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Thermal Energy Storage comments from Bright Energy

Additional submitted attachment is included below.

DOCKETED	
Docket Number:	19-ERDD-01
Project Title:	Research Idea Exchange
TN#	
Document Title:	Thermal Energy Storage comments from Bright Energy
Description:	Comments on the benefits of Thermal Energy Storage to achieving the 100% renewable energy generation
Filer:	Bill Capp
Organization:	Bright Energy Storage Technologies
Submitter Role:	Public
Submission Date:	7/12/2019
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STATE OF CALIFORNIA
BEFORE THE CALIFORNIA ENERGY COMMISSION

Research Idea Exchange	**)**	**Docket No. 19-ERDD-01**

COMMENTS OF BRIGHT ENERGY STORAGE TECHNOLOGIES

Bright Energy is pleased to respond to the issues raised by the California Energy Commission ("CEC" or the "Commission") in its Webinar pertaining to the Preliminary Draft Renewable Energy Generation Research Roadmap. In the Webinar held on June 28, 2019, the commission reviewed the draft roadmap (TN#228863) and the Technical Assessment of Grid Connected Renewable Energy and Storage Technologies and Strategies (TN#228862).

Public comments were solicited.

I. COMMUNICATIONS

Please provide all communications concerning this proceeding to:

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II. ABOUT BRIGHT ENERGY STORAGE TECHNOLOGIES

Bright Energy is an Arvada, Colorado based organization with 10 years of experience in developing very low-cost storage technologies and more recently is also developing cryogenic carbon capture systems.

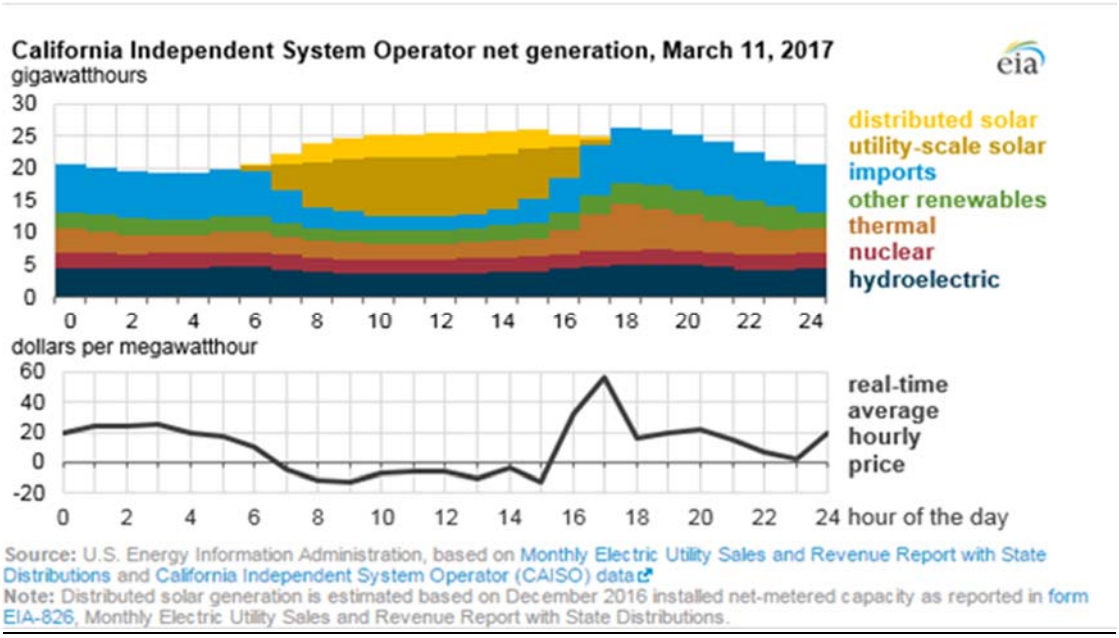
Our Concrete Thermal Energy Storage (“CTES”) systems are currently being evaluated by Electric Power Research Institute (“EPRI”) through their research program. The initial phase of the program is designed to conduct a risk assessment and to characterize the system performance. The second phase of the program involves demonstration of a 10 MWh system at

an operational plant. EPRI applied for Department of Energy ("DOE") funding for this CTES pilot and was recently awarded $4 million of the $5 million cost of the project from DOE.[1]

