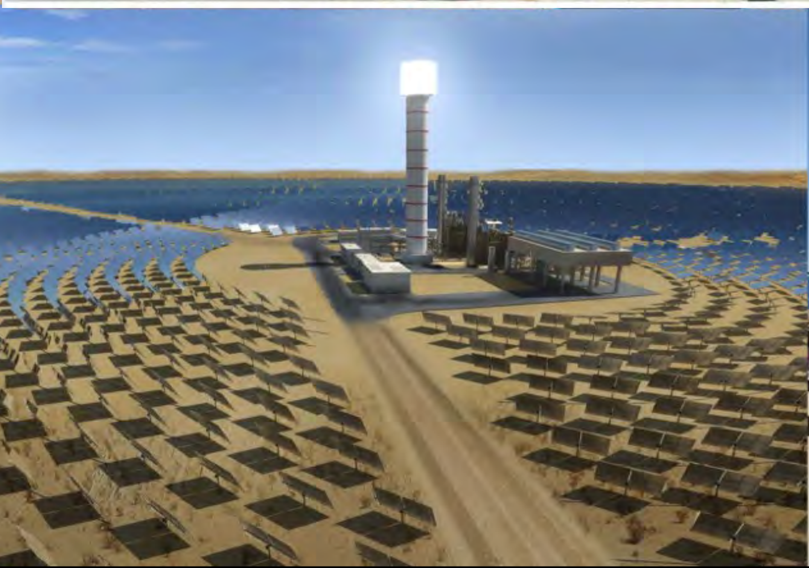
Utility-Scale Solar Thermal 2020

Manufacturing & Assembly OG-5 Solar Thermal Renewable Energy for Projects in The Kingdom of Saudi Arabia Under a LICENSING AGREEMENT

The Next Generation of Solar Thermal

Golden State Energy



CPF Solar Thermal Water & Power

A Proposal of Licensing Sustainable Renewable Energy for Economic Development

Manufacturing & Assembly OG-5 Solar Thermal for Projects in the Kingdom of Saudi Arabia – Selling to the Worldwide Market

May 20, 2020

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GOLDEN STATE ENERGY
400 Dorla Court • PO Box 12187 • Zephyr Cove, NV 89448
Phone: (775) 284-1015 • Fax: (775) 786-6661
Skype: tom.damberger

Mission Statement

To create an economic opportunity for The Kingdom of Saudi Arabia by developing a diversified energy portfolio through a Public-Private partnership and Licensing Agreement for manufacturing and assembly of proprietary CPF technology projects in Kingdom of Saudi Arabia – selling into the global market

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Abbreviations

AC	alternating current
ACF	annual capacity factor
BTM	behind the meter
BTU	British thermal unit
CAES	compressed air energy storage
CAISO	California Independent System Operator
CAPEX	capital expenditure
COE	cost of energy
CPF	concentrated point focus
CSP	concentrated solar power
DAM	day-ahead market
DG	distributed generation
DoD	depth of discharge
DOE	Department of Energy
DSM	demand-side management
DSR	demand-side response
EFR	enhanced frequency response
ESS	energy storage system
FCAS	frequency control ancillary services
FCR	frequency containment reserves
FERC	Federal Energy Regulatory Commission
FFR	fast frequency response
FIP	feed-in premium
FIT	feed-in tariff
FOM	fixed operational & maintenance (costs)
FRD	flexible ramping down
FRP	flexible ramping product
FRU	flexible ramping up
HTF	heat transfer fluid
IRENA	International Renewable Energy Agency
IRR	internal rate of return
ISO	independent system operator
ITC	investment tax credit
kg	kilogram
kW	kilowatt
kWh	kilowatt hour
kWh-e	kilowatt hour electrical
kWh-t	kilowatt hour thermal
L	liter
LMP	locational marginal price
LCOE	levelized cost of energy
MMBtu	million British thermal units
MW	megawatt
MWh	megawatt hour
MW/h	megawatt per hour
NPV	net present value
OCGT	open-cycle gas turbine
OPEX	operating expenditure
O&M	operation and maintenance
PCS	power conversion system
PHES	pumped hydroelectric energy storage
PVT	product verification test
PV	photovoltaic
QF	qualifying facility
REC	renewable energy certificate
RR	replacement reserves
RTM	real-time market
SCADA	supervisory control & data acquisition
SOC	state of charge
SRMC	short-run marginal cost
TES	thermal energy storage
T&D	transmission and distribution
ToU	time of use
VRE	variable renewable energy
W	watt
Wh	watt hour

Executive Summary

The solar technology discussed in this proposal is Concentrated Point Focus (CPF). It is important that this be carefully defined as there are only two types of this technology deployed today[1]. Simply put this technology focuses (or directs/concentrates) the suns intensity at a single location as a spot. The first technology deployed is referred at times as a "Tower of Power" that many have seen before throughout the world. It is as basic as a sun-focus technology can be. Sun's rays impinge on a flat mirror and the flat mirror reflects that energy atop a high tower. The reflective energy has as large of a "spot" as the size of the reflecting mirror, so concentration depends on the number of these mirrors which also move as the sun moves to keep the reflected spot on the tower. If you've observed such an installation it is incredibly impressive in its vast amount of acreage and the phenomenal brightness of the reflective spot. This is an early concept easy to understand, build and demonstrate but suffers from being impractical as it is more of a scientific experiment. The incredible bright spot emanating from the tower is the sun's energy never used, which is lost to the environment! Also never used is the incredible amount of heat being radiated from such a large spot. For energy to do work it needs to be contained. The concept of containment is key to the CPF technology described in this proposal and is the second of the CPF technologies.

The second CPF technology is focusing the sun's energy rather than simply reflecting it. This is accomplished using a parabolic reflector rather than a flat mirror. In comparison to the "Tower" the OG-5 parabolic technology reflects, concentrates and TRAPS the energy in a closed cavity whose entrance area is less than 6.5 cm^2.

Contained energy is the key and primary advantage of OG-5. Without containment there can be little work. Consider a contained liter of gasoline. This amount of energy will work to propel an automobile a great distance. Spill that liter of gasoline out over a surface then ignite it. Some amount of heat will be released for a short time—not much work at all.

Contained energy can heat air to 2000º F, be efficiently stored and later exchanged to produce steam to drive a turbine generator. That is the pragmatic design of the OG-5 technology but why has it taken so long to be recognized?

Stored energy is the only way to the delivery of continuous and "smooth" electrical energy but unfortunately there was very little value or even concern placed on the ability to do this until recently. Solar is intermittent going from little output to maximum output to nothing during say 12-hours. Wind profile has a similar profile throughout the day. This energy must be conditioned (smoothed) to be useful and must be available at any time and that is exactly the pragmatic design of the OG-5 technology without dependence of fossil fuel augmentation. In fact, the OG-5 system may be considered as the prime source of energy rather than an alternative source.

The technology introduced in the OG-5 system is the first to demonstrate solar collection operating temperatures of 2,000º F, inert storage as sensible heat, and delivery on-demand of smooth, uninterrupted energy. Energy delivery is decoupled from collection and capacity factor no longer depends on hours of sun. These characteristics are arguably well beyond performance barriers of any existing CSP technology systems, but CPF remains relatively unknown as a competitive variable energy producer.

About the Company

This history of the company Golden State Energy started from two entirely different companies and directions during the 1970's under different names. In 1979 Dr. Damberger set out to establish the first organization in this country to undertake commercialization of solar-thermal electric conversion with the founding of The Consortium of Alternate Energies (CAE). The second company was Omnium-G—more on that company in next section.

The long-range vision of Dr. Damberger, and that of the Consortium, was the establishment of solar-thermal energy conversion in all of its forms as a viable respected energy industry in the United States. Beyond this, he planned to offer it to the developing nations as appropriate technology in their struggle to meet basic human and economic needs.

In 1978 Congress passed the Public Utility Regulatory Policy Act (PURPA) in the midst of the energy crises that rippled through the industrial world economies.

[1] Most may consider the trough technology as CPF. Trough technology focuses the sun's rays on a line not a spot (point).

Congress acted to reduce dependence on foreign oil, while promoting alternative energy sources and energy efficiency. Due to a confluence of utility rate tariffs, and PURPA laws, the Board of Directors of CAE decided it was the right timing to enter a new service area by offering not only solar thermal energy storage, but also to install combined heat and power systems found in packaged cogeneration modules. As an organization, CAE entered the combined heat and power market.

During the same time another company, not knowing the efforts of CAE, was founded in the Southern California area—Omnium-G. Investigating the solar thermal market, Dr. Damberger discovered the manufacturer of an advanced low-cost parabolic dish which could serve as a platform for power production in remote villages in Africa & Middle East, as well as produce power to the electric grid in the US market. Both companies were very successful in deploying many solar - thermal systems for various applications.

Working together as a team, projects were developed and evolved out of which the Borrego Springs 1-megawatt cogeneration solar thermal project and 30-megawatt Chemehuevi Indian Tribe near Lake Havasu, California and African Village concepts were born. The visionaries also thought about the extreme poverty and plight of those in Africa and wanted to help by further developing and deploying a small system to pump water and produce power. The site opportunity for power production was in Kaeya Island, South Korea, supplying electricity to a small fishing village. The project was a success story providing a small amount of electricity for the locals. The water pumping concept was tested in El-Marj, Libya for irrigation pumping in an agricultural farm zone. El-Marj is an administrative division (*shabiyah* or district) of northeastern Libya, lying on the Mediterranean Sea coast near the Egyptian border. The stage was now set to roll out the proven technology to help the impoverished world through the International Monetary Fund (IMF) founded in 1952. This set the stage for developing multi-megawatt central power plants using multiple dish configuration.

Project Team Background

OMNIUM-G
ANAHEIM, CALIFORNIA USA 92801

The project team is a group of engineers and scientists with collective expertise in radar electronics, laser optics, energy management, and solar thermal energy. Four members of the original design/engineering team have remained actively engaged in the development of CPF technology since the oil embargo of 1973. The principals are sole owners of patents and trade-secrets created as partners in a California partnership called OMMIUM-G. At OMNIUM-G, they developed, manufactured, and delivered single-collector solar powered electrical generating systems fueled by CPF solar thermal technology. It was one of the first pieces of equipment in the U.S. Department of Energy's (DOE) outdoor testing facility. In May 1978, it provided the backdrop for President Carter's dedication and funding of the Solar Energy Research Institute (SERI), now National Renewable Energy Laboratory (NERL), and establishing the first National Sun Day.

Thermal Energy Storage helps to address the challenges of Capacity Factor when co-locating with solar and wind variability

Current team members were instrumental in design and testing of the first parabolic dish system tested by the Jet Propulsion Laboratory's Parabolic Dish Test Site (PDTS) in 1979[2] for commercial evaluation. Results led to a NASA sponsored (NAS7-100) JPL contract (955845) for a Hot Air System Characteristic Study to demonstrate heating of ambient air (at low velocity and pressure) to very high temperatures as the heat transfer fluid into sensible heat thermal energy storage. JPL provided staff assistance and authored a production cost analysis of the OG-7500 system for DOE[3]. Their proprietary Reflector Fabrication Process is trade protected for durable, low-cost, precision parabolic dish (mirror) collectors and remains uncompromised since 1973. This proprietary dish process is now fully automated for mass production, awaiting Feasibility Study validation and certification approval. They received the prestigious IR-100 award for one of the most important products of 1977 and hold three patents for Solar Power Plant (1978), Energy Management System (1980), and the CENICOM Solar Process (2008). A series of solar products were manufactured and delivered to customers in private industry, universities, government agencies, and individual

The OG-5 point focus dishes have demonstrated a 30-year life cycle

[2] "The OMNIUM-G HTC Tracking Concentrator", Proceedings of the First Semi-Annual Distributed Receiver Systems Review, JPL Publication 80-10, January 1980

[3] "Cost Analysis of the OMNIUM-G System7500 in Selected Annual Production Volumes", Solar Thermal Systems Project DOE/JPL 5105-23, May 1980

consumers[4] worldwide. This pioneering prior work in the design, validation, and manufacturing of single and dual collector systems, together with their subsequent design refinements serves as the sound scientific foundation upon which the current proposed solar thermal technology is built.

The team realized that commercially viable Concentrating Solar Power (CSP) systems required the collection of solar energy on a scale much larger than was possible with single or dual collector configuration. In 1986, the task of designing a system of practical size (minimizing cost) and highest efficiency began. The designers again selected CPF solar thermal process as the only viable means of achieving high temperature steam capable of driving modern high-efficiency turbines from solar thermal energy.

The combined strengths of these prominent pioneering technologists form an exceptional project team with a wide variety of professional qualifications in solar energy, large-scale projects, research and development, system engineering, testing, manufacturing engineering, and logistic services. Significant proprietary knowledge remains out of the public domain and is trade-secret protected.

After multiple refinements, and a series of progressively advanced generations of design concepts iterations, the design team arrived at its fifth-generation design – an optimally sized energy-on-demand CPF solar-thermal electrical generating system, called OG-5. The pathway to development is shown in Appendix C.

About the Technology

There seems to be an insatiable appetite for alternative electrical energy production. Wind and solar currently lead the way. The issue is simply the two sources are not exceptionally reliable. Until now, little attention or value was placed on "reliability". One expects their electricity to be available anytime night or day. How do you store the wind or the sun for use at times when neither are accessible?

For many years this issue has been the concern and focus of our project team. Now there is a technology breakthrough! The solution quite frankly, is incredibly superior to anything currently in use or proposed. Furthermore, our technique works as well with wind it does for solar. Solutions today are knee jerk reactions with little thought. With photovoltaics and wind the use of a battery is obvious. With solar thermal heat up substances that hold heat. But little or no thought is given to the on-going logistics and management. Molten salts (having good heat capacity) are corrosive, require replacement, require maintenance all of which result in limited performance and higher recurring costs. The same is true for batteries. They are expensive, short lived, corrosive and dangerous. OG-5 storage technology requires no maintenance, lasts indefinitely and never needs replacing thus virtually has no recurring costs. There is value for smooth and continuous power that must be determined when considering VRE systems[5]. A more detailed discussion of stable conditioned power from CPF solar thermal energy is contained in Appendix E.

Because of this storage technology, the company has been able to focus on reaching a unity annual capacity factor! It is doubtful that any other company can make such a claim. A unity annual capacity factor simply states that the OG-5 system can generate electricity 24 hours a day, 7 days a week, 365 days a year. Years of careful analysis backs up this claim. Launching of CPF transformative storage technology is powerful enough to ensure the realization of Saudi Arabia's vision toward variable energy goals for 2030.

Why is CPF technology important

The CPF parabolic dishes (an accurate three-dimensional parabola of revolution) focus the radiated energy to a point throughout the entire spectrum. Solar energy absorbing surface areas having the same radiation losses back to nature are very inefficient. CPF cavity-trap solar-to-air converter has larger heat transfer area and flow cross section without affecting the radiation losses from the absorber surface. In the OG-5 system, the thermal energy collected at each dish focal plane cavity entrance is transferred to the heat transfer fluid (free air) and heated to a maximum of 2,000º F before entering the thermal energy storage vault at collection efficiencies and temperatures well beyond existing CSP technology systems. Future development goals for elevated steam temperature and pressure Rankine cycle turbines are expected. CPF technology is the catalyst for advanced system integration, engineering scale-up and near-term commercial production of the next generation solar thermal systems; capable of achieving cost parity with existing electrical generation technology.

4 " http://www.goldenstateenergy.com/solar-thermal-energy.php ", Technology Background, Practical Experience and Global Installations

5 IRENA (2018), *Opportunities to accelerate national energy transitions through enhanced deployment of renewables* (Report to the G20 Energy Transitions Working Group), International Renewable Energy Agency, Abu Dhabi **ISBN 978-92-9260-084-6**

What is Water and Land Usage

Utility-scale power plants use a tremendous amount of raw water supplied from local resources to provide for the needs of the plant. To determine the overall effectiveness in thermoelectric power plants, both water and energy need to be considered. The raw water usage can be the determining factor for plant siting and permitting as it may have a significant impact on local water availability and environmental restrictions. The CPF technology used in OG-5 system is the most efficient technique to maximize steam Rankine operating temperatures and minimize energy losses, water, and land usage.

High Capacity Factor Conditioned Power

Conventional utility-scale turbine generators are stable and work continuously, but Solar generating systems are sporadic and unpredictable. They deliver energy to the grid only when sunlight is available, generally less than 30% of the time. According to the Industrial Renewable Energy Agency (IRENA)[6], renewable energy has gone mainstream accounting for the majority of capacity additions in power generators today. Tens of gigawatts of wind, hydropower and solar photovoltaic capacity are installed worldwide every year in a renewable energy market that is worth more than a hundred billion USD annually. Other renewable power technology markets are also emerging.

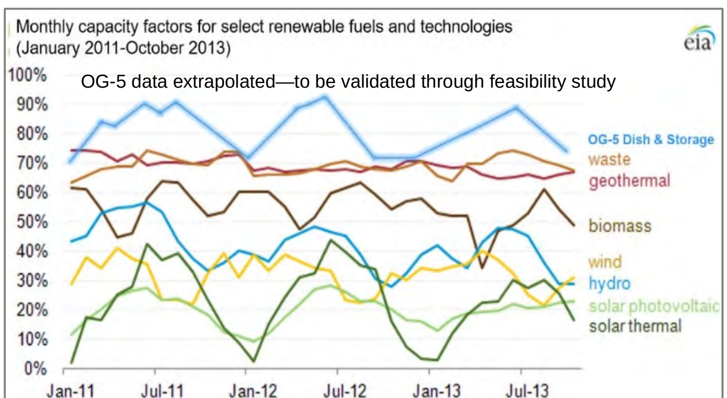

Table 1 Monthly Capacity Factors for Renewables & Technologies

Significantly, most all of the technologies to date suffer low annual capacity factor (ACF*). Capacity factor is the single most important consideration when sizing a renewable energy system.* Capacity factor may vary, but in practice will usually range from 25-30%, depending upon the geographical location. Not mentioned is when the sunlight is available it can be unpredictable and sporadic, causing instability and widespread grid blackouts. **Now, a new CPF solar thermal system is available that solves these problems with high efficiencies and has the ability to create very high capacity factors.**

It is recognized that CPF technology is the most efficient technique to maximize steam-Rankine cycle operating temperatures and minimize energy losses, water usage, and, land size. The OG-5 solar thermal system is the most pragmatic implementation of the CPF technology existing today, however it remains relatively unknown as a competitive variable energy producer.

