Center for Energy Efficiency & Sustainability
800-B Beaty Street
Davidson, NC 28036
Tel (704) 990-3179 Fax (877) 614-8418
Nanette.Lockwood@irco.com

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VIA ELECTRONIC MAIL
DOER.cps@mass.gov

Massachusetts Department of Energy Resources
100 Cambridge St., Suite 1020, Boston, MA 02114

RE: Clean Peak Energy Standard Stakeholder Questions

We appreciate the opportunity to provide the following comments to the Massachusetts Department of Energy Resources ("DOER") Clean Peak Energy Standard Stakeholder Questions which will be used to help develop the Clean Peak Energy Standard required by the enactment of Chapter 227 of the Acts of 2018.

Ingersoll Rand (NYSE:IR) is a global company that advances the quality of life by creating comfortable, sustainable and efficient environments. Our people and our family of brands—including Club Car®, Ingersoll Rand®, Thermo King® and Trane®—work together to increase industrial productivity and efficiency, enhance the quality and comfort of air in homes and buildings, and commercial transport; and to protect food and perishables. We manufacture CALMAC® ice storage tanks within our Trane® portfolio in Fair Lawn, NJ. The ice tanks work in line with chilled water systems and integrated controls to create thermal energy storage ("TES") systems. To date, more than 1 GW of TES peak load modifying capacity has been installed globally.

Ingersoll Rand supports efforts to encourage the adoption of energy storage that can reduce peak GHG emissions in Massachusetts. TES is a proven technology with more than 7 MW, 45 MWH of TES peak load modifying capacity installed in Massachusetts and more than 15 MW, 95 MWH installed in ISO New England. TES provides C&I customers like the Moakely Courthouse in Boston with the ability to materially time shift their energy usage during hot summer months to reduce electricity costs.[1] TES relies on chillers that make ice typically at night (charging) which is then used to provide air conditioning service during the day (discharging).[2] This process enables building owners to use off-peak energy during peak times. TES is also highly durable, efficient and safe, with no flammable or hazardous materials. CALMAC® tanks have a useful life of as long as 30 years with little maintenance cost and achieves round trip efficiencies approaching 97%.[3] Moreover, it can provide cooling service for up to eight hours or more at a time, and most components can be recycled. Overall, TES lasts 2 to 4 times longer than batteries at one-third the cost.[4]

The deployment of TES can also help Massachusetts achieve its clean energy goals. TES is well suited to "storing" the wind energy it uses at night for daytime use.[5] This enables emission-free energy to be utilized during the day and reduces the need for peaking fossil fuel plants.

<u>Demand Response Resource</u>

3. What types of resources should be included in this definition?

Thermal energy storage (TES) systems, which have the potential to reduce customer summer peak load costs by up to 40% or more, should be an eligible technology under this definition. TES charges at night when it creates ice for day-time air conditioning and cooling demand. This time shifting of energy from night to day not only enables end users to arbitrage energy prices but also enables them to use emissions-free resources such as hydroelectricity and wind and

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[1] https://www.wbur.org/bostonomix/2016/08/19/moakely-energy-storage

[2] http://www.trane.com/commercial/north-america/us/en/products-systems/equipment/chillers/ancillary-chiller-equip/ice-making.html.

[3] Batteries by comparison have round trip efficiencies closer to 85% and useful lives of 10 years, according to the 2017 Lazard Levelized Cost of Storage. The report also found that batteries can degrade and must be replaced to maintain capacity. https://www.lazard.com/media/450338/lazard-levelized-cost-of-storage-version-30.pdf

[4] CALMAC® analysis as published in Distributed Energy Magazine, January 2018. http://www.trane.com/commercial/north-america/us/en/about-us/newsroom/blogs/thermal-storage-and-batteries-working-together.html

[5] https://tc0609.ashraetcs.org/documents/research/TC0609%20ASHRAE%20RP-1607%20Research%20Summary%2020180125.pdf

avoid day-time use of dirtier peaking resources, often powered by natural gas or fuel oil. TES units can provide up eight hours of demand reduction on a single charge.

Unlike batteries, which are a static asset, TES is a dynamic asset because its instantaneous grid impact at any given time is correlated with an independent variable. The KW contribution of TES to the grid at any time is directly correlated with both ambient air temperature and operational status of the building or structure it serves (i.e. whether the host building or structure is currently occupied or not). Therefore, to determine actual grid impact and performance, TES should be analyzed with respect to and account for the impact of ambient air temperature. Furthermore, to determine the maximum theoretical grid impact the anticipated output of TES should be determined based on the industry standard worst hour of a 1-in-10-year heat storm. This is comparable to how the theoretical production of a natural gas peaker is determined, because the ambient temperature during the 1-in-10-year heat storm will also affect the peaker's output.

5. How should DOER interpret the inclusion of different types of rate designs in this definition?

DOER should ensure that off peak charges are aligned with clean peak periods, while on peak periods align with times of high GHG output.

7. Should standalone energy storage resources (i.e. not directly connected to another resource type) be eligible to qualify as demand response resources? What requirements, if any should standalone energy storage resources face in order to qualify as demand response resources?

Standalone storage resources such as thermal energy storage should have an opportunity to participate. Please see the response to question 3.

8. Should the DOER view thermal storage facilities as a Demand Response Resource? What requirements, if any, should thermal storage facilities face in order to qualify as demand response resources?

