Defining the Living Pilot, Symposium of Ideas
HVAC Intelligence Driven IDSM Solutions
Scot M. Duncan, P.E., 10/21/2013

<u>I - Background</u>: Large scale HVAC systems, Chiller Plant Environments and/or DX Units larger than 20 Tons, are the single largest electrical load in most commercial facilities and notoriously hard to reach in terms of energy efficiency and automated demand response. Todays' rapidly evolving HVAC intelligence and dynamic control technologies have the potential to provide the "cost effective, preferred resources" sought by the "Preferred Resource Pilot" in order to mitigate the effects of the SONGS retirement.

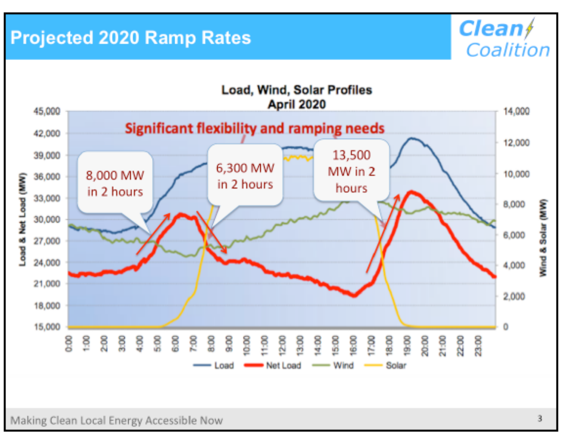
In collaboration with the California IOU community and the CEC, Enerliance CEO Scot Duncan, P.E. has developed a track record for creating innovative, effective HVAC Intelligence solutions for large commercial facilities. Examples include; delivering 4.5 MW of demand response to the 2001 CEC Demand Response Pilot, delivering 3.5 MW of thermal storage to the SCE Permanent Load Shift pilot (with a simultaneous efficiency improvement of ~30%) and the design/execution of an innovative optimization project at the PG&E San Ramon Valley Conference Center which set new standards for HVAC efficiency, reducing HVAC energy use by over 50%.

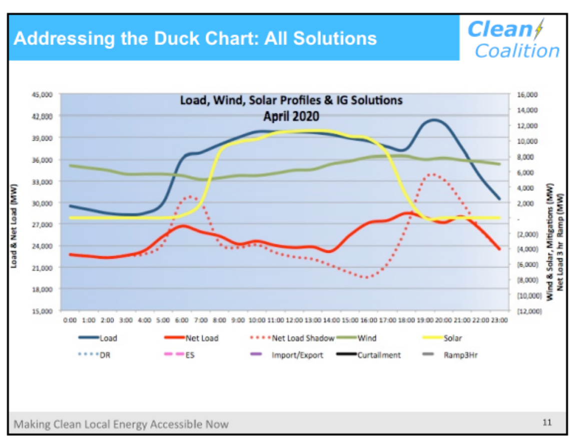
More recently and more specific to the SONGS challenge, Enerliance technology – LOBOS (Load Based Optimization System) – is currently enabling more than 20MW of auto DR capacity, concentrated in the Johanna and Santiago areas, with another 10MW scheduled for installation in the coming months.

<u>II - Technology</u>: While the LOBOS platform is in the early stages of the technology adoption bell curve, early commercial adopters (with the assistance of ~$7 million in CA IOU incentives) have established an installed base plus contracted backlog which includes more than 300 commercial buildings, 49 million square feet, 31.9MW of ADR capacity, and $3.5 million in annual energy savings. This integrated Energy Efficiency and Demand Response activity represents the intersection of Building Intelligence, Energy Solutions and the Smart Grid. It might also be considered proof of concept that this transformative technology, truly integrated demand side management, is capable of making significant contributions to mitigating the 25MW annual unmanaged growth expected in the Johanna-Santiago vicinity.

<u>III - Proposal</u>: We propose that various applications of the LOBOS Energy Efficiency, Demand Response, Load Shaping, and PLS/Thermal Storage strategies be investigated and deployed within the Preferred Resource pilot in the short term, and further developed in a collaborative effort within the Living Pilot over the longer term.

As illustrated in the slides below, the steep ramps in the net load profile (left) have the potential to be effectively mitigated by effective load shaping strategies (right), including several key strategies which are enabled by LOBOS HVAC intelligence, thus the CA Duck and Johanna-Santiago issues can be dealt with in a site and source energy efficient manner.





a) Short Term. We believe the 20MW of ADR capacity enabled by LOBOS controllers (and 10MW soon to be enabled) will continue to be underutilized from a grid perspective. Facility owners within this installed base have the ability but not the financial imperative to utilize these controls to their potential. We propose to develop actionable strategies to harness this capacity within the Johanna-Santiago vicinity the short term.
b) Medium Term. We believe that we can access significant standing reserves of PLS/thermal storage, and reprioritize the control and charge cycle strategies to mitigate the steep ramp-up and ramp-down slopes on the net load curve.
c) Longer Term. We believe that that the short term capacity of ~30MW can be increased to well over 60MW through effective outreach and incentive. This additional capacity can be brought on line supported by an integrated demand side management approach that delivers ADR capacity at a density of ~1 watt per SF and Energy Efficiency savings of 1-3 watts per SF on an annual basis.