Most importantly, the OG-5 CPF system has a theoretical limit of 97% ACF and provides continuous stable conditioned power for nearly 24/7 operation without any supplemental fuels. That is essentially a prime power plant in lieu of a solar augmentation source. After nearly 40 years of dedicated R&D, it is astounding that CPF Technology has not yet reached

Defining Capacity-Related Terms

Capacity generally refers to the maximum output (generation) of a power plant. Capacity is typically measured in a kilowatt (kW), megawatt (MW), or gigawatt (GW) rating. Rated capacity may also be referred to as "nameplate capacity" or "peak capacity." This may be further distinguished as the "net capacity" of the plant after plant parasitic loads have been considered, which are subtracted from "gross capacity."

Capacity from PV systems may be measured by either their AC or DC capacity. PV modules produce direct current (DC) voltage. This DC electricity is converted into alternating current (AC). As a result, PV power plants have both a DC rating (corresponding to the output of the modules) and an AC rating, which is always lower than the DC rating because of losses associated with converting DC to AC. AC rating better corresponds to traditional power plant ratings. CSP plants are rated by their net AC capacity in the same manner as conventional power plants.

Capacity factor is a measure of how much energy is produced by a plant compared with its maximum output. It is measured as a percentage, generally by dividing the total energy produced during some period of time by the amount of energy the plant would have produced if it ran at full output during that time.

Capacity value refers to the contribution of a power plant to reliably meet demand. The capacity value (or capacity credit) is measured either in terms of physical capacity (kW, MW, or GW) or the fraction of its nameplate capacity (%). Thus, a plant with a nameplate capacity of 150 MW could have a capacity value of 75 MW or 50%. Solar plants can be designed and operated to increase their capacity value or energy output.

Courtesy of NREL

[6] Report citation: IRENA (2012), Renewable Energy Technologies: Cost Analysis Series, Volume 1: Power Sector Issue 2/5 Concentrating Solar Power, International Renewable Energy Agency, Abu Dhabi

the marketplace.

OG-5 systems are best configurated to drive large-generator sets at a 76% ACF. This concept maximizes efficiency, maintainability, and reliability of the generating equipment. These plants can also be sized with appropriate solar multiple which provide 10-hours storage. It is doubtful any other type of solar configuration can provide the 76% ACF economically which for OG-5 system would be less than a 15% premium.

Project Description

As part of our development strategy in the Kingdom of Saudi Arabia, working together with various governmental agencies by licensing the CPF OG-5 system, Golden State Energy will work on two distinct but necessary steps.

- Build 150,000 square foot factory and its own integral Solar Power Generator to furnish all utilities for continuous factory operation at full capacity, all without traditional fuels. This factory will be replicable as many as needed in different parts of the country to meet the demand.

- Identify and Build 50 MW Solar Power Plants (or any combination of smaller plants) to form the Country's power grid and water system to all regions of the country, including the neighboring countries. This plant will be replicable as many as needed in different parts of the country, and if needed the 50 MW can be multiplied depending on the size of the project.

Golden State Energy will establish a replicable manufacturing facility employing about 650 locals from the workforce to produce solar elements for new power plants and retrofit existing power plants dependent on fossil fuel. Annual production capacity for each factory is 250,000 square meters (50 megawatts equivalent) of collector surface and supporting structure, storage, and other ancillary locally fabricated equipment. Other power plant off-the-shelf equipment such as steam turbine generators, boilers, feedwater, transformers, switching gear, and balance of plant will be manufactured in Saudi Arabia or imported from various manufacturers around the world.

GSE formed a Solar Thermal R&D division and continue the collaborative effort including a wide range of research and development activities. The Company is dedicated to a progression of value engineering projects from prototyping, exploring new materials, product validation and the pursuit of innovative manufacturing strategies such as "additive manufacturing" or 3D printing. Over several decades, GSE has worked with Sandia National Laboratory, LLNL, NREL, DOE and many other national labs including EPRI on the CPF technology.

There are many advantages to 3D printing, which include an ability to engineer entirely new structures and material combinations first developed through advanced computer modeling. While early on in its development, 3D printing is already a tool with great promise, as it utilizes an advanced and well-refined technical method using powdered material, lasers and systems able to shape layered material. Many of the materials used in the process are still being certified and qualified.

Using AutoCAD® (and other programs) we lay down one layer at a time from a digital data file. Once a digital model of whatever part being designed, then slices of it can be viewed on the screen. With additive manufacturing we create complex geometries. You can change the wall thickness or lattice structures inside to reinforce it. A lattice structure is basically like a cellular structure, so think of an atomic arrangement structure as a honeycomb structure. This tool is applied to most of the key CPF key components and manufacturing strategies. As already applied to the automated dish fabrication process, it dramatically improves quality, cost, and delivery schedules.

An adjunct to our development strategy is to employ additional workforce to build large-scale solar thermal power plants needed to populate the country's grid, while smaller units are built for grid extension to local towns and villages. These smaller units are ideally suited near hospitals, towns, and village communities. Depending on the number of plants being built, there will be several hundred additional people added to the labor force in the construction phase. There will be hundreds of full-time employees upon full commissioning of each site for operations and maintenance. It is envisioned that each power plant will be dedicated to **potable water production** with electricity as a by-product or vice versa.

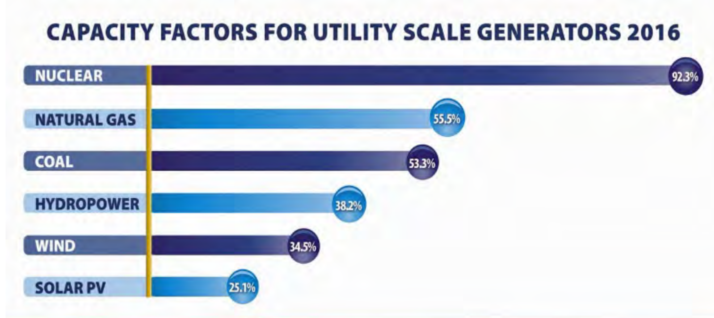

Table 2 Courtesy of US Energy Information Administration

Product Validation Plan

A comprehensive product validation plan is established to conduct a Feasibility evaluation leading to advance funding and construction of the first CPF-OG5 solar power plant installation. Approach to product validation and manufacturing demonstrates commercial viability of the next generation utility-scale OG-5 CPF solar thermal technology. First to market is possible with opportunity to sell into the worldwide marketplace.

The CPF technology proposed, when compared to all other solar processes delivering the same amount of solar energy will cause a greater value of smooth conditioned power at a lower cost, utilizing less land and raw water usage. The Feasibility project is to conduct economic value analysis and product verification testing (PVT) to validate materials used and design of key components for production (see Appendix A). These results further demonstrate viability of approach to utility-grade manufacturing of CPF-OG5 solar powered systems with 30-year service life. Successful results of the product validation plan establish a technology readiness level of TR6 to proceed with CPF-OG5 system integration and market transformation, according to DOE energy development pipeline definition.

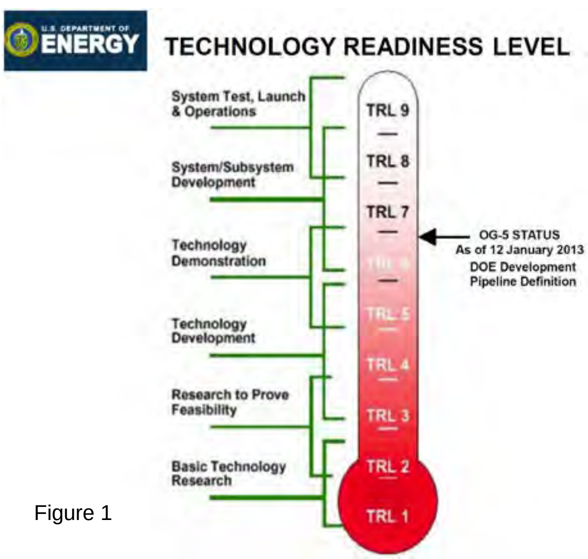

Figure 1

GSE is following an established product validation plan for progression of linear expansion from prototype to pilot-scale production rates. Maturity of this plan has been the basis of all projects proposed over the past ten years and formally described in our response to DOE proposal submitted in April 2013[7]. The Company's complete validation plan is a progression of value engineering activities from present to system integration in five (5) linear expansion stages over a period of 18-months. The timeline of activities for CPF product and power block facility is divided into two parts to accelerate earlier plant commissioning is shown in Appendix B:

Part 1-Site Independent – Contractor controlled
Part 2-Site Dependent – Deployment controlled

DOE Milestone/Deliverables Table show non-recurring costs ranging from USD$5M to USD$16.6M depending on number of arrays tested (see Appendix B-1).

An earlier generation CPF dish installed in a single testbed tracking mount is used to collect solar energy to produce hot air up to 2,500º F (1371º C). This single dish provides the non-contaminating heat source to accurately test focal plane and other high temperature heat transfer materials and components. These key components/materials operating at their maximum useable temperature are also required to withstand rapid temperature cycles from ambient to 1,200º C without loss of integrity for long service life.

The demonstration of this process validates not only the economic viability of CPF solar-derived steam generation for nearly unity ACF power plant operation, but identifies CPF technology as the only type of solar energy system having any practical impact in the goal of VRE systems. The key attribute of the OG-5 system, as compared to any other VRE system to date, is the potential saving of more fossil fuel consumption per solar BTU delivered, utilizing less land, at less cost, and less raw water. Validation of the cost/benefit and ecological impact of the OG5 system paves the way toward the most effective method of gradually augmenting or replacing conventional fossil fuel combustion polluting power sources.

Roles of Participants

The management team includes the inventors and intellectual property owners who initially developed the OG-5 design to the level it is today. The solar team is dedicated to the value engineering and product validation of the OG-5 module to achieve cost parity with existing prime energy generation sources.

The principal inventors of the design/engineering team are focused on the CPF technology development stages leading to market transformation. Bibb and Golden State Energy will execute an Engineering Services Agreement (ESA) as the basis for the Feasibility Study.

[7] CSP Heat Integration for Baseload Renewable Energy Development (CSP HIBRED), US Department of Energy. Funding Opportunity Announcement, DE-FOA-077201508, April 9, 2013

- Golden State Energy (GSE) is the lead group for this project. GSE will be delivering many of the project services including management, controls, insurance, milestone deliverables, along with many other tasks a required.

- Bibb Engineers, Architects & Constructors (Bibb) will provide the seamless experience and expertise to complete this study as a successful renewable energy project. They command a full understanding of the utility industry. Our team member has managed every phase of an energy-related project, including preparing siting studies, transmission and power supply planning studies, operations and maintenance reports, and other management assignments. Our team has the breadth, as well as the depth of knowledge necessary to successfully complete complex renewable energy projects as described in this proposal.

- Lake Basaka, Ethiopia Site. A significant need already exists for a renewable solution to the expanding ecological problem currently destroying productive agricultural land in the Metehara district of Ethiopia. Our proposal is being processed to build a CPF solar thermal water & power plant to purify water taken from Lake Basaka. Further, it is understood that any number of CPF modules can be duplicated for applications in different site locations. Only the solar field civil works and site survey guidelines are unique. Pending disclosure of a Saudi Arabia site location, an opportunity exists for early funding of the Lake Basaka Feasibility Study validation of the CPF technology disclosed in this proposal.

The Kingdom's Opportunity

In the Kingdom of Saudi Arabia electricity generation is 40% from Oil, 52% from Natural Gas and 8% from steam. Generation capacity is approximately 55GW. A looming energy shortage requires the Kingdom to increase its capacity and is planned to be increased to 120 GW by 2032.

According to IRENA, "**in 2018, the Kingdom reported burning an average of 0.4 million barrels per day (b/d) of crude oil for power generation, the lowest since at least 2009.**
https://www.irena.org/Search?keywords=future+of+csp
Saudi Arabia consumes considerably more crude oil directly for power generation than any other country. Between 2015 and 2017, Saudi Arabia used more than three times the amount of crude oil for power generation than Iraq, the second-largest user of crude oil for power during those years."

GSE has the background and unique renewable energy technology to strengthen Saudi Arabia's infrastructure at the local level by providing electricity and clean water for drinking and agricultural irrigation to the citizens from all regions. In the process, without using any fossil fuel or molten salt, the scaling of individual solar powered electrical generation plants ultimately become building blocks for creating the Country's overall water and power utilities, and consequently our technology will save the Kingdom over a million barrels a day of crude oil and natural gas which could be exported. In October 12, 2019, the Guardian reported that **"UAE, the frontrunner in the region responsible for nearly 70% of all installed renewable capacity in the Arab Gulf in the past four years, has increased its oil production by 800,000 barrels a day over the past decade."** Additionally, the licensing agreement will allow the Kingdom to be the **ONLY** exporter of the technology which will generate huge revenue in foreign currency to the Kingdom.

GSE developed the first potential sale of a solar desalination plant at Lake Basaka in Ethiopia using three different technologies including CPF Solar Thermal to desalinate over 119 million liters of brackish water daily. This is the reason for the request for funding of the Feasibility Study which is attached in Appendix D. Technical description supplement of three key elements of this study are shown in Appendix A. Assuming this project is funded by Saudi Arabia, they may choose to Build-Own-Operate, Build-own-Transfer or any combination which are traditionally used as tools of finance. Results of this Feasibility Study will validate this technology on a large scale (Appendix B).

Other countries such as Vietnam, Brazil, Nigeria and Mexico have voiced interest in installing this technology for water and power projects. Furthermore, this Feasibility Study becomes the foundation for using solar thermal for power generation, industrial applications, enhanced oil recovery, or water desalination for in-country uses, or for sale to the world market.

The OG-5 system will facilitate in accomplishing the Kingdom's, GCC member countries, and MENA's renewable power generation plans. By using our 100% renewable energy technologies which are cost effective and more efficient than any other renewable, makes KSA the hub for a huge pent-up demand for this technology. A Feasibility Study of new CPF technology project is expected to determine the possibility of developing a CPF power plant at a selected regional

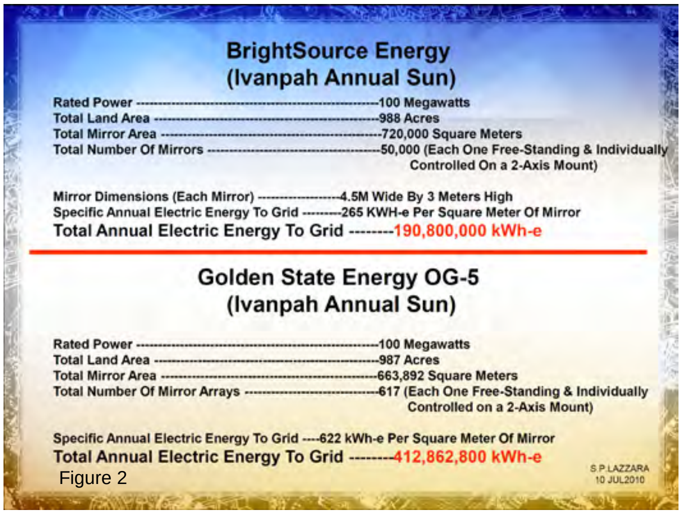

Figure 2

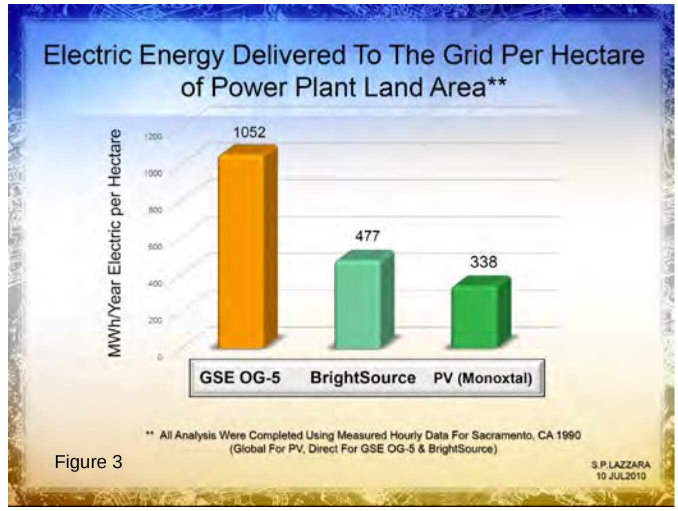

Figure 3

site location (Appendix F). As described in this proposal most all the components are ready to produce. However, validation and certification of the automated dish fabrication process is vital to mass production success and may require supplemental funding to quality the single long-life pattern mold before the two-step automation process begins.

Potential Direct Competitors

As a serious evaluator and reader of this proposal, you are beginning to realize the significance a new generation technology, called CPF Technology. Very little reference is made to obsolete technology, called CSP Technology. History provides sufficient evidence to doubt the economic success of any VRE scheme. Making practical use of both successes and failures provide the necessary steps to avoid the pitfalls of the past. This allows the goals for both performance and economic success of the next generation VRE systems to exceed expectations with responsible risks.

The focus of this proposal is to foster an awareness of how much progress has been made to provide a practical commercial scale solar energy generating system. As previously mentioned, the "Tower of Power" was the first implementation of a way to capture solar energy and put it to work. Still in use throughout the world, little has changed since its inception. It is simple and easy to understand.

But the newer technology presented to you is the result of over 40 years of dedicated research to create the most cost-effective system to date. We liken our growth and philosophy to the automobile industry. Practical autos today provide the most economical, reliable and long-lasting way to go from point A to point B. We too are dedicated to creating the most economical, reliable and long-lasting way to put solar energy to work.

We are keenly aware of your 2030 energy goals and know the OG-5 technology will be an asset and complement to this worthy ideal. As the auto, one expects to reach their destination without failure and sufficient energy. With commercially provided electricity, it is expected and needed all the time! No other alternative technology is available today that can make the claim of 100% availability. Though competitors may balk we fully expect the opportunity to become a viable partner as you give our proposal serious consideration.