III. COMMENTS

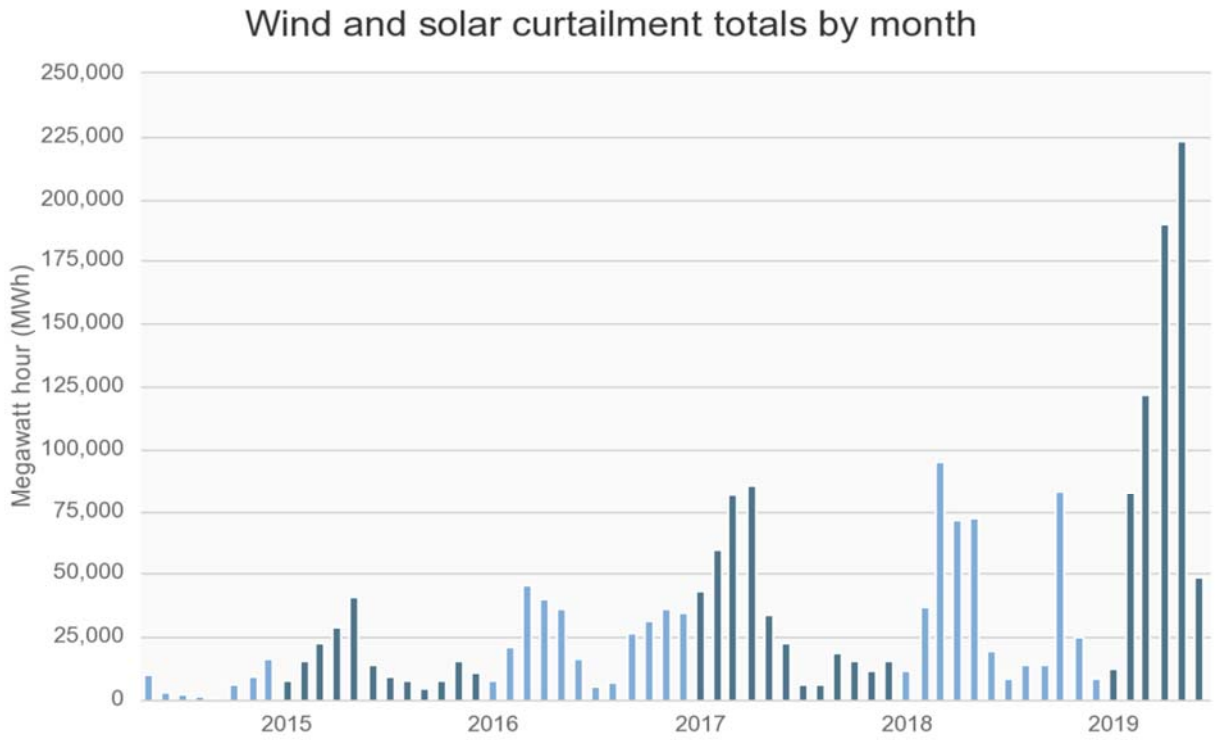
Thermal Energy Storage ("TES") is increasingly an attractive technology that can provide significant benefits to California as the State works toward the goal of 100% zero carbon electricity by 2045. As wind and solar PV have become more competitive than traditional generation resources and their costs continue to decline, it is clear variable renewables will represent the majority of new generation procurement. The challenge for California is to identify the best way to incorporate these carbon-free resources onto the grid while maintaining safety, cost effectiveness and reliability of the electric system.

Today, during these periods of surplus energy the ISO's market automatically reduces the production of energy from renewable resources, or "curtails" energy generation. In instances when economic bids from generators are insufficient, ISO operators manually curtail production to maintain the balance between supply and demand, as shown here:



[1] http://www.globenewswire.com/news-release/2019/07/01/1876757/0/en/EPRI-to-Lead-5-Million-DOE-NETL-Project-to-Test-Concrete-Thermal-Energy-Storage-Technology.html

While curtailment is an acceptable operational tool, with increasing renewable resources, oversupply conditions are expected to occur more often, as evidenced in the June 2019 CAISO data[2] shown here:



The Commission has concluded that although lithium-ion batteries ("LIB") offer good performance in terms of efficiency and response, but alone cannot satisfy the need for long duration storage required by the grid. Part of the cost problem is that the life of LIB systems are inversely proportional to the number of charge-discharge cycles, so as these systems are utilized to a greater degree their lives can drop quickly.