IV - Inventory of Potential HVAC Intelligence and other Strategies for Discussion

1. Energy Efficiency. Deep Dive Energy Efficiency projects that include “LOBOS-EE” (Load Based Optimization System) to address occupant comfort, energy efficiency at the air distribution system and energy efficiency at the cooling plant level. LOBOS EE can also be developed for DX rooftop packaged units, Variable refrigerant flow, water source heat pumps and pretty much any other type of refrigerant based cooling system.
2. Demand Response. Fully automated, scalable Automated Demand Response, in the form of the LOBOS-DR 10 stage controller can be implemented. LOBOS DR is designed to maintain comfort to the highest degree possible during DR events.
   a. In addition to curtailing load in a DR event, LOBOS DR is also designed to add load, and can be used to address part of the Tail of the CA Duck load curve, by adding load when renewables are starting to take over the loads, to allow a “soft landing” for fossil fuel power plants.
3. Short Duration DR Events. ADR can be effectively used to control large swaths of C&I portfolios, if the duration of the event is short. You can deliver approximately four times the DR reduction for a 30 minute period as you can for a two hour period while having minimal negative impacts on facility occupants. The ability to precisely manage tenant comfort impact dictates usable ADR capacity in C&I spaces.
4. Data Center EE Projects. To include conversion from hundreds of distributed packaged units without economizers to dozens of more centralized AHU’s equipped with economizers and direct evaporative cooling. On a 10 MW data center, the kWh can be reduced by approximately 13,000,000 kWh per year with a 3 MW peak demand reduction.
5. Fast Charge PLS Systems. Typical PLS (Permanent Load Shift aka Thermal Storage) systems charge their “thermal batteries” over an 8 to 18 hour period, far too long to help deal with the “Duck” load curve. A fast charge PLS system can be designed to charge the system in as little as 3 hours.
6. Enhance Existing PLS Capacity. 25% to 70% capacity gains are possible by converting them to “LTD” or “Large Temperature Differential” PLS designs to allow use of every cooling BTU contained in the water. Increases PLS capacity and usefulness, as well as cutting chiller energy by 25%+ and pumping energy by 50%+.
7. High Efficiency PLS. One example is the PLS retrofit project for the PG&E San Ramon Valley Conference Center, annual kWh consumption related to the HVAC system was cut by over half with a combination of “Fast Charge” PLS and LOBOS EE.
8. Data Center PLS. For the data centers that are not converted to centralized units with economizers and direct evaporative cooling, PLS systems can be added and designed to address the load ramping problems at the head and tail of the CA duck.

9. Load Shaping Through Fully Integrated Demand Side Management (IDSM) Systems. By combining Energy Efficiency, ADR, PLS, and some or all of the potential high efficiency HVAC system designs, the demand curve can be bent to fit the production curve in a much more usable manner.
10. Fast Cool Down HVAC Design. Most HVAC systems require at least 4 hours of "cool-down" time on hot days to get the buildings comfortable by 8 AM – a direct contributor to the "Tail of the Duck" load problem. A properly designed HVAC system can cool a facility down in 60 minutes, even on peak load days, to allow the tail of the duck to be trimmed.
11. Fast Recovery HVAC Design. Current HVAC designs do not allow much temperature setback during the day even when spaces are unoccupied, as even a few degrees deviation from setpoint can take several hours to recover from, which is unacceptable to tenants and facility owners, so setbacks are rarely used during occupied hours. A design strategy that allows a comfort based recovery in under 15 minutes can be promoted via design guides and incentives.
12. Large Temperature Differential Cooling Coil Replacements. When cooling coils are due for replacement, or as an "early retirement" program, incent the use of much larger face area and depth cooling coils to reduce airside pressure drops and allow the use of series chillers and 50°F CHW temperatures to improve chiller plant energy efficiency by a minimum of 35% over existing conditions.
13. Stable Tariffs with EE Investments. Offer stable tariffs in connection with energy efficiency investments for a 5 year period, to incentivize Owners to make investments in their infrastructure. No matter how big the initial incentive is, if the rates do not support the operation of the system over the long haul, the Owners will not make the investments in the upgrades, or if the investment has been made and the rates turn unfavorable, the Owners will reduce using the systems.
14. Cooling Tower Design Optimization. Having the most energy efficient HVAC system design is for naught if the cooling towers are not designed to operate effectively at low flows and low loads, as well as high flows and high loads with "abnormal" wet bulb temperatures. A design guide and incentive program could be developed to optimize cooling tower energy as well as the rest of the HVAC system.
15. High Efficiency Dehumidification System (HEDS). Facilities such as clean rooms, labs, manufacturing sites that need to control relative humidity use a substantial amount of energy to cool the air down to dry the air out, then re-heat it back to provide comfort conditions. The HEDS can cut peak day cooling loads by 30%+ and eliminate 90% of the peak day reheat energy required. A sample study at a large chip fabrication facility showed annual savings of 27,000,000 kWh and over 700,000 Therms of natural gas by combining LOBOS and HEDS with variable speed drive chiller plant equipment.
16. Alternate TRC Cost Effectiveness Test Methodology
    a. The TRC uses an estimated cost per kW to build a power plant as the cost to test the cost effectiveness of EE, PLS and DR solutions. The test assumes a cost per kW of a marginal power plant, but it is impossible to build an energy efficient power plant of any scale in CA at this point in time, so the real cost is infinite. What is the cost to build something that you cannot build? If you could build a large scale plant someplace, the T&D infrastructure to get the power to where it is used needs to be included in the TRC as well.
    b. A more realistic cost per kW as the baseline would be a distributed fuel cell system – EE, PLS and ADR reduce pollution and conserve natural resources, while even fuel cells consume natural resources.

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