The competition uses several different technologies to generate solar energy and the method of using solar cells has been given the most notoriety. Solar cells generate electricity directly when illuminated by sunlight using an electrochemical reaction. Since solar cell systems are very expensive, an alternate method is to utilize Concentrating Solar Power (CSP) to thermally produce power by using heat engines to turn generators. There are three types of CSP technologies apart from the CPF technology that are considered to generate electricity, they include:

1.) Trough systems use line focusing mirrors
2.) Tower systems use reflector field of flat mirrors on a target atop a tower
3.) Single mirror point focusing systems convert heat to electricity using a generator at the focal point, but never commercially available

The efficacy of each of these CSP systems is determined by the receiver upon which they focus the sun's energy. This receiver determines the ultimate temperature the system can achieve and the higher the temperature the better for storage of energy. Higher temperatures also increase the efficiency of the generation of electric power.

In comparison, the GSE/OG-5 system uses CPF parabolic mirrors to focus the sun's energy in a linear converter configuration. This converter has a small opening located at the mirrors focal point to allow the sun's rays to enter. Once inside, the rays heat the receiver material that in turn heats air to the working temperature of 1,093° C. Losses from the receiver to the atmosphere are limited in a cavity receiver. Conduction and convection losses are limited by insulation and design shape. Radiation losses are limited by the small aperture of the converter.

Higher efficiency is due in part to higher operating temperatures providing more efficient conversion to electricity. The GSE/OG-5 system allows for un-interrupted power delivery making it superior for connecting to grids. PV systems, Windmills, and Sterling engine-base systems are all sporadic power deliverers. They require backup if the wind stops or the sun is obscured by a cloud. Cost is a major factor in determining the winning technology for non- polluting electricity generations. The GSE/OG-5 system provides kilowatt-hours at costs that are approximately 25% of those delivered by PV systems. It is also approximately 30 to 90% less than other CSP systems.

It is concluded that these companies will continue to be successful, as long as there are significant government subsidies. These subsidies are reduced as the burden increases and as the impact of trough system's lower cost affects the market. And is reduced further when the GSE/OG-5 impact is apparent, especially for systems greater than 200 kilowatts. As other systems have higher costs and are polluting, once GSE/OG-5 has operating experience, they win the competitive battle. The tower of power system will gain a few government sponsored installations and are viewed as being a force in the commercial market. Sterling Engine systems may become a force if they can get the manufacturing volumes up to automobile levels. Since they are a sporadic power producer, we do not believe they will be able to achieve their desired scales of economy. Wind Generator systems will continue to be a force in the marketplace, but believe they have a limit of 20%± of the grid power because their technology is sporadic. The GSE/OG-5 system will be able to balance the sporadic effects of wind and PV solar cells. Presently, GSE views wind farms and PV power plants as a large potential vertical market for the GSE/OG-5 systems.

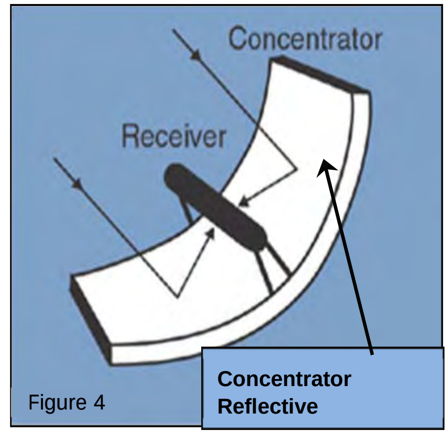

Figure 4

Trough systems focus the sun on a long receiver pipe. The better systems insulate the pipe and only allow the energy to impinge on the evacuated heat collector element in the pipe. This pipe however is many hundreds of meters long and becomes a serious leak of radiant energy from the line receiver. This limits the temperatures that can be obtained by troughs to about 390° C. Due to this low temperature, heat storage is limited to several hours of storage. And to increase the efficiency of the power conversion a natural gas fired boiler is used to raise the temperatures of the steam to meet the requirements of modern steam turbine generating systems. This energy from natural gas is about 25% of the energy used to produce electric power. Thus, these plants are essentially, carbon polluters. There are several companies involved in these systems. KJC Operating Company has been operating large parabolic trough solar power park at Kramer Junction in Boron, California for over twenty-years. Solel (formally LUZ) was the originator of the troughs and produced the fields that KJC now operates. Albengoa is putting in trough plants in Spain and other Mediterranean Countries.

Comparison of Point-Focus & Line-Focus Technologies*

*using pure solar-thermal energy only

250 Acre Site Using Daggett Solar Data				
Parabolic Dish Concentrator (Point-Focus)		Parabolic Trough Concentrator (Line-Focus) (Per Sandia National Laboratory Data)		
Turbine-Generator Size	Annual Capacity Factor	Turbine-Generator Size	Annual Capacity Factor	
30 MW	0.55	30 MW	0.28	
40 MW	0.41	40 MW	0.21	
50 MW	0.33	50 MW	0.16	It is doubtful that Line-Focus can store enough energy to operate with these combinations.
60 MW	0.28	60 MW	0.14	
70 MW	0.24	70 MW	0.12	
Collector Area: 244,417 m^2		Collector Area: 244,417 m^2		
Annual Electrical Generation 593 $kWh_{-e}/m^2/yr$		**Annual Electrical Generation** 299 $kWh_{-e}/m^2/yr$		
Annual Electricity Production 144,939 MWh		**Annual Electricity Production** 73,080 MWh		

Table 3 CPF produces twice the energy with same collector area

As described in this document, GSE OG-5 is a highly improved Next Generation of the trough system seen worldwide. CPF is in fact, the Next Generation of Solar Thermal technologies.

The system can be sized (configured) to deliver energy continuously 24-hours per day, or specific amount of energy on-demand, or all its stored energy only during the most profitable time-period (on-peak). Ability to store and deliver energy on demand ensures that supply and demand are always in balance. Thus, generation plants and transmission equipment do not face 'shut-down'. The OG-5 on-demand conditioned power is compatible with the electric power grids worldwide. The concept of stable conditioned power from solar is shown in Appendix E.

A CPF OG-5 storage vault core can be charged using embedded electrical heating elements connected to a wind turbine generator to improve their economic viability. The added benefits from this vertical integration include the following:

1.) The wind generator does not have to be as sophisticate as they are now. The power does not have to meet grid parameters. It can be highly variable in terms of voltage and frequency (DC if the wind turbines are at some distance from the vault). This allows a much wider set of operating parameters for the wind turbines and thus more of the energy is extracted from variable winds. The turbines can be smaller, thereby quieter, less susceptible to turbulence from adjacent turbines, thereby can be closer together using less area for a given output. They can produce power at lower velocities because they are smaller with less inertia. All of this "de-sophistication" can lower the cost of wind turbines. It may be with some ingenuity the smaller turbines can have bird protection.

2.) The interconnection of the generators and the vault heaters (chargers) can be at high voltage DC so that a fairly large expanse of wind turbines can be connected to a single vault.

3.) The vault can discharge its energy into the grid at peak times or a series of vaults can be multiplexed to provide a portion of the base requirements. This allows ISO's or grid managers to actually rely on wind power for a significant and known time period.

4.) With planning, the low-level heat from the Rankine cycle prime mover system can be used because there is great flexibility in the siting of the vault and turbine/generator system

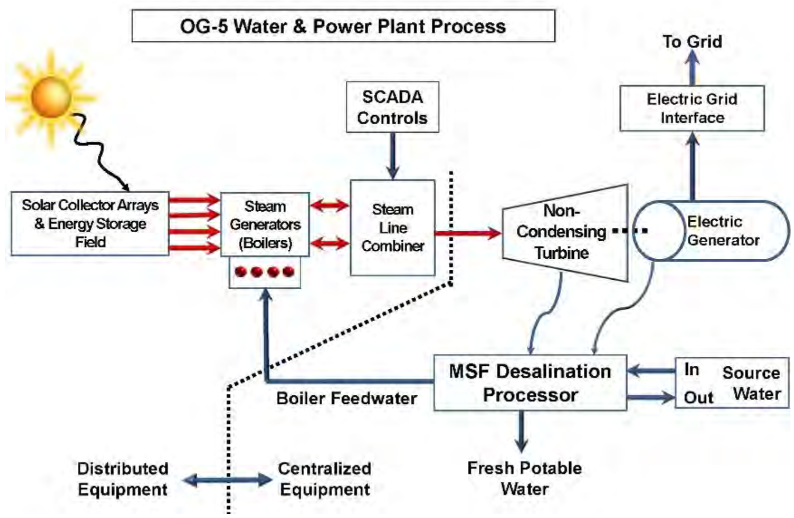

Figure 5. Simplified Schematic Diagram of the OG-5 Process

GSE/OG-5 CPF Comparing to the Noor of Morocco

The Morocco NOOR project of 2000 MW plan, at a cost of 9 Billion USD has become the largest in the world, which includes of three technologies; Tower, Trough, and PV. This project is using parabolic trough technology with the capacity of storing the heat for seven or less hours at night using molten salt, liquid metals, organic fluids and/or thermal oils.

According to World Bank, CIF (Climate Investment Funds) & CTF (Climate Technology Funds) http://pubdocs.worldbank.org/en/608591486394607927/MENA-CSP-Knowledge-and-Innovation-Program-EN.pdf)
Noor 1 (parabolic trough technology, 160 MW, **three hours storage**) is in operation. It provides electricity at **USD$0.184/kWh**. Noor 2 and Noor 3 (parabolic trough and solar tower respectively, 340 MW in total, and **up to eight hours storage**) are in an advanced state of construction. They are contracted to provide electricity at **USD$0.157/kWh.**

GSE's OG-5 CPF technology has developed a parabolic dish (mirror) requiring 50% less collector surface area than the competitor's mirrors, reaching operating temperatures up to 2000° F (1093° C) see Table 3. The collected heat is stored for more than 12 hours without using any fossil fuel or molten salt, which makes CPF technology less expensive than any other solar-thermal technology and very efficient. Typically, it is estimated that the OG-5 system will deliver power at USD$0.06/kWh or less.

Placement of first manufacturing facility in The Kingdom of Saudi Arabia offers job creation for at least 650 skilled and non-skilled people and appropriate training of the work force. Production expansion of solar powered plants is expected to satisfy the needs of The

Kingdom of Saudi Arabia and other nations as well, assuring stability and economic growth. The largest build-up of Concentrating Solar Power (CSP) capacity is expected in Middle East and North Africa (MENA) where 1430 megawatts of projects have been announced. Growth has been spurred by funding from World Bank, the Union for the Mediterranean, the Desertec Industrial Initiative, and the Evergreen Project.

Integrated CPF Solar Plant: Clean Water and Flexible Power

Sandia National Laboratory and GSE worked together to design an innovative solar thermal desalination system suitable to sites in the Southwestern U.S. and desert areas of the world to provide inexpensive drinking water and electricity in a flexible manner by varying the amounts of thermal energy stored, converted to electric power, or used for desalination. All the energy to drive the system can be provided by a unique, low-cost, high-collection and receiver efficiency, concentrating solar field of modular units of parabolic dishes coupled to a novel thermal energy storage system. On board PV panels can be installed to sustain or conserve internal parasitic power for keep-alive operations and automated maintenance activities. In either case, the system produces no on-site greenhouse gasses. The energy storage aspect allows the system to operate at a high capacity factor, and importantly to provide electricity at times of peak demand (and peak price). This improves the economics of the system when selling water at the <$0.50/m^3 cost target of the challenge. The solar thermal energy is ultimately used to produce steam, which drives a non-condensing turbine. Lower temperature steam and electricity exiting the turbine is used to drive the water purification system. SCADA control platforms regulate the relative amounts of energy used for each end purpose to optimize the economics.

A commercially available Multi-Stage Flash (MSF) water purification system designed for use on cruise and military ships was chosen for the baseline design case, for its robustness, minimal feed pretreatment requirements, operability, and reliability. Additionally, the team had access to detailed and reliable cost and performance data for this particular system. Additional work to further refine the design and techno-economic evaluations and particularly of the desalting apparatus and downstream operations is recommended, and could include novel approaches to pretreatment to improve performance (e.g. maximize recovery, minimize discharge, maximize the gained output) and cost metrics.

CPF Solar Water Module

Each independent water module operates from a solar collector field of four quads (16 arrays, 4 steam boilers),

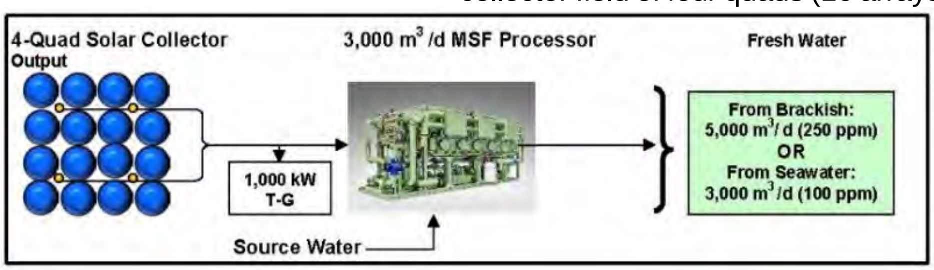

Figure 6 Schematic of the Solar Collection and MSF Processor

Water Module Output	Quantity (1)	Quantity (6)	
Annual Freshwater Output	1,095,000	6,570,000	Cubic Meters
Total Annual Electric Energy Generated	8,143,151	48,858,906	kWh_e
Annual Electric Energy Required by MSF Unit	4,905,600	29,433,600	kWh_e
Annual Electric Energy Required by Solar Field	704,000	4,224.000	kWh_e
Annual Electric Energy Required to Pump Water, est.	33,551	201,306	kWh_e
Annual Surplus Electric Energy Solar to the Grid, est,	2,500,000	15,000,000	kWh_e
Land Area Required	23.7	141.9	Acres
Solar Collector Intercept Area	17,120	102,720	Square-Meter

Table 4: OG-5 Solar Powered Water Output Specifications

grouped together with a 1,000 kW non-condensing steam turbine, and an MSF distillation processor rated at 3,000 m^3 per day capacity. Any number of these solar-powered modules in Figure 6 can be duplicated for centralized or distributed water applications at any location with adequate land and sun condition. For the Lake Basaka, Ethiopia site, a central grouping of six (6) OG-5 modules are co-located adjacent to the OG-5 Power Plant to produce 6,570,000 m^3 (6.57 billion liters) annual fresh-water production from seawater.

Note each module generates sufficient electrical energy required by MSF unit and solar field, as well as pump source, return, and product water. Surplus electric energy is delivered to the grid.

The system is designed to provide fresh water and electricity in a flexible manner by efficiently varying the amounts of heat and power to prioritize water and/or electricity as needed. Figure 6 illustrates a schematic of a single water module. As described above, there are three operating modes: grid priority, water priority, and idle. Electricity is scheduled to be prioritized over water for the summer super peak during which the favorable weighting provides an opportunity for arbitrage. Otherwise, water provides a more favorable return. Water module output specifications[8] for single and centralized group of six are provided in Table 4. In addition to the Siemens 1,000 kWe nameplate turbine, the initial design specified two Hamworthy MSF 1500 systems rated at 1,500 m^3/day each from seawater, able to produce 3,000 m^3/day fresh water from Lake Basaka water source.

Description of the Design

In this OG-5 system design, CPF technology is applied to an innovative solar-thermal desalination system that powers a non-condensing steam turbine-generator and a robust thermal distillation system. Important advantages of CPF technology over other competitors are the ability to capture and utilize a larger fraction of the solar spectrum, and the relative ease, lower cost, and efficiency of storing heat rather than electricity. Solar thermal energy is sustainable and, with storage, a source of dependable (dispatchable) around-the-clock power and, in this case, co-production of water.

Figure 5 is a schematic of the clean water and power process for any number of these self-powered water modules able to be duplicated for centralized or distributed water applications at any location with adequate land and sun conditions. Figure 6 is an example, at the Lake Basaka Ethiopia site, a central grouping of six (6) OG-5 modules are collocated adjacent to the North border of the proposed 70 MW OG5 Power plant. This grouping produces 5,570,000 cu-m (1,735 million US gallons, or 6.57 billion liters) annual clean water production from seawater. This grouping of modules generates sufficient electricity required by the MSF equipment and solar field arrays, as well as pump source, return, and product water. Annual surplus electricity is applied to the grid.

Figure 7 is a modular array of CPF collectors grouped together in a land area of 23.7 acres (9.6 hectare, 95,910 m^2) and having a total solar intercept area of 17,120 m^2 concentrates solar energy to produce high energy heat. High HTF temperatures (1,093º C) are achievable using a series of high precision dishes working together with thermally efficient receiver subassemblies (consisting of a series of cavity-trap converters in a modular configuration). The energy is aggregated at the module level and stored as sensible heat through a direct coupling to a novel thermal energy storage system (TES). The TES stores sensible heat in well-insulated vaults containing a unique, low-cost, well-characterized, inert solid storage media. Thermal energy is dispatched from storage alone, or in combination with contemporaneously collected energy, to produce high quality steam using conventional steam generators distributed near the storage. The steam is provided to a centralized system to drive a

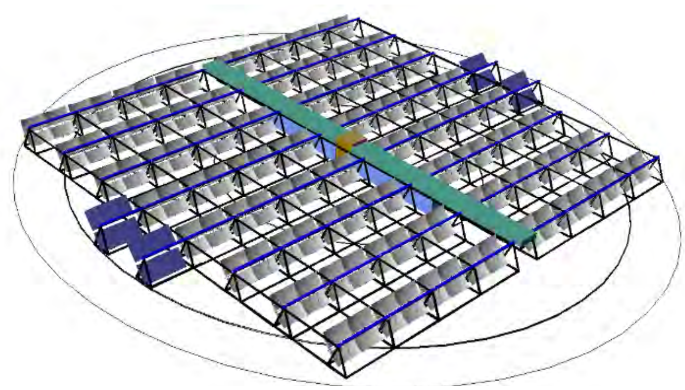

Figure 7 Two-axis tracking array of 128 elevation tracking dishes & eight PV modules w/swing circle 253.75 feet (77.3 meters) & land area of 1.46 acres (0.59 hectares)

commercially available non-condensing steam turbine-generation and a MSF desalination system. The baseline MSF system is a robust system designed and sold for use on cruise or military ships or even land-based systems. As shown in the schematic, waste heat (steam) from the generator is routed to the MSF apparatus. A control system varies the amounts of heat and power to prioritize water and/or electricity as

[8] Performance determined using actual direct sunlight measured hourly at Daggett, California for the year 1990

needed or to optimize the system economics. Electricity generated by the system can be dispatched to power the facility itself and/or feed the power grid. The high steam temperatures allow us to project annual "sunlight-to-electric" conversion ratios better than 17%, and still having a thermal output for the water desalination. Optional PV modules sustain or conserve internal parasitic power for solar collection field keep-alive tracking operations and maintenance activities.