There are thermal energy storage systems that can provide benefits for commercial and industrial applications such as making ice or chilled water to later provide air conditioning; these are well known. As the duck curve becomes more extreme, these systems have the disadvantage of removing load during the peak of the solar generation cycle.

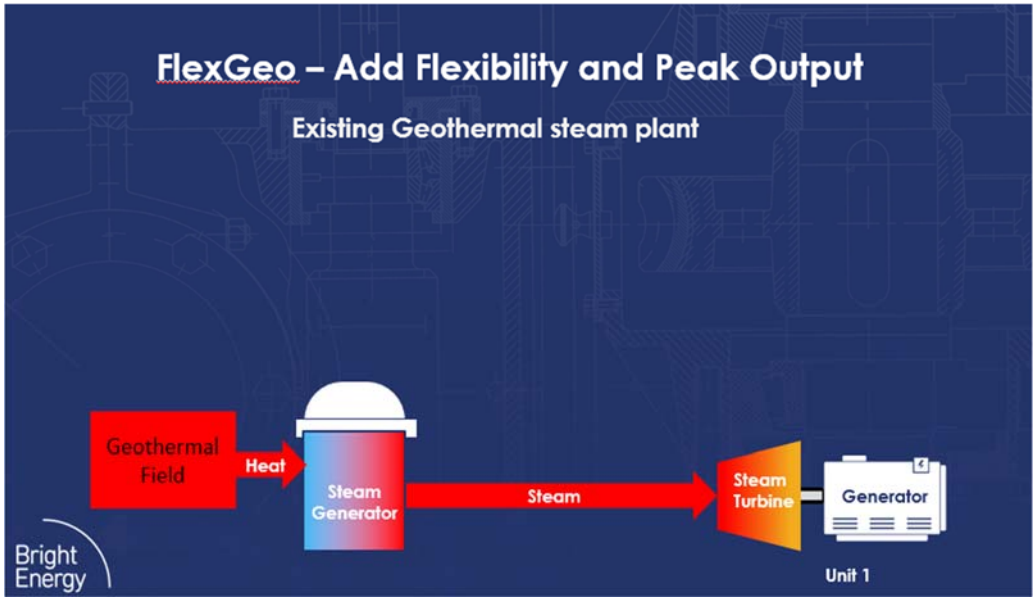
[2] http://www.caiso.com/informed/Pages/ManagingOversupply.aspx

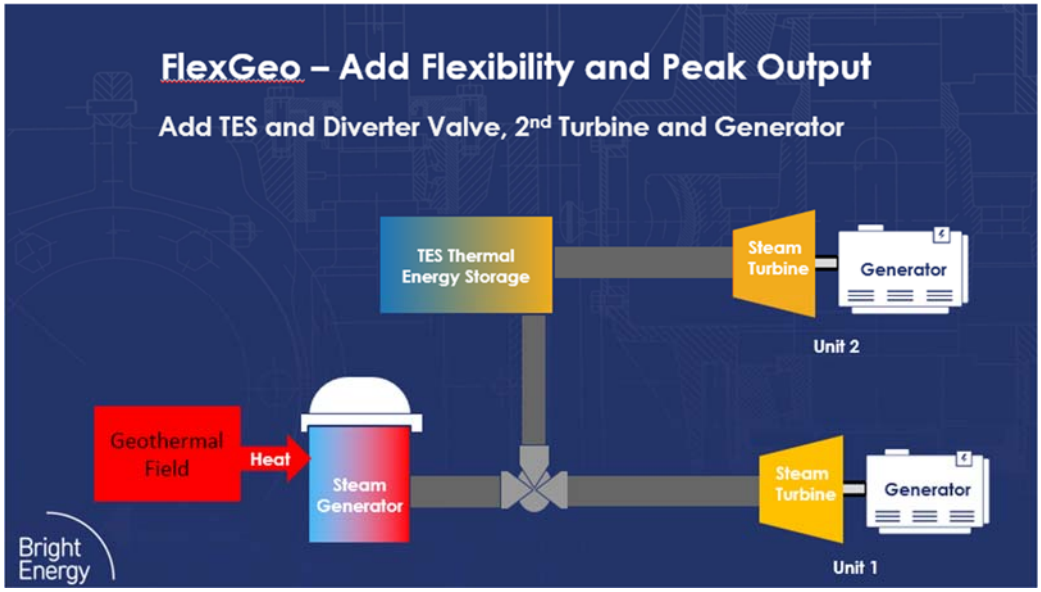
The CTES is different in that it stores energy in the form of heat (up to 600 deg C) and provides benefits to the bulk energy system. Providing long duration bulk storage with 20+ years of service life is where Thermal Energy Storage can play an important role, as outlined below. There are four specific applications reviewed followed by a chart showing the potential for over ten possible uses. It is recommended that the Commission reflect this potential in their allocation of resource and demonstration resources.