Yes. TES should be viewed as an improved form of demand response resource. TES is a dynamic asset in that its instantaneous grid impact at any given time is correlated with an independent variable. The KW contribution of TES to the grid at any given point is directly correlated with both ambient air temperature and operational status of the building or structure it serves (i.e. whether the host building or structure is currently occupied or not). Thus, to determine actual grid impact and performance, TES should be analyzed with respect to and account for the impact of ambient air temperature. Furthermore, to determine the maximum theoretical grid impact the anticipated output of TES should be determined based on the industry standard worst hour of a 1-in-10-year heat storm. This is comparable to how the theoretical production of a natural gas peaker is determined, because the ambient temperature during the 1-in-10-year heat storm will also affect the peaker's output.

The power (KW) and energy (KWH) consumption of HVAC Systems are well known to be variable, with the highest power and energy consumption coming during the hours with the highest ambient air temperature. For this reason, the grid impact of discharging a large TES system is dynamic, varies over the year, and peaks with high ambient air temperature. At any given time, the power and energy consumption of an HVAC system is a function of equipment thermodynamic performance (fixed), and the variables of building occupancy status and ambient air temperature. By continuously monitoring both KW and ambient air temperature, very accurate performance curves can be calculated in both the occupied/unoccupied building modes and the large TES discharging/not discharging mode. The data collected will allow accurate estimates of KW for any combination of occupancy, ambient air temperature, and large TES discharge status. Comparing the expected system KW for a given condition with actually measured KW during large TES discharge at that same set of points over time is used to compute the delivered KWH. It also allows GHG calculations on a moment by moment basis.

Buildings have two major loads to satisfy, thermal (HVAC) and electrical. It would not be efficient or economical to store enough electrical energy in an electro chemical battery to drive an electric chiller for instantaneous cooling. Efficiency and economics point to storing energy in the form it will be used - thermal battery for thermal loads and electrical battery for electrical loads.

Qualified Energy Storage System

11. How should DOER view thermal storage facilities with respect to eligibility as a qualified energy storage system?

TES should qualify as an energy storage system because it is commercially available technology that is capable of absorbing energy, storing it for a period of time, and thereafter dispatching the energy using thermal processes to store energy that was generated at one time for use at a later time.

Generation of Certificates

23. Should qualified energy storage systems that can demonstrate they were charged during minimum load windows be provided additional incentives or benefits under the CPS? If so, how should these be structured and how should minimum load windows be established?

DOER should develop emissions baselines on an hourly basis for each day of the year. This will then enable DOER to properly value energy storage's ability to time shift periods of high renewable energy production to fossil production. For example, TES should be compensated for its ability to time shift nighttime renewables (e.g. wind energy) to day time use, when it would likely reduce the need for fossil resources such as natural gas and fuel oil.

Verification of Metered Data

24. Do you support this proposal? If not, please describe why.

Ingersoll Rand agrees with DOER proposals to verify performance of Clean Peak Resources. But respectfully asks that DOER be flexible in how verification is performed. TES systems are often integrated with advanced monitoring and controls equipment in lieu of a traditional meter. This same equipment can be used to provide the same data needed for verification purposes as a meter does. Adding an additional meter to TES equipment unnecessarily increases cost and complexity and so Ingersoll Rand respectfully asks that DOER be flexible on how verification data is provided for performance evaluation purposes. In addition, DOER should consider how any dynamic asset is given attribution, including, but not limited to, TES. Because of their variability, dynamic assets require a verification process that is able to fairly, accurately, and repeatedly provide measured results. With a form of attribution in place that is appropriate to a dynamic asset, independent verification is enabled and made relatively simple, while at the same time equitably compensating a dynamic asset for actually delivered grid benefits.

Metering Specifications and Requirements

28. What other verification mechanisms could be deployed to simplify the process, particularly for small-scale systems for which some types of metering solutions may be cost-prohibitive?

Please see response to question 24 above.

Long-term Contracts

31. If DOER does require competitive procurements:

> *a. What types of facilities should be able to participate in solicitations? Should it be limited to certain types of facilities (e.g. facilities that are either new and/or not already supported by another type of long-term contract or financing tool)?*

TES users should have the opportunity to bid their verified clean energy certificates into any solicitation under the same defining conditions as other assets. Because of the reduction in capacity of fossil fueled generation as ambient air temperature increases, this is commonly accounted for in contract. For example, if a combustion turbine is rated at a nominal 50 MW at 77°F, but only 42 MW at 105°F, and the anticipated 1-in-10 peak air temperature for that location is 105°F, then that asset would only be valued at 42 MW for capacity purposes.

From an equity standpoint, TES should be evaluated at the same conditions, and policy should reflect the fact that this attributable value increases with ambient air temperature. The solicitation should allow all provable resources to participate, at the owner's option.

Demand Response Resource Carve-out

34. How should DOER interpret this requirement?

DOER should interpret this requirement such that it is only a floor and not a cap on the amount of DR resources that can provide clean peak certificates.

<u>Other</u>

36. Please discuss any other implementation issues not addressed above.

Ingersoll Rand respectfully suggests that DOER use the following definition of energy storage:

> A qualified energy storage system is a commercially available technology that is capable of absorbing energy, storing it for a period of time, and thereafter dispatching the energy using mechanical, chemical, or thermal processes to store energy that was generated at one time for use at a later time.

In the post 2019 standards section (Questions 32 and, 32), one issue that should be considered is how this number is calculated. The number should be based upon overall consumption, not annual sales. This would avoid the adverse impact of reducing overall electric energy sales on the policy goal of increasing energy storage.

Please contact me with any questions.

Sincerely,

Nanette Lockwood

Nanette Lockwood
Sr. Global Director, Climate Policy and Advocacy
Center for Energy Efficiency and Sustainability
Ingersoll Rand
Nanette.Lockwood@irco.com