A key feature of the OG-5 is the modularity of the collectors, energy storage, and steam generators, coupled to a centralized production facility. Modularity is a concept that is gaining increasing attention and acceptance for its advantages in manufacturing and fast learning curves. For the case here, modularity has the added advantage of providing operational flexibility. The thermal energy storage is critical for our system as it facilitates virtual around the clock operation, which has the advantages of (1) very high capacity factors of the centralized power and water production equipment; (2) grid services (arbitrage or demand response); and (3) potentially qualifying for incentives (e.g., 30% investment tax credit, energy storage credits (the latter not considered herein). Each of these advantages can improve the potential profitability of the system.

The OG-5 solar thermal system can be sized (configured) to deliver energy continuously 24-hours per day, or specific amount of energy on-demand, or all stored energy only during the most profitable time period (on-peak). Ability to store and deliver energy on demand ensures that supply and demand are always in balance. Therefore, conventional generation plants and transmission equipment do not face emergency 'shut-down' or damage. The on-demand conditioned power is compatible with the electric power grids worldwide. The concept of stable conditioned power from solar is shown in Appendix E.

In contrast, PV solar cells, windmills, and other engine-based systems without storage are all sporadic power generators and incompatible with national/local independent grids. In fact, the solar thermal system is able to balance the sporadic effects of these technologies for connection to the grids.

Each of these advantages can improve the potential profitability of the system. A brief description of the individual system components is provided below.

The OG-5 Parabolic Dishes Reflect the Entire Spectrum of the Sun, Both Visible and Invisible Which is Far Beyond What the Human Eye can See

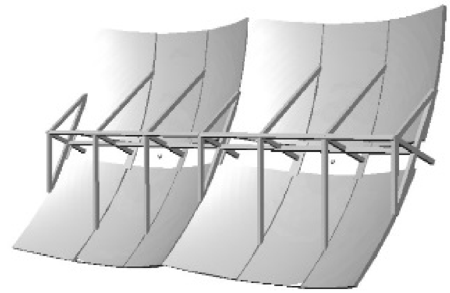

Figure 8: Collector Geometry

Advanced Collector

CPF dishes have superior optical characteristics, high specular surface over the entire energy spectrum of the sun (from radio waves and infrared to ultraviolet) and have been proven in the field to have 30-year long service life. For this application, we introduce a new 3-meter square dish (factory automated process and no manufacturing drop waste) that is directly interchangeable and self-aligning with existing 3-meter octagonal dish (round with eight wedge segments).
The dish concentrates and focuses sunlight into a 6.35 cm diameter circular aperture to ~2000 suns. The 3m x 3m dish has a solar intercept area of 8.36 m^2 (net collector area) consisting of four precision-shaped parabolic dish segments, each 2.09 m^2 and 7.8 kg. Total dish weighs 31.2 kg. Compared to the round dish, the square dish (Figure 8) has 14% more collector area, 47% less weight, and zero factory waste. The automated dish fabrication technology is cost-effective and ideally suited for mass production and ensures shape and reflectivity stability over a 30-year life span in all global environmental and temperature zones. Each dish segment is interchangeable and self-aligning. Dishes are capable of withstanding harsh environments, wind loads, wind buffeting (85 mph maximum non-gusting operational wind speed and 120 mph maximum survival wind speed,) while accurately and reliably focusing collected sun rays into the 6.35 cm

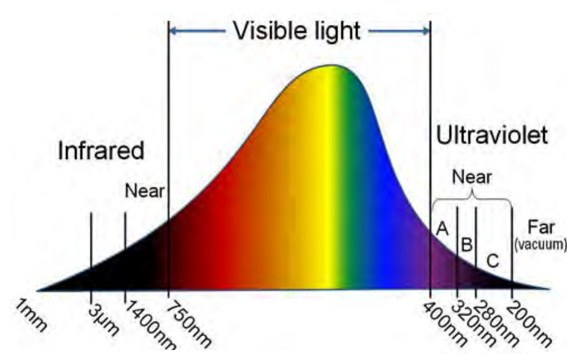

Figure 9 Visible Light Spectrum

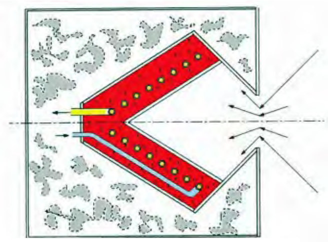

Figure 10 Cross Section like OG-5 Cavity Receiver

Figure 11 Outside Surface Absorber Technologies Without Cavity Receivers—Examples of Extreme Heat Loss, Low Temperatures & Inefficiencies (Line-Focus, BrightSource, AREVA

aperture. (< 2.0 mrad optical error in both calm and windy conditions). The surface is fracture-proof against wind-driven hail.

Advanced Receiver

The receiver subsystem (Appendix A) consists of a series of individual-dish-level devices for capturing the sun's focused radiation to heat the transfer fluid (free air) with minimal losses.

High thermal efficiency greater than 90% is achieved by conversion of concentrated solar radiation to heated air inside an insulated cavity with small entrance opening. Ambient air injected into the focal-plane is heated to maintain a set temperature of hot air exiting the components. Thermal solar thermal energy collected at each dish is transferred to the heat transfer fluid (HTF), then transported to the storage vault as sensible heat up to 1,093º C.

Solar Collector Array

The collector array is designed for low profile survivability, improve reliability and minimize costs. Standard modules of CPF dish concentrators are mounted on a common carriage frame able to move in azimuth position to allows all dishes to track the sun in elevation as a single unit. Dishes are arranged in standard 16 half-row groups of eight closely coupled dishes for a total of 128 dishes having a total solar intercept area of 1,070 m^2 (Figure 12). Each dish is mounted on its own half-row elevation tracking dish carriage assembly to permit individual dishes to track the sun in concert with all 16 standard modules on the azimuth-tracking full array platform.

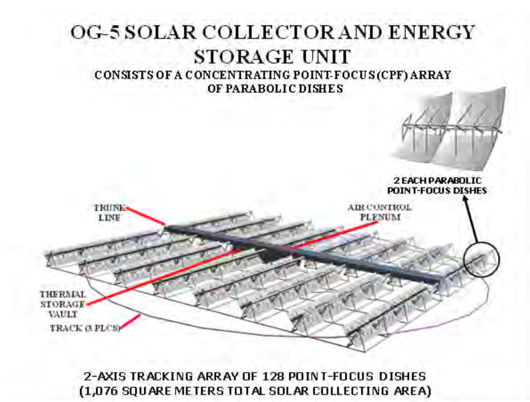

Figure 12 2-axis tracking array subassembly consisting of 128-point focus dishes.

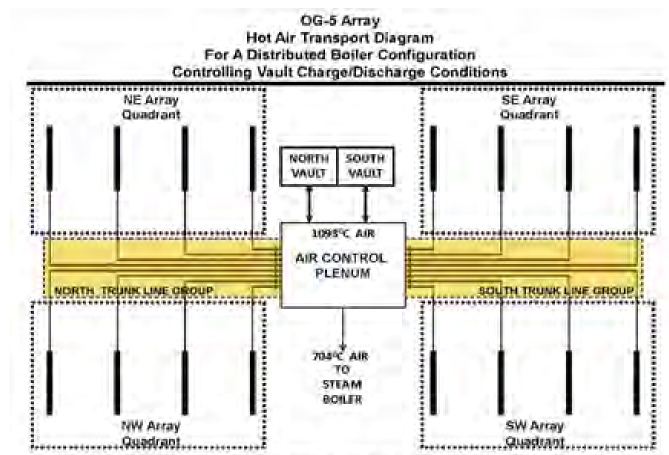

Figure 13. OG-5 Array Hot Air Transport for a Distributed Boiler Configuration controlling the Energy storage value charge and discharge conditions

Air Control Plenum

The sensible heat from each half-row transports via hot air through insulated pipes to the air control plenum above the array rotary joint (Figure 13). All half-row pipes, encased together within a heavily insulated trunk line, route to the on-board plenum combiner. The combiner operates to proportion and direct all the hot air to the energy storage vaults. The hot air output from the storage vault to the boiler is down-mixed with ambient air to match the 704º C temperature required by the steam boiler to produce the desired output steam temperature, nominally at 566^{o} C (3.6 MJ/kg) to the turbine injection point. The half-row branch air transport line diameter and insulation quality are responsible for 11% of the thermal losses in each array for a temperature of 1,093^{o} C.

Quad Module

The solar collector arrays are organized in standard groups of four (Figure 14). This group is called a "Quad" and has a combined 512 dishes and a solar collector area of 4,280 m^2. The Quad is the basic building block of a collector field supplying steam to a centralized turbine-generator power block and to a MSF water purifier. Each quad has its own thermal storage and steam generator.

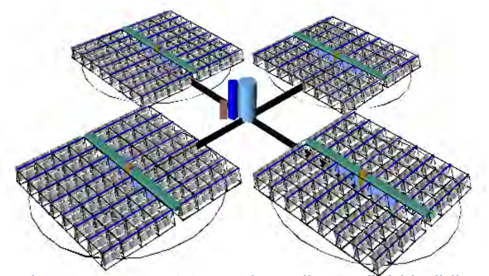

Figure 14 An OG-5 solar collector field building block group consists of four arrays and one steam generator. This grouping is called a "Quad". Total land area 5.91 acres (2.39 hectares)

The specified amount of energy to be delivered in a year's time ultimately determines the size of the solar collector field. Multiple arrays are conveniently grouped together, permitting graceful scaling and build-up of large-scale power plant. At first glance the arrays comprising the solar field are similar in appearance to solar troughs, however they are in fact, individual highly accurate point-focus parabolic tracking concentrators. Build-up of a solar collector fields by grouping multiple quads together, has the advantage of quick start-up distributed form of steam generation and ability to control heat on-demand turbine operating time from thermal energy sensible heat storage. This separation of steam quality (type-boilers) is critical to large solar collector field steam distribution and makes possible the OG-5 centralized water and power plant described herein.

Thermal Storage Vault

The CPF solar thermal process consists of three steps—collection, storage, and delivery of, uninterrupted energy from solar ON-DEMAND. Each solar collector array contains two TES vaults. Thermal energy collected at each dish is transferred to the heat transfer fluid (free air), heated to a maximum temperature of 2,000º F (1,093º C), and stored as sensible heat in the inert material vault core at very low atmospheric pressure and flow rate. Only HTF temperatures up to 1,300º F leave the array on its way to the steam boiler. When energy is needed (on-demand, dispatched or continuous), steam is created from the sun or combinations of stored heat energy to drive conventional high efficiency steam Rankine cycle turbine generators. Vault storage is a dynamic process changing with conditions, such as sun intensity, vault status, time of day, demand status for steam, weather predictions, and collector field status. Each vault capacity is sized for the highest sun intensity day of the year using the standard site location of Daggett, California[9]. This is determined to be May 30th producing 8.004 kWh per square meter, relating to 8,564 kWh in an array or 4,282 kWh in a single vault. Accordingly, for Daggett, this results in 2,600 kWh-electric to the grid at 30.2% efficiency. A vault is fully charged by injecting 1,093º C air and can be fully discharged in10-minutes at a rate of 900 kW-thermal.

Most importantly, the vault enables OG-5 systems to achieve a theoretical limit of over 97% ACF. It provides continuous stable conditioned power for nearly 24/7 operation without any supplemental fuels, resulting in essentially a prime power plant (without fossil fuel) in lieu of a solar augmentation source with fossil fuel. Sensible heat storage eliminates environmental risk of phase change material associated with lower operating temperature renewable energy systems. Since each OG-5 energy vault is a non-toxic inert material core, there is no danger of toxic spills, core damage, or depletion of the storage material. An extra competitive advantage exists because the vault is self-contained and doesn't require replacement during the expected life of the system.

Multiple grooved slabs of inert solid material are used to create a series of air passageways forming a linear core along the vault length. The design optimizes pressure drop, thus minimizing overall parasitic power. Energy stored in a filled vault core can be discharged from each solar array at temperatures up to 1,300º F (704ºC) for Rankine cycle steam generation. Any remaining energy is used to down-mix 1,093º C air from the array. Remember 1,093º C hot air is not needed for steam generation. The high specific heat core material and high-temperature insulation density limits vault loss to 0.05% per 24- hours at full charge and can be rapidly discharged. The storage material establishes the temperature limit; necessarily at a temperature significantly higher than the required steam temperature. This is necessary to maximize the energy storage capacity of the vault. The 1,093º C hot air output from the storage vault is adjusted down to match the 704º C temperature required by the steam boiler to produce the desired output steam temperature,

[9] Performance determined using actual direct sunlight measured hourly at Daggett, California for the year 1990

nominally at 538º C to the turbine injection point. Equally spaced temperature, pressure, and flow sensors in the vault determines status. Blower power required during charge and discharge is less than 5 kWh-electric. Existing SCADA steam combiner control platforms are incorporated to determine status of the dynamic changing conditions and adjust the steam load sensing combiner in response to user demand.

Some operational strategies to demonstrate flexible energy management include:

1.) 704º C air from each quad array is sent directly to the distributed steam generator to meet the demand for steam at the moment

2.) Excess is sent to the vault

3.) If demand is greater than the sir supply from the array, then hot air from vault is added

4.) If the demand at the moment is less than the air supply from the array, then the excess air is passed to the vault for charging

High heat-transfer-fluid temperatures (1,093˚C) are achievable using a series of high precision dishes.......

The OG-5 storage vault makes unity ACF possible, significantly improves economic viability and can be vertically integrated with other naturally intermittent energy sources, such as ballasting of wind turbines and PV farms.

HRSG Steam Boiler

The rapid response Clayton exhaust gas boiler has been identified as a suitable steam generator for the OG-5 system. This single pass tube boiler is similar to that used for waste heat (heat recovery) steam generation (HRSG), and, is able to respond dynamically to the demand from a low-mass rotor turbine-generator. Each quad distributed boiler produces a nominal output steam temperature of 454ºC and maximum of 538º C at steam rates of 3266 kg/hour and feed water temperatures of 16-60º C. Nominal input air temperature is 593º C and a maximum of 704º C. The nominal input air mass flow is 18,325 kg/hour to the quad boiler. The steam generation configuration also has the following specifications and/or requirements: Cold-start in less than 30-minutes, unattended operation with remote supervision, and air-to-steam efficiency >90%.

Each of the four distributed steam generation (boiler) outputs is compatible with existing SCADA steam combiner control technology. The load sensing combiner uses SCADA controls to adjust steam conditions to the turbine and MSF by varying sensible heat from storage to boiler and feed water temperature in the range of 90ºC to 120ºC from the MSF (substituting as condenser) to the solar field distributed boilers. If the load demands steam at a specific pressure and temperature, the SCADA system senses this load requirement and adjusts the feed water pumps to the four solar array boilers.

Siemens Steam Non-Condensing Turbine

We have identified Siemens as the supplier of choice for the steam turbine. CPF solar plants require steam turbines which are optimized for their complex and challenging cycle conditions. Siemens is a market leader and incorporates its operational experience into extensive R&D and engineering activities to adapt the turbines to the specific requirements of the CPF technology. They offer a comprehensive product portfolio for solar thermal plants, covering the full range from 1.0 MWe (1000 kWe) to more than 250 MWe.

Multi-Stage Flash Evaporator (MSF)

A special advantage of MSF technology is that the specific heat consumption (or thermal efficiency) can be continuously adapted to individual requirements of each application, i.e. there is flexibility. Two MSF units are coupled to the cold end of the OG-5 steam cycle, extracting steam at 90-120º C from the non-condensing turbine to feed the brine heater of the MSF unit. An advantage of this combined generation is that the condenser required for a conventional plant is substituted by the desalination unit. The amount of feed water required is adjusted to include both desalination and cooling.


Figure 15 Hamworthy 1500 MSF

The Hamworthy MSF 1500 is the MSF unit initially considered for this OG-5 system because it is highly reliable and low cost. Originally designed for the military/cruise industry, the self-contained modular design is attractive for remote land-based applications, particularly those lacking a highly trained workforce. The downside of this unit is that it is a simple once through system so the gain ratio is very poor, and the recovery is low.[10]

Based on the parameters of this challenge, performance would be more highly valued than simplicity and robustness. It is planned to consider the range of possibilities during the Feasibility Study by basing our initial economic calculations on MSF 1500 and then allowing and scaling for improvements in the performance. In the feasibility analysis to be performed, it assumes decreased heat consumption (increases the gain ratio) to produce water, and accordingly increases the cost of the MSF unit. Procurement specifications are based on MSF unit selected.