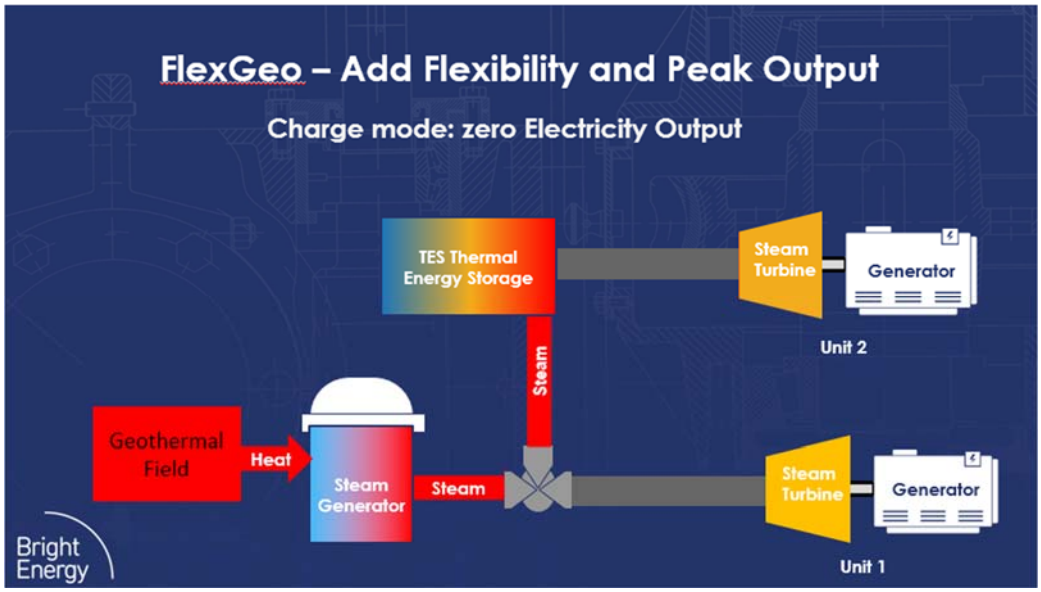
A. Thermal Energy Storage can make carbon free resources designed to operate as baseload generation into very flexible resources while increasing their peak capacity. This provides the needed flexible balancing from non-fossil resources while increasing the contribution to resource adequacy.