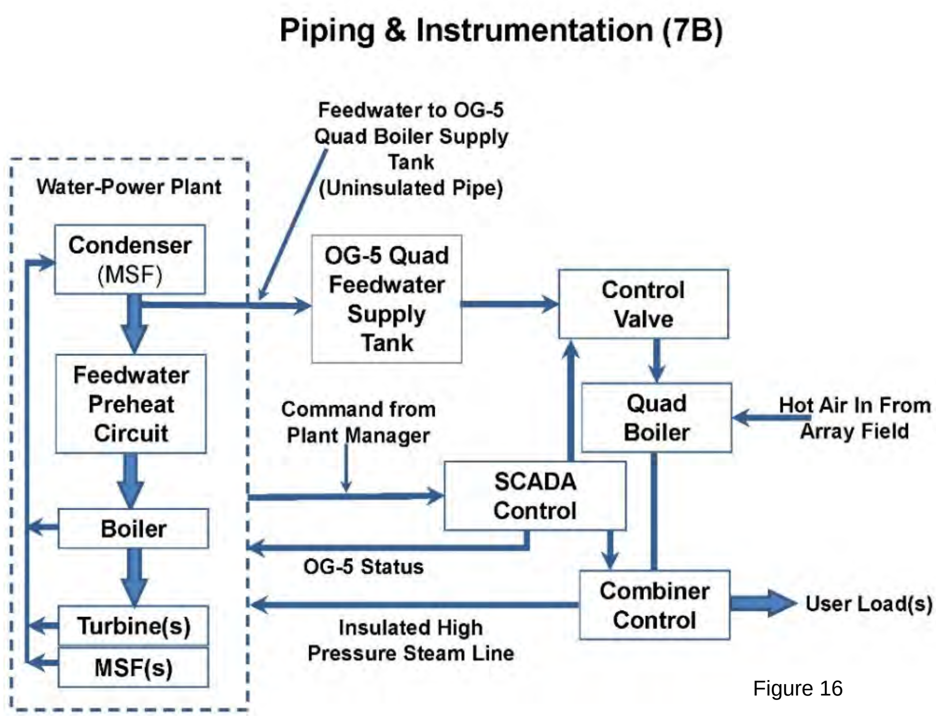

Figure 16

Solar Collector Field

The amount of solar energy collected in a day's time is directly proportionally to the area of the collectors and the intensity of the direct sunlight. The specified amount of energy to be delivered in a year's time ultimately determines the size of the solar collector field. Multiple arrays are conveniently grouped together, thus permitting graceful scaling and build-up of large-scale power plant. Though on the surface each of the arrays comprising the solar field is in appearance similar to solar troughs, they are in fact individual highly accurate optical quality point-focused parabolic concentrators. Designed for low-profile survivability, the rotating array platform of CPF dishes is capable of withstanding harsh environments, wind loads, wind buffering, and hail while accurately and reliably directing its full spectrum of collected sun's energy into the small entry aperture of all 128 focal plane receivers/converters. Additionally, the modularity affords the ability to shut down an individual array for maintenance, if needed, without requiring the entire plant to shut down.

The overall site requirements and preparation plan for CPF-OG-5 follows a fundamental modular integration approach applied to start early revenue generation with a high degree of confidence (see Appendix B for Part 1 & Part 2 schedule overlap). The initial four (4) arrays are grouped and connected to a common steam boiler, called a quad. The combined steam output is routed to the power generation control facility. When the solar field is populated with the first four (4) quads, energy is delivered at full turbine nameplate capacity for shorter demand period. As additional quads are staged demand periods are extended, but no other changes in power generation or water purification equipment are required to achieve full plant commissioning. Pre-grid connection waivers may be required before full advantage of earlier ramp-up installation procedures to full plant operation of CPF technology and storage is achieved. A single array module of CPF dishes form a square platform (carriage) size of 175 ft x 175 ft (53.4 m x 53.4 m), forming a swing circle of 253.75 ft (77.3 m) diameter. Each platform frame is azimuth controlled and supported by safety-lock casters and three azimuth track foundations (inner, mid, outer).

System Connectivity

The OG-5 solar-thermal plant is designed to operate with modern process control systems to monitor and control connectivity between all points of information as an integral part of the system. From the heat collection to electricity and water production, and to the grid

[10] The gain ratio is defined as kg steam/kg clean water. Heat consumption is inversely proportional to the gain output ratio (GOR). The GOR of the baseline MSF 1500 is ca. 3.3 for seawater and 5.5 for brackish water. The recovery for seawater is ca. 12%, higher <17% for brackish water.

interface, all systems are designed to operate in a synchronous and fluid motion. Master control of the power systems have imbedded points of connectivity, which seamlessly integrates, monitors, and manages the entire system from a single control point. Using the power of distributed intelligence and advanced communications software, there are packaged systems that facilitate a seamless SCADA system. Several platforms offering SCADA performance and configurability include SCADAdvantage, SurvalentONE SCADA & DMS, Comverge 6D iNET, or Beckwith with their Modern Intelligent Electronic Devices (IEDs) for equipment protection and security, which are all solutions that allow real-time energy collection, system compliance monitoring, energy market interface, performance diagnostics and remote fault notification to name a few.

Operation & Maintenance Phase

Equipment maintenance is one of the functions that is scrutinized on every project and to which the company applies the most rigid standards. Proper maintenance tends to be an activity that is often deferred in many facilities and, at the same time, can determine the success of an energy savings program. The operation and maintenance (O&M) of a CPF parabolic dish power plant is very similar to CSP line-focus steam power plants that cycle on a daily basis, except fossil fuel combustion process is replaced by solar-thermal steam generation. Parabolic dish power plants typically require similar staffing and labor skills to operate and maintain the power generation equipment 24-hours per day, but solar plants require additional O&M requirements to maintain the solar fields. The solar field maintenance cost of CPF plant is more than offset by elimination of recurring fossil fuel resources.

A standalone power plant adjusts costs depending on the size of the solar field and total electric generation per year. Because of energy storage capability, we prefer to project O&M costs on the basis of both kilowatt-hours and total square meters of solar dish collector area. O&M estimate for CPF power plant is based on proven commercial experience at the KJC Operating Company of five co-located Solar Electric Generation System (SEGS) trough power plants at Kramer Junction California. As CPF parabolic dish technology proceeds to commercial operation, it is expected that O&M costs for the first-of-its-kind dish power plants benefit from a thirty-year maturity of the SEGS operation. The advantage of dish technology is increased solar-to-electric efficiency and thermal storage to obtain a high capacity factor that reduces O&M by obtaining higher annual MWh generation and elimination of fossil fuels. The CSP annual O&M costs of 0.0208 $/kWh are estimated to be less than half of the SEGS target costs.

The O&M staffing is a fixed cost, and manpower requirements are considered reasonable based on comparable data from Solar Electric Generation System (SEGS) plants at Kramer Junction[11], California. Staff expansion is related to scaling the solar field by adding the solar array for increasing power generation capacity. The staffing for CSP trough technology is shown for reference.

STAFF	CPF Dish	CSP Trough
Administrative	3	7
Plant Operations	9	17
Power Plant Maintenance	6	8
Solar Field Maintenance	6	19
Total	24	51

CPF technology of OG-5 system produces (saturated or unsaturated) steam well beyond the current performance barriers of existing CSP technology systems including that of a High Capacity Factor.

[11] Assessment of Parabolic Trough and Tower Solar Technology Cost and Performance Forecasts, NREL/SR-R-550-34440, October, 2003

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المملكة العربية السعودية
KINGDOM OF SAUDI ARABIA

"IT IS MY PLEASURE TO PRESENT SAUDI ARABIA'S VISION FOR THE FUTURE. IT IS AN AMBITIOUS YET ACHIEVABLE BLUEPRINT, WHICH EXPRESSES OUR LONG-TERM GOALS AND EXPECTATIONS AND REFLECTS OUR COUNTRY'S STRENGTHS AND CAPABILITIES"

MOHAMMAD BIN SALMAN BIN ABDULAZIZ AL-SAUD
Chairman of the Council of Economic and Development Affairs

Economic Development Conclusion

We fully understand the disbelief of many forward statements expressed in this proposal. The very first assertion made in the beginning executive summary **"In fact, the OG-5 system may be considered as the prime source of energy rather than an alternative source"** is true. No other existing variable energy source can make that statement. The test readiness level of TR6, within the DOE development guidelines, attest to beginning system integration and market transformation. The first step is to conduct the Feasibility Study and validate claims are factual, commensurate with development stages, leading to actual market transformation. Milestones are now in place to justify serious consideration and commitment to accept the challenge and complete the journey together.

The OG-5 system is not widely distributed now because of economic viability and lack of VALUE recognition for its optical quality dish collector, solar-to-air converter, and innovative thermal energy storage process at 2,000º F (1,093º C). CPF/OG-5 will play a vital role in future global energy transformation to next generation renewables. According to IRENA studies, there is value for smooth and conditioned power that must be determined when considering alternative systems[9]. Because collection is decoupled from delivery in the OG-5 system, the ACF could be unity if storage was sufficient to drive a turbine generator 100% of the time at its nameplate rating. The thermal storage vault enables OG-5 to achieve extremely high ACF. Since each vault is a non-toxic inert material core, there is no danger of toxic spills, core damage, or depletion of storage material. An extra competitive advantage exists because it is self-contained and doesn't require replacement during the expected life of the system.

All components of the feasibility study are ready to produce. Once completed the Saudi/US arrangement will find itself instantly becoming the pre-eminent enterprise delivering the highest capacity factor alternate energy solutions globally, beginning locally in the Kingdom of Saudi Arabia and providing the immediate solution of preventing the Lake Basaka environmental disaster facing Ethiopia. That is, first to market assured that no other country or enterprise has had the development advantage of our nearly four decades of work and as much time optimizing the necessary building blocks of capturing, storing and delivering solar derived energy.

Our approach to manufacturing demonstrates commercial viability of utility-scale concentrating point-focus (CPF/OG-5) solar thermal technology. First to market is possible with technology transfer and manufacturing license for projects in the Kingdom of Saudi Arabia and selling into the worldwide market.

GSE has the background and unique (proprietary) energy technology to strengthen Saudi Arabia's infrastructure at the local level. In the process, without any fossil fuel, toxic batteries, or molten salt, the scaling of individual solar powered OG-5 plants ultimately become building blocks for creating the Kingdom's overall water and power utilities. Our technology will save the Kingdom millions of barrels of crude oil and natural gas which are exported.

This proposal introduces the solution coupled with the pragmatic steps necessary for manufacturing, assembly and complete implementation. The only exercise remaining is the obvious product validation through a feasibility study, i.e. validating the integration of the building blocks to affect continuous electrical and clean water distribution throughout large communities. Once done, an enormous market opportunity awaits assuring long-term competitive edge

A current need already exists for a renewable solution to the expanding ecological problem currently destroying productive agricultural land in the Metehara region of Ethiopia. It is proposed to build a solar thermal water and power plant to purify water taken from Lake Basaka. See Proposed Feasibility Study (Appendix F).

CPF First to market is possible with opportunity to sell into the worldwide marketplace.

References

AEMO (Australian Energy Market Operator) (2017a), "Black System South Australia 28 September 2016", AEMO, Melbourne.

AEMO (2017b), "Fast frequency response in the NEM", AEMO, Melbourne.

AES (2018), "Alamitos Energy Center fact sheet", *www.renewaesalamitos.com/Alamitos-Fact-Sheet.pdf*

AESO (Alberta Electric System Operator) (2018), "Overview of the Alberta capacity market", AESO, Calgary.

Appunn, K. (2015), "Energiewende hinges on unblocking the power grid", Clean Energy Wire, *www.cleanenergywire.org/dossiers/energy-transition-and-germanys-power-grid* (accessed 21 March 2019).

APS (Arizona Public Service) (2019), "Batteries transform Punkin into a vital energy storage center", *www.azenergyfuture.com/blog-details/2018/Batteries-transform-Punkin-into-a-vital-energy-storage-center/default.aspx* (accessed 21 March 2019).

Arefifar, S. A. and Y. A. I. Mohamed (2014), "DG mix, reactive sources and energy storage units for optimizing microgrid reliability and supply security", IEEE Transactions on Smart Grid, Vol. 5, Issue 4, pp.1835–44, *https://doi.org/10.1109/TSG.2014.2307919*

Arellano, B. (2012), "PNM Prosperity PV storage project", *www.pnm.com/documents/396023/396157/Prosperity+Project+Fact+Sheet.pdf/fddfe81b-cfb3-484a-af3c-18cf414c1a44*

Aurecon Group (2018), "Hornsdale Power Reserve: Year 1 technical and market impact case study", *www.aurecongroup.com/-/media/files/downloads-library/2018/aurecon-hornsdale-power-reserve-impact-study-2018.ashx?la=en* (accessed 7 February 2019).

Batlle, C. and P. Rodilla (2013), "Security of generation supply in electricity markets", in Regulation of the Power Sector, Springer, London.

Brakels, R. (2018), "Tesla big battery cost $89 million AUD. First year was profitable", Solar Quotes Blog, *www.solarquotes.com.au/blog/tesla-big-battery-first-year* (accessed 28 March 2019).

Brooks, D. (2018), "Using customer batteries as a power source saved Vt. utility $500K", Granite Geek, *https://granitegeek.concordmonitor.com/2018/07/23/using-customer-batteries-as-a-power-source-saved-vt-utility-500k* (accessed 2 April 2019).

Bushnell, J. M. Flagg and E. Mansur (2017), "Capacity markets at crossroads", Energy Institute at Haas, *http://ei.haas.berkeley.edu/research/papers/WP278Updated.pdf*

CAISO (California Independent System Operator) (2019), "California ISO – Supply", CAISO, Folsom, CA, *www.caiso.com/TodaysOutlook/Pages/supply.aspx*

CAISO (2015), "Flexible ramping product", CAISO, Folsom, CA.

CAISO (2007), "Integration of renewable resources: Transmission and operating issues and recommendations for integrating renewable resources on the California ISO-controlled grid", CAISO, *www.caiso.com/Documents/Integration-RenewableResourcesReport.pdf*

California Energy Commission (2018), "Tracking progress – Energy storage", California Energy Commission, Sacramento, CA.

EPRI (Electric Power Research Institute) (2019), "Storage Value Estimation Tool (Storage VET)", *www.storagevet.com/*

EPRI and US DOE (Department of Energy) (2013), "DOE/EPRI Electricity Storage Handbook in collaboration with NRECA", *https://prod-ng.sandia.gov/techlib-noauth/access-control.cgi/2015/151002.pdf*

EPRI and US DOE (2003), "EPRI-DOE Handbook of Energy Storage for Transmission and Distribution Applications", 1001834, *www.w2agz.com/Library/Storage/EPRI/EPRI-DOE%20Storage%20Handbook.pdf*

Ernst & Young and Fraunhofer Institute for Solar Energy Systems (Fraunhofer) (2011), *MENA Assessment of the Local Manufacturing Potential for Concentrated Solar Power (CSP) Projects*, The World Bank, Final Report, Washington, D.C.

International Energy Agency (IEA) (2010), *Technology Roadmap: Concentrating Solar Power*, IEA, Paris. http://www.iea.org/papers/2010/csp_roadmap.pdf

IRENA (forthcoming-a), "Innovation Landscape Brief: Dynamic line rating", International Renewable Energy Agency, Abu Dhabi.

IRENA (forthcoming-b), "Innovation Landscape Brief: Virtual power lines", International Renewable Energy Agency, Abu Dhabi.

IRENA (2019a), "Global energy transformation: A Roadmap to 2050" (full report, 2019 edition), International Renewable Energy Agency, Abu Dhabi.

IRENA (2019b), "Innovation landscape for a renewable-powered future: Solutions to integrate renewables", International Renewable Energy Agency, Abu Dhabi.

IRENA (2019c), “Innovation Landscape Brief: Aggregators”, International Renewable Energy Agency, Abu Dhabi.

IRENA (2019d), “Innovation Landscape Brief: Behind-the-meter battery storage”, International Renewable Energy Agency, Abu Dhabi.

IRENA (2019e), “Innovation Landscape Brief: Time-of-use tariffs”, International Renewable Energy Agency, Abu Dhabi.

IRENA (2019f), “Innovation Landscape Brief: Net billing schemes”, International Renewable Energy Agency, Abu Dhabi.

IRENA (2018a), “Power system flexibility for the energy transition, Part I: Overview for policy makers”, International Renewable Energy Agency, Abu Dhabi.

IRENA (2018b), “Power system flexibility for the energy transition, Part II, IRENA FlexTool methodology”, International Renewable Energy Agency, Abu Dhabi.

IRENA (2018c), “Renewable power generation costs in 2017”, International Renewable Energy Agency, Abu Dhabi.

IRENA (2018), *Opportunities to accelerate national energy transitions through enhanced deployment of renewables* (Report to the G20 Energy Transitions Working Group), International Renewable Energy Agency, Abu Dhabi **ISBN 978-92-9260-084-6**

IRENA (2017a), “Electricity storage and renewables: Costs and markets to 2030”, International Renewable Energy Agency, Abu Dhabi.

IRENA (2017b), “Adapting market design to high shares of variable renewable energy”, International Renewable Energy Agency, Abu Dhabi.

IRENA (2015a), “Renewables and electricity storage: A technology roadmap for REmap 2030”, International Renewable Energy Agency, Abu Dhabi.

IRENA (2015b), “Case studies: battery storage”, International Renewable Energy Agency, Abu Dhabi.

IRENA (2012b) “Renewable Energy Technologies: Cost Analysis Series”, Concentrating Solar Power June 2012

IRENA, IEA (International Energy Agency) and REN21 (Renewable Energy Policy Network for the 21st century) (2018), “Renewable energy policies in a time of transition”, *www.irena.org/-/media/Files/IRENA/Agency/Publication/2018/Apr/IRENA_IEA_REN21_Policies_2018.pdf*.

Kolb, G.J., C.K. Ho, T.R. Mancini, J.A. Gary (2011), *Power Tower Technology Roadmap and Cost Reduction Plan*, Sandia National Laboratories, Albuquerque, NM.

NREL (2012), Concentrating Solar Power Projects Database, US Department of Energy, Available at: http://www.nrel.gov/csp/solarpaces/by_country.cfm

Sargent & Lundy Consulting LLC., **(2003)**, *Assessment of Parabolic Trough and Power Tower Solar*

Technology Cost and Performance Forecasts, National Renewable Energy Laboratories & US

Department of Energy, Washington, D.C. http://www.nrel.gov/csp/pdfs/34440.pdf

Trieb, F., et al. (2009), *Global Potential of Concentrating Solar Power,* DLR, Stuttgart.

Turchi, C., M. Mehos, C.K. Ho, G.J. Kolb (2010a), *Current and future costs for Parabolic trough and power tower systems in the US market,* National Renewable Energy Laboratory (NREL), CO.

Turchi, C. (2010b), *Parabolic Trough Reference Plant for Cost Modeling with the Solar Advisor Model,* NREL, Boulder, CO

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Appendices

A……………………………….Technical Description Supplement

B……………………………….Linear Expansion to Pilot-Scale Production

B-1……………………………DOE Milestones/Deliverables Table

C……………………………….OG-5 Pathway of Development

D……………………………….Experience and Qualifications of Key Team Members

E……………………………….Conditioned Power From Solar Energy

F……………………………….Feasibility Study Lake Basaka-Ethiopia

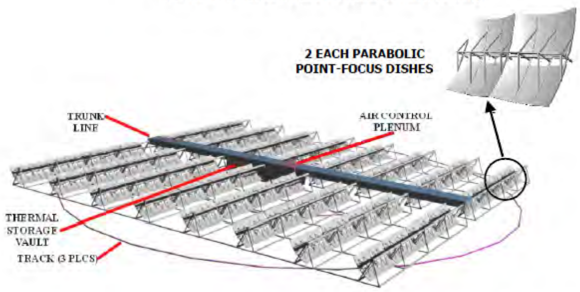
Appendix A

ADDENDUM

A. Technical Description Supplement

OG-5 SOLAR COLLECTOR ARRAY AND ENERGY STORAGE VAULT

(CONSISTS OF AN ARRAY OF 128 CONCENTRATING POINT-FOCUS PARABOLIC DISHES FOR A TOTAL OF 1,070 SQUARE METERS TOTAL SOLAR COLLECTING AREA)



OG-5 Array Has 16 Half-Row Groups Of 8 Dishes. Each Hot-Air Output Is Independently Controlled Based On Array Status & End-Use Of Heat Energy

TESTBED FOR STORAGE AND HTF VALIDATION

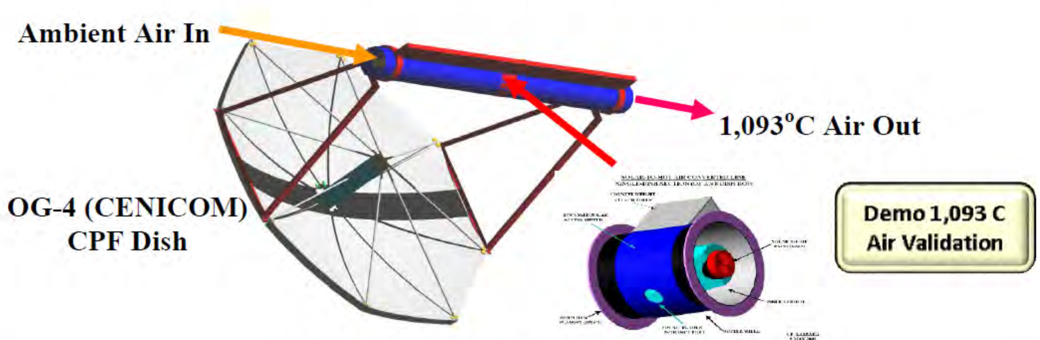


Figure 1. GENERATE 1,093°C AIR FROM SOLAR

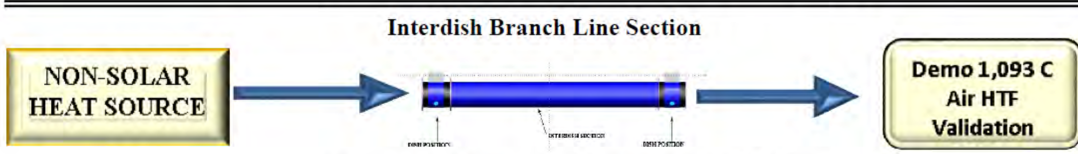


Figure 2. HTF TRANSPORT OF 1,093°C AIR

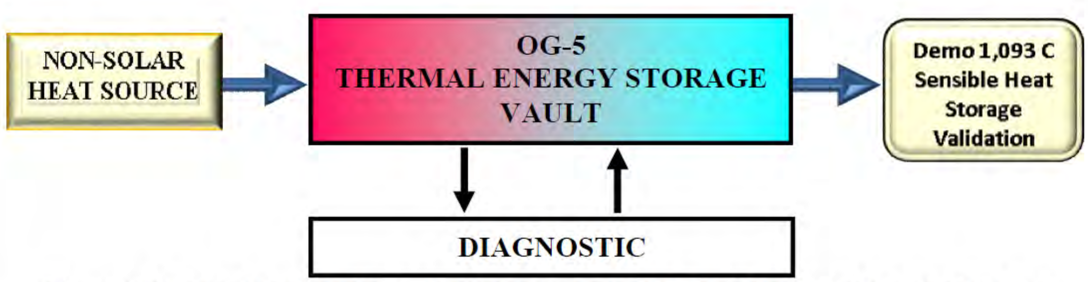
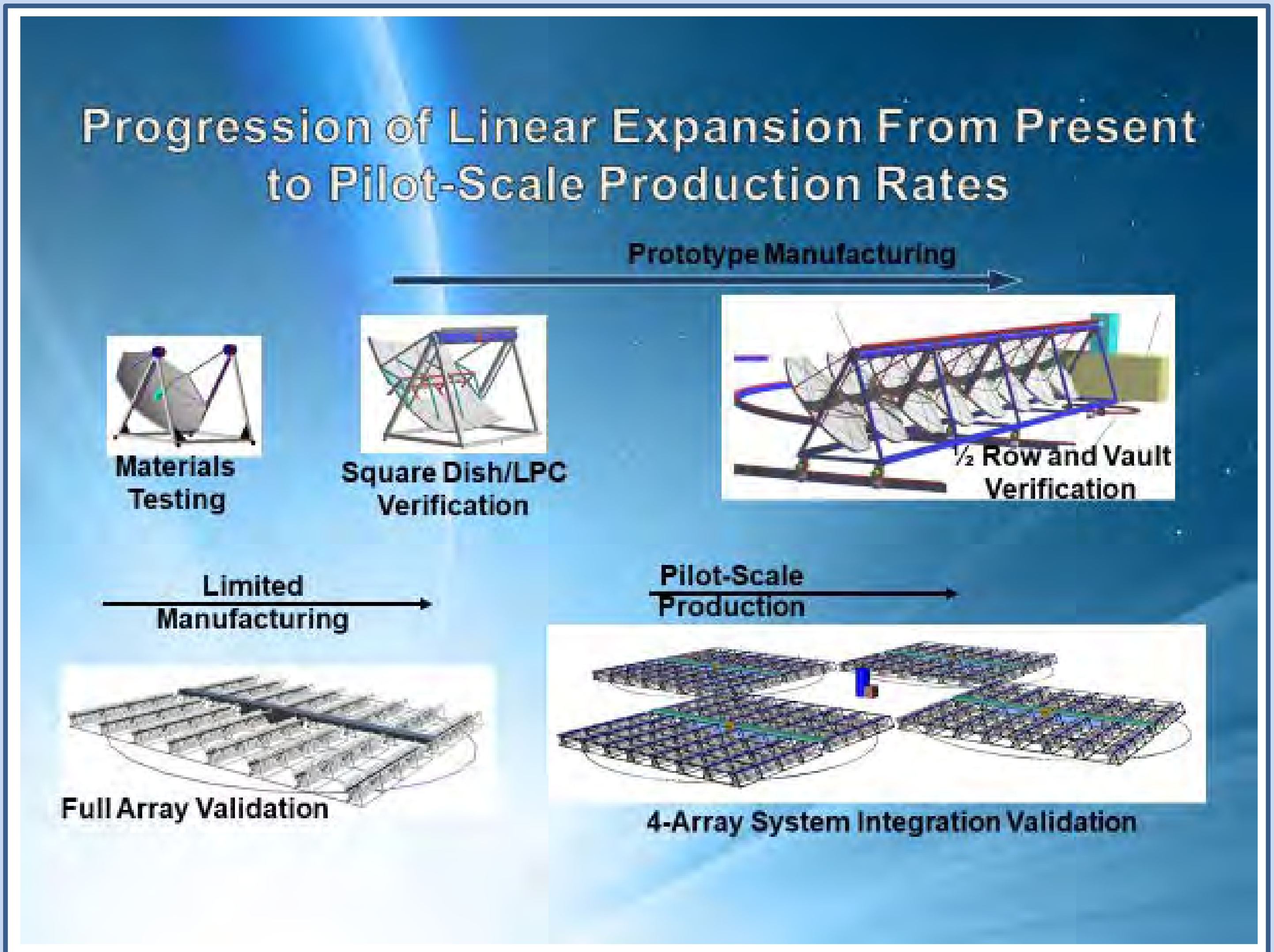
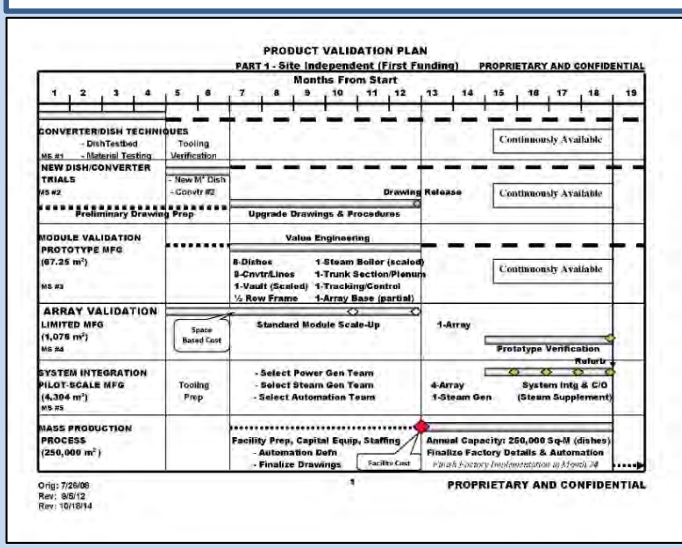


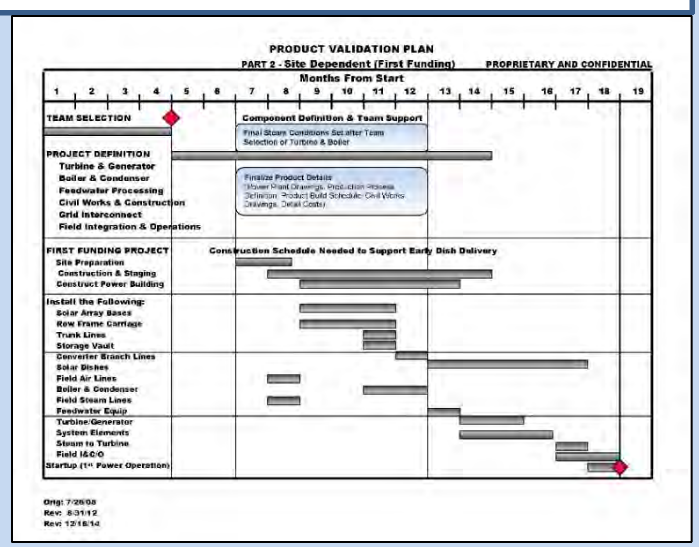
Figure 3. DISH TEMPERATURE AIR INTO OG-5 THERMAL ENERGY STORAGE VAULT

Appendix B

Linear Expansion to Pilot-Scale Production







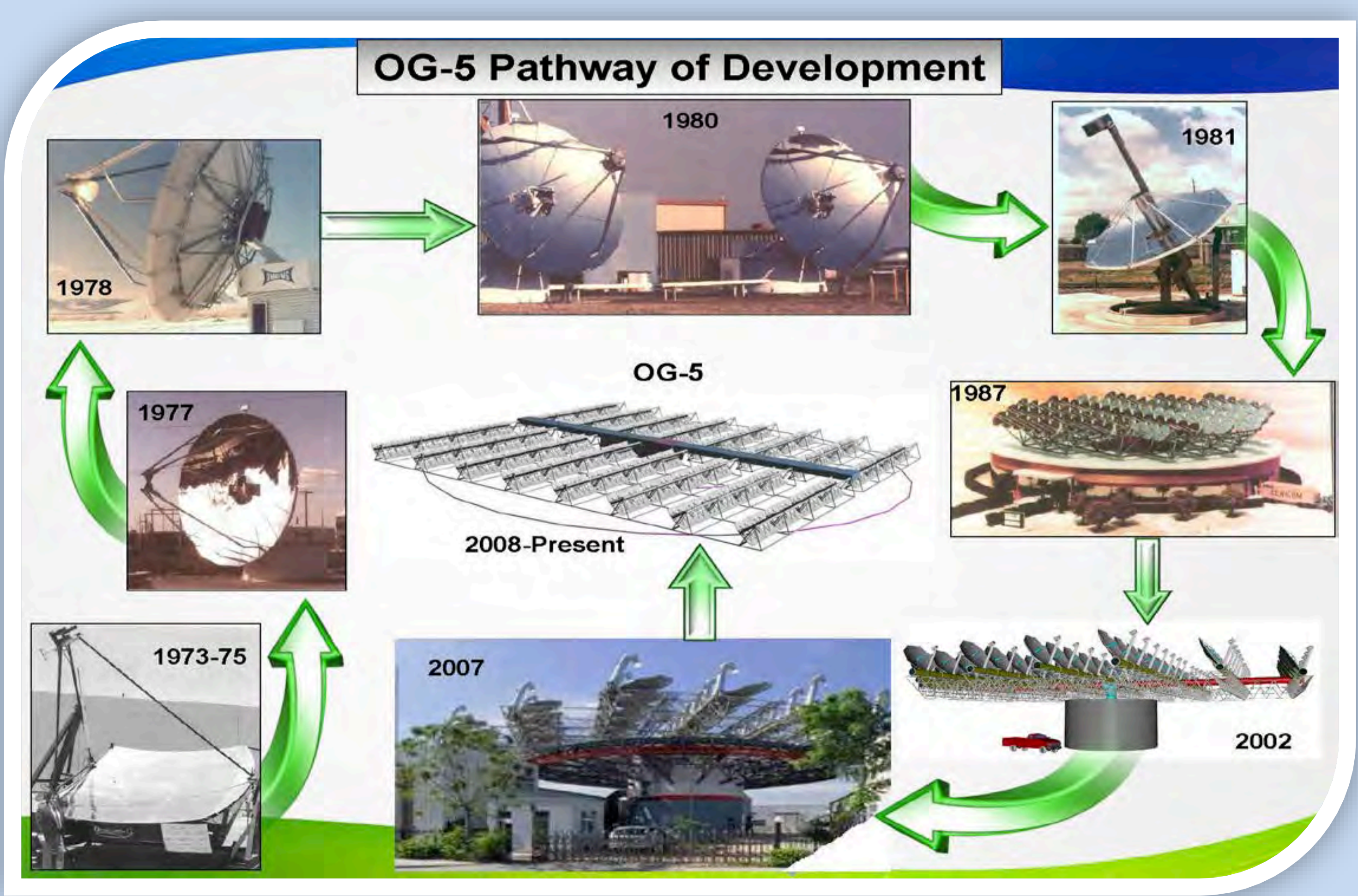
Appendix B-1

DOE Milestone/Deliverables Table

Milestone/Deliverables Table					
Company Name: Golden State Energy, Inc.					
PI: Dr.Thomas A Damberger			Ph: (916) 541-5350		E-mail: damberger@goldenstateenergy.com
Phase I					
Task	Milestone	Criteria and Deliverable	Months Afer Start	Total Funding %	Additional Notes
1.1 Converter	Thermal Cycles	Maximum useable temperature without loss of component integrity	4	2.70%	Withstand rapid temperature cycles from ambient to over 2,300F
1.2 Parabolic Concentrator	Yield	Lowest waste aluminum reflector segment piece-parts	6	3.16%	Research present generation of aluminum reflective materials and best source mass production and 30-yr life
1.3 Parasitic loss	Horsepower	Comparison of Vault core pressure drop and optimal blower horsepower	5	1.84%	CAD routines using computational fluid dynamics to minimize pressure drops over given paths and materials.
1.4 Component Performance	Process Integration	Heat gathering from 1/16 Array delivers air at set temperature from 1,300F to 2,000F	12	8.99%	Tooling and fixtures suitable for scale-up manufacturing process
1.5	Review	Demo performance parameters		0.00%	Design & Project Progress Review
1.6	Go/No-Go #1	Demo air control logic		0.00%	Decision Point 1 to proceed
Phase II					
2.1 Scale-up, 1-Array	Limited Production	Structural integrity in acquisition, pointing & tracking precision, and emergency stow	18	16.58%	Product Validation of Manufacturing Process & Demonstration of Key Performance Parameters
2.2 4-Array Quad	Distributed Boiler Integration	Generation of steam at 1,050F temperature and 1,000 psia at the boiler output .	24	15.75%	Demonstration of how 1,050F steam from distributed boiler is delivered to existing power block.
2.3 4-Arrays w/storage	Centralized Boiler Integration	Verify centralized boiler operation by adding transportable vault energy to quad boiler	36	19.76%	Demonstration of a pilot-production run-rate & how transport thermal energy is delivered to existing centalized power block equipment
2.4	Review	Demo system design functionality		0.00%	Functional Review
2.5	Go/NO-Go #2	Demo steam generation at 1.050F		0.00%	Decision Point 2 to proceed
Phase III					
3.1 Coal Plant Validation	Solar-Coal Hybrid Operation	Integrated Solar Steam Generation & Coal Plant Hybrid Electric O&M	48	31.21%	Demonstration of a pilot-production run-rate & how 1,050F steam is delivered to existing centalized power block equipment
3.2	Final Deliverable #1	Commecial operation readiness		0.00%	Test, operate, maintain for 1 year and commission solar steam genration system
3.3	Final Deliverable #2	Economic evaluation analysis		0.00%	Demonstrate cost of coal saved over OG-5 life is > cost of OG-5 system

Appendix C
OG-5 Pathway of Development

Solar Product Pictures—42 Year History



Appendix D

Experience and Qualifications of Key Team Members

Dr. Thomas A. Damberger, CEM—President, Golden State Energy

Golden State Energy
400 Dorla Ct., Suite 12187
Zephyr Cove, NV 89448
Direct Phone: (916) 541-5350
Email: damberger@goldenstateenergy.com

Education:

Ph.D., Applied Management and Decision Sciences, Walden University, Minneapolis, Minnesota, 2003

Master of Public Administration, California State University Long Beach, California, 1978

Bachelor of Arts in Public Administration, San Diego State University, San Diego, California. 1975

Associate in Fire Science, San Diego City College, San Diego, California, 1973

Certifications/Credentials:

Certified Energy Manager, Association of Energy Engineers, Atlanta, Georgia

Certified Demand-Side Management Professional, Association of Energy Engineers, Atlanta, Georgia

Teaching Credentials in Fire Science and Public Services & Administration California Community Colleges

License:

State of California, General Building Contractors License B-1 (Inactive)

FCC General Radiotelephone with Radar Endorsement

Amateur Radio Advanced Class

Dr. Thomas Damberger, CEM is a Certified Energy Manager, and has over 30-years of experience in the energy industry focusing on renewable energy. His accomplishments include: the development of ground breaking public-private energy solutions, successful "C" level marketing, and product demonstrations producing millions of dollars of cost saving energy initiatives. He participated in various high-tech energy systems integration, providing clean and highly profitable energy alternatives for enhanced efficiency, profitability, and public relations. He has a proven record of teambuilding, strategic partnering, and long-term planning. He has led successful executive level marketing and energy related finance campaigns in corporate environments where growth and accountability are paramount. His work with parabolic dish concentrators are well known.