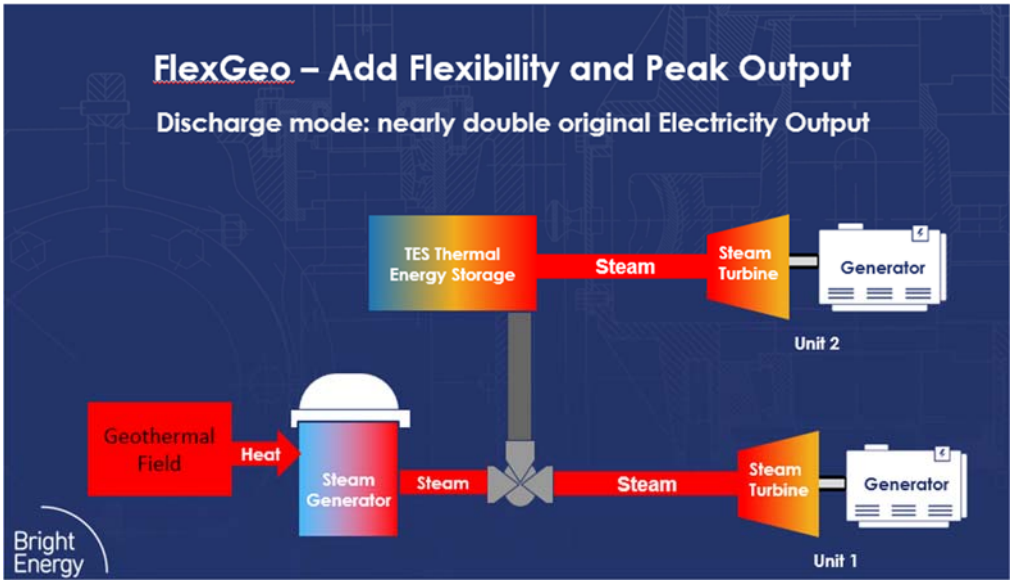
Geothermal and nuclear generation are carbon free but are not flexible in output. With a higher priority in dispatch order than fossil resources, they can lead to higher curtailment of wind and solar.

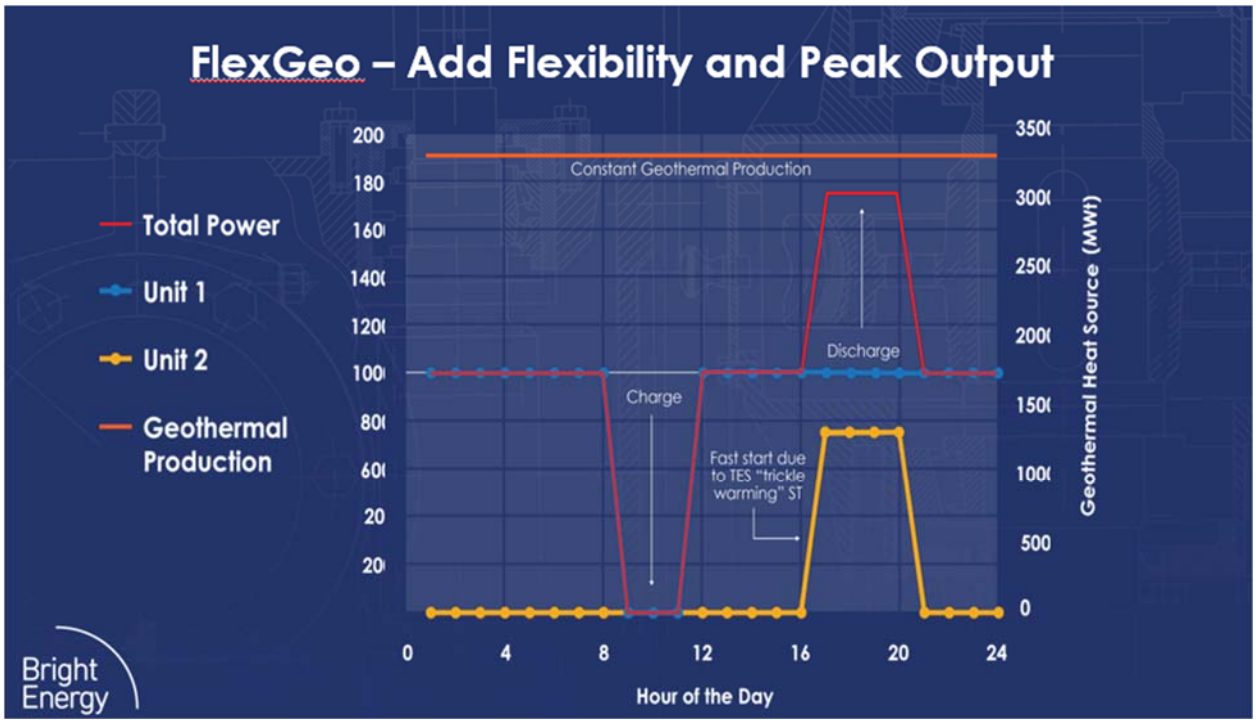
The addition of thermal energy storage would allow these assets to operate between zero output to nearly twice the original output while keeping the actual thermal output of the source of heat (the geothermal field or nuclear reactor) at a constant level. The following diagrams show how this works for a geothermal system. Note that the nuclear case is basically the same.