While at Kaiser Hospitals he managed an annual energy budget of $42 million and a Capital Remodel budget of $7 million, he implemented Demand-Side Management, project management, and developed the installation of multiple fuel cells. At a hospital in Riverside, he saved over $1,800 a day in a Demand Side Management (DSM) lighting project. Dr. Damberger spearheaded two of the first permitted plasma-energy system in the US to produce syngas with medical and hazardous waste as a feedstock (San Diego, Indianapolis). Agua Fria Unified School District near Phoenix, Arizona commissioned Dr. Damberger to validate the outsourced economic model for central plants used in their district.

Additionally, he brought together a team consisting of Sandia National Lab, Boeing, Altergy Systems, MultiQuip, and NASA in commercializing a light tower powered by a hydrogen fuel cell to market. Lighting towers are used for aircraft maintenance, freeway construction, and on construction sites. The lighting tower incorporated a more efficient LED lighting system with improved quality and life expectancy. This is now the world's first commercial fuel cell powered lighting tower used on the last two NASA space shuttle launches, at CalTrans used for lighting the mountain snow chain control area and at San Francisco Airport for runway and aircraft maintenance. He served as Program Manager Project Development at DGS the State of California where he managed a portfolio of projects with value exceeding USD $196 million in Energy Assessments.

As a consultant, he was selected by Sandia and Lawrence Livermore National Laboratories to spearhead an effort to install fuel cells on their campuses in Livermore. The two sites were selected serving the data centers at both labs.

Dr. Damberger has received the Clean Air Award from the South Coast Air Quality Management District, and Special Recognition for Outstanding Contribution in Promoting an Environmentally Sustainable Energy Future from the United States Department of Energy. In 2012 he received an Award for Excellence in Technology Transfer from Secretary of Energy Steven Chu using a hydrogen fuel cell. He received a patent for this effort. More recently, after completing several CHP systems, he is assisting in permitting a plasma processing facility in Indiana designed to process 50 TPD of post-consumer products producing syngas to heat, cool and power the facility. Finally, he provided consulting services to General Energy Solutions (GES), the world's largest PV manufacturer located in Taiwan consulting on various projects and project development.

He is President of Golden State Energy, a consulting/project development company focusing on CPF Solar Thermal enhancing the renewable energy infrastructure worldwide and are based in Nevada.

Senior Project Design Engineer
William P. (Bill) Dampier, *Project Management*

Cofounder of OMNIUM-G, Bill is a respected technical manager with nearly fifty years of engineering and management experience. He has consistently strengthened core business by achieving favorable awards and timely completion of many diverse projects at a profit. He is a leader in the promotion of renewable resources technologies and has in-depth experience in manufacturing engineering of solar thermal electric generating systems. As one of the Cofounder's of OMNIUM-G in 1973, he was involved in developing a proprietary method of producing low-cost point-focus parabolic dish concentrators making solar-thermal electric plants economically viable. This substantial historical knowledge forms the basis of factory automation design for cost effective large solar-driven power plants worldwide.

Prior to his work on solar-thermal electric generation, Mr. Dampier held executive positions at General Motors Hughes Electronics Corporation responsible for transitioning complex technology products from engineering to manufacturing. He has received many cost savings awards and received $1,035,000 Certificate of Merit for reinstatement of a $27,000,000 Army contract. He received a commendation award from the Department of the Army for his distinguished participation in the development and deployment of the battlefield Army Data Distribution System.

Mr. Dampier holds a Bachelor of Science Degree in Electrical Engineering from the University of Florida and has extensive education and training in System Engineering and Project Management.

Director, Business Development
Stanley H. Zelinger, Business Development Manager

Cofounder of OMNIUM-G, a solar technology company founded in the mid-1970. There he managed the company's worldwide business relationships and assisted in the design of the electro-mechanical solar energy power generation system. His creativity resulted in development of the early phases of the CENICOM concept. He has over thirty-five years of experience using computer technology for design and simulation of products and processes. Throughout his working career he has held positions ranging from Vice President of Marketing, to Sales Management, to General Manager.

Mr. Zelinger's academic accomplishments include a Bachelor of Science in Electrical Engineering with honors from the University of Colorado and an MS in Electrical Engineering from the University of Southern California.

Engineering Review, Measurement and Verification
Ted Kobayashi, Director of Product Assurance

Mr. Kobayashi has thirty-five years of experience in application software development. He is a founder of a database management consulting business providing data management and data analysis. He is also a co-developer of the first computer automated PERT project management graphics software product that became the first software product issued a US patent. Position's he has held includes vice president of development and vice president of product support responsible for strategic planning and pricing. As a Member of the Technical staff for a major ground systems defense electronics company, he performed radar systems analysis through computer simulation.

Mr. Kobayashi holds degrees of Bachelor of Science and Master of Science in Electrical Engineering from the University of Southern California.

Engineering Review, Measurement and Verification
Brad Shepherd – Director of Product Validation

As one of the original three employees of Omnium-G, Mr. Shepherd became a skilled manufacturing craftsman with experience in product development of point-focus parabolic dishes for power plants. Later, he investigated and built solar receivers with various metals and composites testing the finished product for longevity and life-cycle costing. He had major breakthroughs in the fabrication and production processes related to a variety of custom designed commercial specialty production to precision tolerances. His success driven business gained the reputation of quality, honesty, and precision workmanship. Known as a visionary leader in this area, he has remained associated with founders of Omnium-G for the past 35 years. Mr. Shepherd devoted to the development of renewable energy manufacturing facilities and dispatchable solar power plants for a whole new industry.

Mr. Shepherd has more than 35 years of experience and has extensive education training in state-of-the-art complex tooling and material fabrication.

Appendix E

Conditioned Power From Solar Energy

April 1, 2020

Authored by: Stan Zelinger

Conditioned Power From Solar Energy

Background: Utility company generators work nearly continuously. These powerful generators are stable and well controlled to provide energy smoothly. Solar energy by its very nature is not. Solar electrical generating systems put energy into the grid only when the sunlight is available and that is generally less than 30% of the time in the course of a year. In the vernacular of electrical power generation, solar generators have an Annual Capacity Factor[12] of less than 30%.[13] But it is even worse than that. When sunlight is available it can be for very short bursts of time, unpredictable and quite sporadic. Conditioned power by definition is smooth and continuous. Spurious spikes in a grid can easily cause an instability resulting in complete and widespread blackouts. This is a very serious situation when solar or any other augmentation system is considered on a large scale. OG-5 Solar Thermal Technology solves this problem.

Energy Versus Power: As in the above topic, energy and power are terms intermingled in the same discussion which at times can cause confusion. Utility companies deliver energy not power. Energy is the commodity with which Utility companies receive revenue. The electrical bill is in "Kilowatt-Hours" and for gas it is in "Therms" or Btu's all of which are measurements of the amount of energy used and have almost nothing to do with power. Power is similar to size (Kilowatts, Horse Power, etc.). A small boy is less powerful than a man. You may pay more, however, to keep the boy quiet than a resting man. The boy is delivering energy whereas the man is not. The real difference is their *capacity* to deliver the energy and, of course, the larger one has a much larger capacity to deliver. Power is ability to deliver energy; energy is the capacity to do the work. Power is a measure of how much *energy* can be delivered in a period of time. Consider an intimidating large water tower several stories high. How much energy and how much power are there? Yes, the tower is potentially very powerful but drains its capacity through a syringe and not much work (energy) is being done. Have a breach in the tower thus releasing its energy in milliseconds and you have much work done (destruction—energy).

Cost for Installed Watt: Power companies are *sized* based on how much *energy* is required from their customers. Once known, then how *powerful* the equipment must be to supply the customers is determined. Energy usage is the initial consideration and then the sizing of the equipment is determined. Once done, then the cost of installing the equipment can be determined. Because a large share of the cost will be the equipment itself and since the equipment is rated in terms of *power* rather than the energy it will deliver, a classical *figure of merit* for a plant is its cost per installed *watt* (power). But when sizing a solar electrical generating plant, this may become a misleading figure of merit because of the solar's implied Annual Capacity Factor (ACF). The result is in clever marketing as will be demonstrated in an analysis to follow.

Energy Usage: Energy usage is the amount of power by the amount of time the power is delivered. 1000 Watts of *power* (One Kilowatt) delivered in an hour is one kilowatt-hour (kWh) of energy. The utility company derives its revenue based on the energy used, not the power of the equipment that delivered the energy. Thus, you pay by the kilowatt-hour and not by the kilowatt.

Designing Solar Electrical Power Plants: Solar power plants should be analyzed in much the same way. That is, by how much energy is required. Since there are so many different ways to implement solar plants and ways to define their attributes, the industry has been struggling to find its own figures of merit. Solar

[12] Annual Capacity Factor is the amount of hours an electrical generator is generating its energy divided by the number of hours in a year (365 x 24= 8,760 hours)

[13] Annual Capacity Factor for solar is between 25%-30% depending upon the geographical location.

power plants are still considered as *alternate* energy devices basically serving an augmenting role where classical figures of merit may not make much sense and again, may be misleading.

The Annual Capacity Factor and Clever Marketing: As previously defined, the Annual Capacity Factor (ACF) is basically the percentage of time a power generator will deliver its energy in one year. Example: A 6.0 Megawatt Generator working with a 76% capacity factor will deliver energy from the 6.0 Megawatt generator over approximately 6658 hours (0.76 x 365 day per year x 24 hours per day). The amount of energy delivered is simply 6 MW x 6658 Hours or 39,948 MWh (Megawatt-hours). On the average, this works out to be a little over 18-hours of usage in a 24-hour day. Suppose that the energy requirement is only to be delivered for 6-hours a day each and every day. Six hours a day is a 25% capacity factor. In order to deliver the *same* amount of energy as before, the generator would have to be 3 times more powerful or would have to be 18 MW in *size*. Now for some clever marketing: suppose that the 6 MW generator sold for $600,000 and the 18 MW sold for $1,200,000 (twice the amount). The cost per installed watt would be 10 cents for the 76% ACF but only 6 2/3 cents for the 25% ACF. If the cost per installed watt were the deciding factor, the 18 MW system would be the clear winner. But the *revenue* would be the same because the amount of energy delivered would be the same. The 18 MW system would show a much poorer return on investment. Thus, the cost per installed watt cannot be considered alone as a figure of merit. In fact, cost per installed watt may indeed be misleading. Sizing is an important criterion when designing a power plant but it is more a dependent factor. The independent factor must always be what best serves the end user and that is the amount of energy ultimately delivered. Of course, nothing was mentioned about whether the energy delivered was smooth and conditioned, which must also be considered as an important factor

Annual Capacity Factor and Solar Power Plants: In general, solar electrical power plants have no practical means of storage[14]. For this reason, the annual capacity factor for a solar plant is usually *fixed* at about 25-30% (the average amount of time the sun shines in a day in a particular region.). As just stated, boasting a lesser cost per installed watt is not only misleading but may just be the hook that the general public needs to lean toward solar plants unable to store their energy. But uncontrolled spurious solar spikes are dangerous. What follows is a discussion of a solar technology able to store its energy and deliver it conditioned anytime night or day.

Conditioned Power From a 6-MW Turbine-Generator via OG-5 Solar Thermal Technology

The company behind the technology was recently asked to propose one of its systems to drive an existing 6 MW turbine generator set. The chief engineer after going through *several* tradeoff analyses concluded that the most efficient way to drive this output device was to operate it at its maximum rated power for no less than eight (8) consecutive hours at a time. His analysis was based upon actual hourly measured sun intensities. The system was configured (storage capacity determined) to meet this goal. As a result of this comprehensive analysis, the system provided full rated conditioned power for approximately 6658 hours during the course of an average year or 76 percent of the number of hours in that year. The *fallout* of the simulation analysis was an average ACF that serendipitously maximizes the reliability and maintainability of the rotating machinery.

Hours of Operation: 365 x 24 x 0.76 = 6658 hours

Energy Output: 6658 hours x 6,000,000 watts = 40 x 10^6 kilowatt-hours electrical energy

The Derived Figure of Merit: As a result of the above example, it has been determined that OG-5 systems are best configured to drive large electrical generating sets at a 76% average ACF. This concept maximizes efficiency, maintainability and reliability of the large generating equipment. Based on the 6 MW example, OG-5 power plants are able to be sized to provide a 76% average ACF with approximately a solar multiple of 2 2/3 which provides approximately 10 hours of storage per day. It's doubtful that any other type of solar configuration (PV, trough or tower) can provide the 76% average ACF economically which for an OG-5 system would be less than a 15% premium.

[14] The exception to this the technology discussed whose major feature is its ability to deliver conditioned (smooth) solar derived energy anytime night or day.

Photovoltaic (PV) comparison: It is important now to understand the misleading metric of "cost per installed watt" and to emphasize that when comparing OG-5 to PV arrays that PV arrays *do not store energy* and must be capable of delivering all of its energy only during sunlight hours and even spuriously at that and the power generating equipment for the PV array must be able to handle the PEAK power of the array field.

Over the years, PV array efficiency has dramatically improved from about 8% to over 15% and most likely will continue to improve. For the sake of being current, it is assumed that PV arrays can operate at 17% efficiency. Knowing that at sun's peak, the array is collecting a kilowatt of power per square meter. At a 17% efficiency that means the array power handling equipment must be sized to handle a PV field at 170 watts per installed square meter. The published information states that the daily average of energy collected via a non-tracking PV array is 4.5 KW-H per square meter per day which with a 17% efficiency is 0.765 KW-H per square meter per day. This relates to 279.2 KW-H per year for each installed square meter. This now dictates the size of the PV array field to provide the same amount of energy that was provided by the OG-5 field which is 40 million kilowatt hours. This amounts to 143,266 square meters of collecting surface which relates directly to the size of the power handling equipment which is 170 watts per installed square meter. Thus, the power handling equipment must be able to handle 24.4 MW of power.

This is a remarkable result because this is over four times the 6 MW generating equipment required for the OG-5 to deliver the same 40 million KW-H of energy. It becomes obvious that pricing the system as cost per installed watt, the PV price is divided by 24.4 where the OG-5 price is divided by 6 which is totally misleading. Also, the OG-5 field required is 2.1 times less than the required PV field. To summarize, PV arrays require 2.1 times the land area, 4.1 times the power generating equipment operating only 29% of the time delivering uncontrolled spikes to the grid. The more appropriate comparison is the cost for the energy delivered in a year's period of time, which must include the cost to install the system and the cost of land.

Grid Instability: Some time ago when alternative energy systems began augmenting the grid, the amounts were negligible compared to the grid's size. Now, when much larger alternative systems are being considered, their effect becomes more significant. In areas where grids are many and small, there is the possibility that the grid can become unstable when there are sporadic surges from these alternative systems. Grid surges present serious and dangerous problems and must be controlled, especially now that these alternative systems are evolving into much larger size. That is, the grids must be conditioned and *smoothed*. The only solution to this problem is to make certain that any augmentation system is countered with an equivalent sized standby system. This solution almost makes no sense but must be required because the current augmentation systems proposed only deliver their energy when the wind or sun is available. Once again, the augmentation systems have no ability to ballast their output. If they *could* smooth themselves, standby systems would not be required.

The Value of Smoothing: There is *value* for smooth and conditioned power that must be determined when considering alternative systems. Value is placed on driving a turbine generator set at an attractive ACF. Value must be associated with the power generating equipment directly. Value must be placed on supplying the energy on demand on not just when the energy is available. Value must be placed on an alternative system that does not require standby systems. All told, this can easily amount to significant dollar savings over the life of the system. OG-5 technology possesses all of these attributes, and thus can practically augment a grid, large or small without requiring specialized and costly controls. In fact, OG-5 technology is a practical *standby* solution in itself for those wind and PV projects already in place, under construction or in the planning stages.

Appendix F

Feasibility Study Lake Basaka Ethiopia

2018

GreenTech for Africa

Dr. Thomas Damberger, CEM

Lake Basaka

FEASIBILITY STUDY LAKE BASAKA

GreenTech for Africa is proposing the use of thermal energy production to purify brackish water from Lake Basaka for irrigation and potable quality to use locally in the towns and surrounding farms. The thermal energy is produced by three different technologies for use in a multi-stage flash (MSF) distillation process. The residue can be harvested for the salts, pharmaceuticals, fertilizers and chemical building blocks for a plethora of products. Electricity is a byproduct of producing steam for the MSF process. Thus, we begin a Feasibility Study to verify the technologies can reduce the size of the lake, produce potable water, and generate electricity—all at the same time.

April 4, 2018

Thomas Damberger, CEM
Golden State Energy
www.goldenstateenergy.com

Re: Feasibility Study for Three Cogeneration and Desalination Solutions for Lake Basaka near Metehara, Ethiopia

Dear Mr. Damberger:

Bibb Engineers, Architects, & Constructors (Bibb) is pleased to submit this letter Proposal for Professional Services to Golden State Energy for performance of a Feasibility Study for the Steam Power for Potable Water and Electricity Production for Lake Basaka in Ethiopia.

This letter Proposal is a presentation of the approach, capabilities, and expert resources that Bibb Engineers will put forward to complete the feasibility study.

I. PROJECT DESCRIPTION

Bibb Engineers proposes to study the use of thermal energy to purify water from Lake Basaka for irrigation and potable quality water to use locally in the towns and surrounding farms. The thermal energy (saturated and unsaturated steam) is produced by three different technologies for use in a multi-stage flash (MSF) distillation process. These three solutions, the potential distilled water production, and the electric power production potential for each are summarized below:

44 MW Solar Turbines Site (2 Titan 250 Gas Turbines)
100,000,000 Liters Water/Day
Annual Electricity Production 300,900 MWhe

10 MW Capstone MicroTurbines Site (10 C-1000 MicroTurbines)
950,000 LitersWater/Day
Annual Electricity Production 87,000 MWhe

6* MW Solar Thermal Site (6 4-Quad Solar Collectors)
18,000,000 Liters Water/day
Annual Electricity Production 15,000 MWhe

Bibb Engineers will study and develop the basic process designs for the three technology solutions utilizing thermal modeling methods and vendor supplied equipment performance specifications. Preliminary engineering activities will then be applied to the recommended configurations for each of the three (3) technology solutions. These activities, as described below, will further develop and define the equipment configurations, sizing, arrangement and site plot plans, lake intakes, utility integration, expected performance and production rates, estimated operations and maintenance costs, and estimated capital costs. This decision level information will provide a basis for the project execution phase.

II. SCOPE OF WORK

1. Project Start and Definition

   a. Project Information Memo – A summary of the companies and the key personnel, including contact information, participating in the project.

   b. Project Scope / Design Basis – A summary description of the three cogeneration / desalination solutions, the scope of the study, and the process objectives to insure that there is up front agreement among participating parties.

   c. Basic Engineering Design Data – Information that defines the parameters and boundaries for the solutions including ambient conditions, seismic and other design basis conditions, utility interfaces, a list of local codes applicable to the project, and the local utility companies and contacts.

2. Technical Feasibility

   a. Process Flow Diagrams (3) – Engineered diagrams showing the principle process equipment, flow paths, and process conditions.

   b. Available Equipment & Sizing – Equipment sizing decisions that are necessary to complete the process solution and the principle equipment design parameters.

      i. LNG Vaporizers– The vaporizers should be sized to convert LNG to fuel gas for the Solar and Capstone combustion process with adequate margin and redundancy.

      ii. Desalination – The desalination process will be sized to provide the design-basis desalinated water flowrates (or raw water intake flowrate) using the heat available from the combustion turbines and solar fields.

      iii. LNG Storage – The LNG storage will be sized to provide an adequate number of days of storage for operations based on the LNG delivery schedule plus margin.

      iv. Water Tanks – Configure and size water tanks for storage based on inflows and outflows with volumes for required duration.

      v. Substation Interface / Transformer - Evaluation of what step-up transformer(s) are needed, what their voltage and capacity need to be, and how the system will connect to the existing power grid.

      vi. Aux Power– The aux power will be estimated for all equipment and tabulated to size electrical systems and determine net power.

vii. The solar collector field process will be sized to convert annual energy production based on direct sun data measured hourly in Daggett, California scaled to Northern Ethiopia solar intensity.

c. Heat & Material Balance – The operating conditions, compositions and key physical properties of the major process streams on the Process Flow Diagram (PFD). This optimization effort will establish the recommended cogeneration / desalination solutions that will be the basis for further study.

d. Philosophy Descriptions – Summary level 1-2 page descriptions that will identify the recommended solution approaches in the following areas:

i. Microgrid / Island Mode – Method for developing a project electrical system that can operate independently of the existing power grid.

ii. Lake Intakes, and discharges to lake, pumping, and supply –Size the intake and discharge structures to meet the production rates of potable water distillation process. Spacing of the intake and discharge structures will be as necessary to properly dissipate the more concentrated brine solution going into the lake through the discharge. Intake and discharge structures will be constructed of cast-in-place concrete. The intake structure will have a screen to prevent the intake of trash and debris from the lake.

iii. Water Treatment Needs Pre/Post Desalination – Need and approach for removing suspended solids prior to desalination. If there are potential treatment needs to make potable water.

iv. Buildings & Shelters –Buildings and shelters will be provided as needed to aid in the production of the potable water distillation process. Building and shelters will be constructed of materials typically used locally.

v. Material Handling – Determine if required for the project.

vi. Control System– Type of controls system, locations of cabinets and operator interface. Benefits to networking the 3 systems together.

vii. Safety System - Description of protective relaying philosophy, arc flash mitigation, fire safety, and applicable codes.

viii. Firewater – Capacity of system and location of hydrants.

ix. Electrical Building – Description of plant(s) electrical buildings and design considerations (i.e. pre-manufactured or stick-built, suggested locations, etc.)

x. Packaged Equipment – Opportunities to utilize skidded or packaged equipment to reduce field labor.

3. Estimated Costs Pertaining to Commercial Feasibility

a. Estimated Capital Costs

i. Major Equipment

1. Project Specifications (all disciplines) – Requirements issued to all equipment suppliers for which pricing is requested.
2. Control System Block Diagram – Simple drawing of control system in block diagram form for pricing purposes.
3. Control & Safety System I/O Count – Summary of analog and discrete I/O for pricing purposes.
4. Equipment Data Sheets – Developed to be included with the equipment specification for vendor proposals.
5. Equipment Requisitions & Bid Tabs– Equipment bids will be reviewed against the specification.

ii. Bulk Materials

1. P&IDs – Piping and Instrumentation Diagrams will be developed for all plant systems at each site, including water systems, LNG, fuel gas, steam, condensate, and plant utilities.
2. Major Line Sizes – These will be shown on the P&IDs and used for material takeoffs.
3. Utility Tie-in Locations – General Arrangement showing utility tie-in locations for gas, water, electric, etc.
4. Steel Design Sketches –Steel design sketches will be developed to provide typical details that will be used for the development of the cost of the project.
5. Foundation Sketches – Foundation sketches will be developed to provide typical details that will be used for the development of the cost of the project.
6. One Lines – Will show the overall plant electrical distribution system and protective relaying.
7. Motor List – Will show all motors and loads for plant operation.
8. Equipment List with Size & Weights– All plant equipment will be tabulated with sizing description plus physical size and weight.

iii. Estimated Construction Costs

1. Civil Site & Plot Plans (3) including Roadways –A technical drawing that shows information about grading, site details, access areas, building and equipment footprints, travel ways, drainage facilities, sewer lines, water lines, lighting, parking areas, and other improvements.

2. Solar Field Plot Diagram - Solar field configured to site location to run the turbine and desalination system for the maximum uninterrupted operating time. A geo-technical site survey may be required.
3. Plot Plans(3) – General layout of equipment for each site.
4. General Arrangements –Are more in depth documents showing a greater amount of detail for the building & equipment, such as rooms and corridors inside a building and the details for equipment such as maintenance access, and general makeup of the equipment.
5. Soil Boring Drawing –Show the locations on-site where soil boring/soil samples will be obtained to be used to determine the best type of foundation system to use, type of road paving to be used, degree of compaction needed for the subgrade to support loads induced by structures and equipment.
6. Material Takeoffs (all disciplines) – Construction bulk material feasibility level estimates will be developed from the project drawings and lists.
7. Construction Labor & Material Costs – Bibb Engineers will provide project drawings and lists and the material takeoff quantities to METEC. METEC will develop a feasibility level construction labor and materials cost estimate for the project and provide this to Bibb Engineers. Bibb Engineers will review the METEC estimates, and as needed, supplement the estimates for specialty items such as installation of equipment as necessary.
8. Taxes & Legal – Bibb Engineers will not provide information pertaining to taxes or legal issues during the feasibility study.

b. Estimated Operating Cost

   i. Process Descriptions – A general description of each process.

   ii. Operations Summaries – A summary of operations including startup, shutdown, and normal operation.

   iii. Utility Summaries – Utilities required to operate the plant.

   iv. Facility Staffing – A proposed staffing plan for normal operations.

   v. O&M Costs – Estimated O&M costs for major equipment including personnel, chemicals, utilities, maintenance, and lubricants.

c. Estimated Schedule

   i. Project Permitting Philosophy – A summary of the critical permits required for project construction and operation.

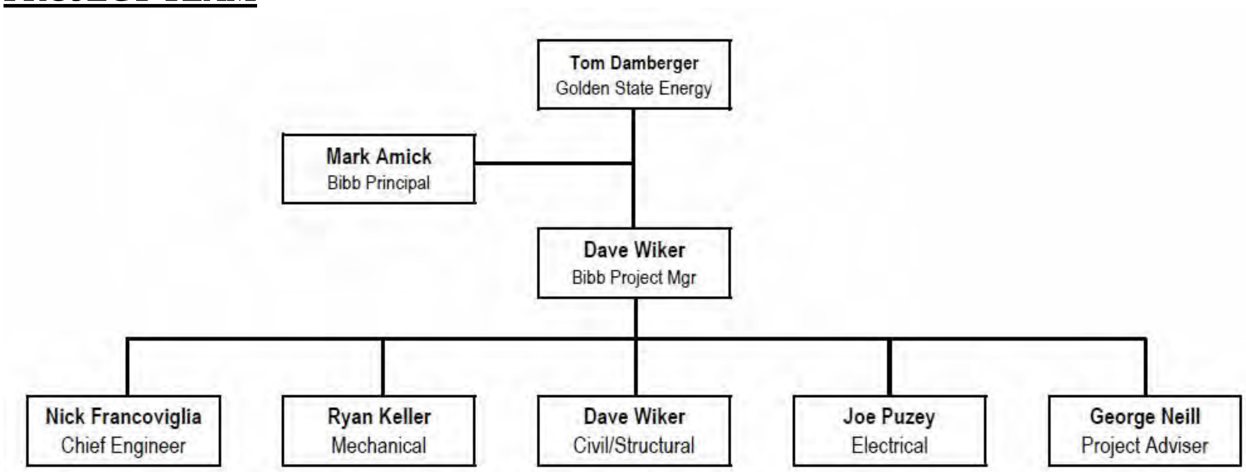
ii. Project Execution Philosophy – A summary of the recommended execution approach considering consultations with Owners and Financiers.

iii. Project Schedule – Level 1

III. SCHEDULE

Bibb can begin work on this project upon receipt of a signed agreement, notice to proceed, and initial payment. Bibb will endeavor to complete the work in a 5-months timeframe. An estimated schedule for the study activities is provided in Appendix E.

IV. PROJECT TEAM



V. FEE

Bibb proposes to complete the work as a level of effort, that is we will manage the depth of our evaluation within the fixed fee basis summarized below and in Appendix F.

Total Fixed Price for Study Work	$ 861,936
Allowance 1: Solar Thermal Field Sizing	18,000
Allowance 2: Travel and Living (expenses only)– California Trip	10,000
Allowance 3: Travel and Living (expenses only) – Ethiopia Trip (2 trips, one early, one at the end to present the study)	60,000
Allowance 4: Geotech Survey Solar Turbine Site	30,000
Allowance 5: Geotech Survey MicroTurbine Site	30,000
Allowance 6: Geotech Survey Solar Thermal Site	30,000
Allowance 7: Construction Estimate Specialty Consulting If Needed	40,000
Total Including Allowances	**$ 1,079,936**

All allowances are estimated. Any use of allowance funding must be approved in advance by Golden State Energy. Ethiopian taxes, if applicable, have not been included in the pricing above.

Payment Terms

10% of Contract Value	Due Upon Proposal Acceptance
20% of Contract Value	Due 1 Month following NTP
20% of Contract Value	Due 2 Months following NTP
20% of Contract Value	Due 3 Months following NTP
20% of Contract Value	Due 4 Months following NTP
10% of Contract Value	Due Upon Receipt of Study Report

VI. FORM OF AGREEMENT

Bibb and Golden State Energy will execute an Engineering Services Agreement (ESA) as the basis for the Feasibility Study. Bibb's standard ESA is proposed in Attachment B.

Bibb Engineers is very thankful to be considered to perform this important feasibility study that helps move forward the project which will have major, beneficial impact on Lake Basaka and the surrounding citizens. We hope this Proposal meets your needs at this time and please contact myself (amickmt@bibb-eac.com | 913.707.2979) or those copied below to discuss.

Very truly yours,

BIBB ENGINEERS, ARCHITECTS AND CONSTRUCTORS

Mark T. Amick
Vice President

cc: Bob Bibb, Chm, Pres, CEO (bobbibb@bibb-eac.com | 816.285.5501)
Dave Wiker, Project Manager (davewiker@bibb-eac.com | 816.285.5514)

Attachment A: 2018 Billing Rate Schedule
Attachment B: Engineering Services Agreement
Attachment C: Insurance Certificates
Attachment D: Foreign Corrupt Practices Act Certification
Attachment E: Estimated Study Project Schedule
Attachment F: Study Task Summary
Attachment G: Bibb Power, Architecture, & Industrial Capabilities
Attachment H: Team Resumes

FOREIGN CORRUPT PRACTICES ACT

CERTIFICATION

I MARK T. AMICK, V.P. [Name and Title] do hereby certify that I have received a copy of the Foreign Corrupt Practices Act Compliance Policy ("FCPA Policy") of the Company, that I have read the FCPA Policy, that I understand the provisions of the FCPA Policy and that I agree to comply with the provisions of the Foreign Corrupt Practices Act and the FCPA Policy.

I certify that I have not made and will not in the future make use of the mails or any means or instrumentality of interstate commerce corruptly in furtherance of an offer, payment, promise to pay, or authorization of the payment of any money, or offer, gift, promise to give, or authorization of the giving of anything of value to (a) any foreign official for purposes of influencing any act or decision of such foreign official in his official capacity, including a decision to fail to perform his official functions; or inducing such foreign official to use his influence with a foreign government or instrumentality thereof to affect or influence any act or decision of such government or instrumentality in order to assist the Company or any of its subdivisions, representatives or agents or other employees in obtaining an inappropriate advantage or obtaining or retaining business for or with, or directing business to, any person, (b) any foreign political party or official thereof or any candidate for foreign political office for purposes of influencing any act or decision of such party, official or candidate in its official capacity, including a decision to fail to perform its or his/her official functions; or inducing such party, official or candidate to use its or his/her influence with a foreign government or instrumentality thereof to affect or influence any act or decision of such government or instrumentality, in order to assist the Company or any of its representatives, agents, other employees or subdivisions in obtaining an inappropriate advantage or obtaining or retaining business for or with, or directing business to, any person; or (c) any person, while knowing or having reason to know that all or a portion of such money or thing of value will be offered, given or promised, directly or indirectly, to a foreign official, to a foreign political party or official thereof, or a candidate for foreign political office, for purposes of [i] influencing any act or decision of the foreign official, political party, party official, or candidate in his/her or its official capacity, including a decision to fail to perform his/her or its official functions; or [ii] inducing a foreign official, political party, party official, or candidate to use his/her or its influence with a foreign government or instrumentality to affect or influence any act or decision of the government or instrumentality, in order to assist the Company or any of its representatives, agents, other employees or subdivisions to obtain an inappropriate advantage or obtain or retain business for or with, or directing business to, any person.

I will immediately advise the Company's General Counsel in writing in the event that I learn of, have reason to know of or suspect any violation of the Foreign Corrupt Practices Act or the FCPA Policy.

By: Mark Amick

Title: VICE PRESIDENT

Date: 3/30/2018

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- **Reopened Late 2003** (After Noncompete Agreement Expired)
- **Diversified Industrial, Power and Architectural Projects**
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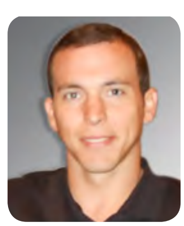
  - Owner's Engineer
  - Investigations
  - EPC Design-Build Teams with Contractors

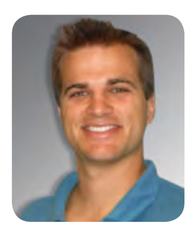
Contact us Anytime!

Bob Bibb
President/CEO
bobbibb@bibb-eac.com



Brian Norris
VP Business Development
briannorris@bibb-eac.com

Mark Amick
Vice President
markamick@bibb-eac.com



Matt Helwig
VP Operations
matthelwig@bibb-eac.com

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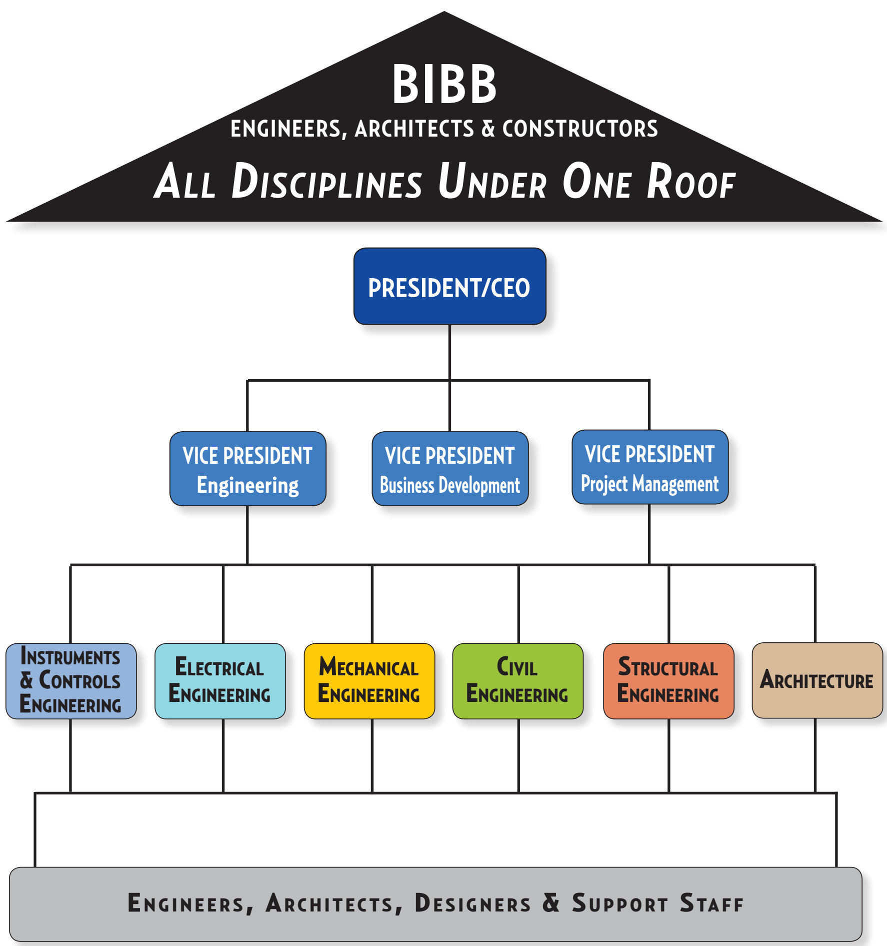

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  - Industry
  - Commercial
  - Developers
  - Institutions
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400 Dorla Ct., Suite 12187
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