FlexGeo – Add Flexibility and Peak Output
Existing Geothermal steam plant
Geothermal Field
Heat
Steam Generator
Steam
Steam Turbine
Generator
Unit 1
Bright Energy


FlexGeo – Add Flexibility and Peak Output
Add TES and Diverter Valve, 2nd Turbine and Generator
TES Thermal Energy Storage
Steam Turbine
Generator
Unit 2
Geothermal Field
Heat
Steam Generator
Steam Turbine
Generator
Unit 1
Bright Energy


FlexGeo – Add Flexibility and Peak Output
Charge mode: zero Electricity Output
TES Thermal Energy Storage
Steam Turbine
Generator
Unit 2
Steam
Geothermal Field
Heat
Steam Generator
Steam
Steam Turbine
Generator
Unit 1
Bright Energy





The addition of the CTES system allows the geothermal system to operate in accordance with the needed output to match the net generation requirements after the contributions from solar (the "duck curve"). This benefits the California grid by providing more carbon free peak capacity to meet resource requirements and benefits the economic viability of geothermal systems by providing for the sale of energy when prices are higher and also providing higher resource adequacy payments.

B. Thermal Energy Storage can provide cost effective thermal energy storage for Adiabatic Compressed Air Energy Storage ("ACAES") systems and Concentrating Solar Power ("CSP") systems.

Compressed Air Energy Storage systems have been demonstrated to provide cost effective electricity storage but are not carbon free because they utilize natural gas as part of the generation process. ACAES has been proposed to address this limitation by storing the heat of compression created during the storage phase and utilizing it in during the discharge (generation) phase. A CTES can provide this reheating of the compressed air required for efficient operation by reusing the heat of compression, avoiding the need to burn natural gas to generate heat.

The addition of thermal storage in the form of thermal salts has allowed CSP systems to be more dispatchable and able to contribute to needed generation after sundown. The Commission report suggested that the costs of these thermal salt systems adds $2 to $3 per W to the CSP systems for 6 to 10 hours duration of output. Although the costs of molten salt systems are coming down, CTES systems can provide the same benefits at much lower costs.

C. Thermal Energy Storage can convert fossil steam plants into electricity storage assets. There are two configurations; 1) a heat pump version with good efficiency and lower costs than batteries and 2) a resistance heated version with lower efficiency and much lower costs.

One of the effects of the conversion from fossil to renewable energy is the obsolescence of natural gas and coal resources before they have reached the end of their operational life. With the addition of CTES systems, the majority of the value of these assets (interconnection system, steam turbines, condensers, generators, transformers, skilled operators, economic benefit to the local community, etc.) can be preserved by repurposing these fossil plants into electricity storage systems. This re-use also avoids the economic problems associated with stranded assets.

There are two configurations; both take surplus electricity from the grid during surplus solar hours and convert the electricity into heat which is then stored in the CTES system. When generation is needed the heat from the CTES is used to make steam which is then utilized by the plant as it was originally designed, expanding through the steam turbine and running the generator. There are two approaches to the generation of heat from electricity that are similar to the choices used by residential and commercial systems.

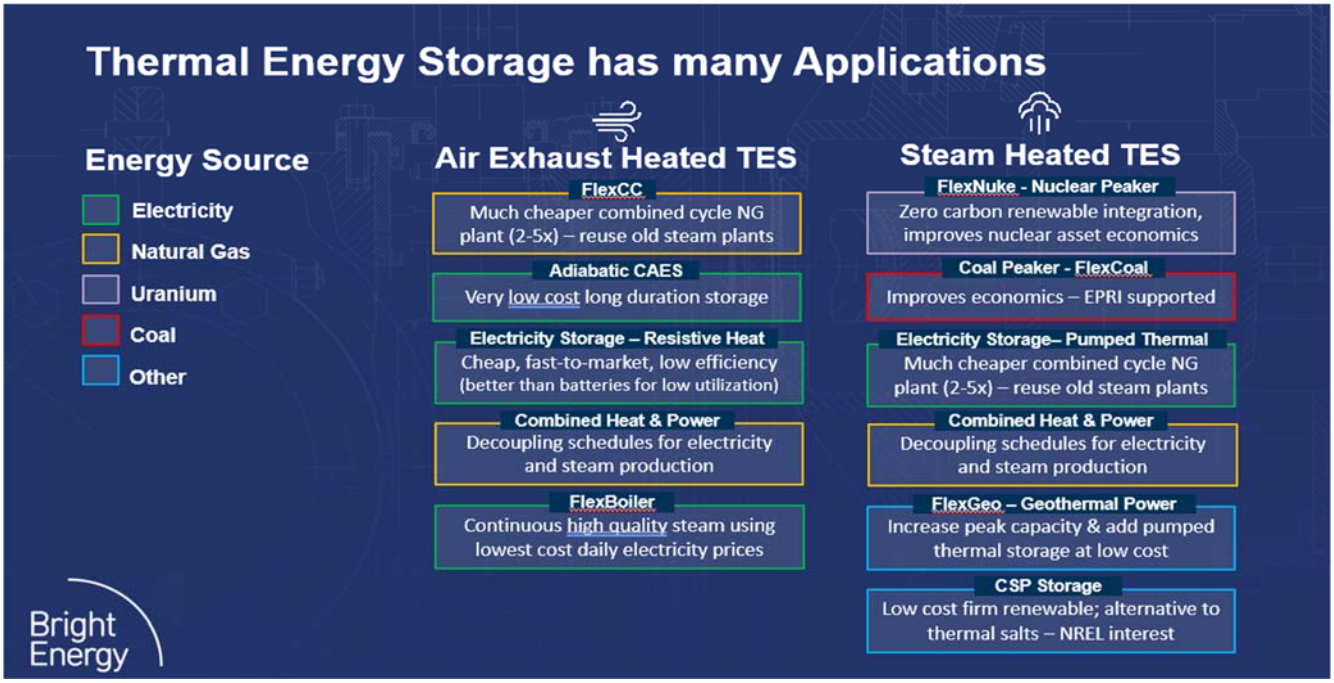
The first configuration utilizes a heat pump to create heat. In cases with high utilization, the additional cost of the heat pump can be offset by higher round trip efficiencies in the range of 60-65%.

In select locations where the capacity utilization is low (i.e. load pockets with inadequate transmission) the second configuration using resistance heating is a viable solution. Even with a 30-35% round trip efficiency this approach is the most economical as the system cost is much lower, offsetting the higher cost of electricity.

D. Thermal Energy Storage can dramatically improve the financial performance of Combined Heat and Power (CHP) systems by decoupling the schedules of electricity generation and steam generation.

Many CHP systems have a fixed schedule for proving steam to various processes and are forced to generate electricity according to that schedule. In most cases, the generation schedule has poor correlation with the highest clearing prices resulting in lower revenues from the sale of electricity. Thermal Energy Storage allows the generation schedule to be optimized around prices while still meeting the steam schedule because the surplus heat from the electricity generation is stored until needed, at which time it is converted into steam.

E. Thermal Energy Storage has many additional applications beyond those outlined above. The following graphic shows over ten valuable applications.



IV. CONCLUSION

- There is an increasing need for flexibility in the electricity system in order integrate variable renewable resources.
- TES costs are low and continuing to decline
- TES can provide low cost, long duration storage
- TES can minimize stranded asset costs

Bright Energy appreciates the opportunity to provide these comments. Including support for the development and demonstration of Thermal Energy Storage systems will benefit California as it achieves the goal of 100% carbon free energy.

Respectfully submitted,

Bright Energy Storage Technologies

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Dated: July 12, 2019