LIPAedge Impact Methodology

The LIPAedge program is a residential and small commercial direct load control program. The program has the following components:

1. Customer receives a programmable thermostat that can directly control one (1) HVAC compressor (averaging 3 tons with a connected load @ 95F of approximately 4.4 kw).
2. The utility control is through a 2-way paging network operated by SkyTel.
3. Two-way communication provides information to and from the control site (customer's thermostat).
4. Information going to the thermostat includes time, instructions for operating thermostat (from the customer) and control instructions (from the utility). All communications are performed through the Internet. The control system is maintained and hosted by a Company (Silicon Energy), which specializes in these types of applications. The system is maintained at a secure location which where it is monitored on a 24/7 basis and where backup power is available.
5. The thermostat stores and transmits information back to the utility. This information includes, by hour, run time data (the number of minutes per hour that the compressor and compressor fan operate), indoor room temperature, number of times the compressor shuts on and off and the time that the customer overrides the utility control (if overrides are permitted). This information is available on all customers that have 2-way communication and a version 3 or higher thermostat. LIPA estimates that 12,000 of the 18,000 thermostats, which will be installed by July 1, 2002, will have the capability to transmit data from the thermostat back to the utility.
6. Connected load data for each unit will be collected on the field. The connected load data will be determined from the manufacturer's provided estimates of RLA (Compressor Load Amperage) and FLA (Fan Load Amperage) combined with the known voltage. In addition, 200 participants will have their connected load measured during a peak like day with a hand held watt-meter. These metered results will be compared to the connected load data estimated from the RLA and FLA (compressor and fan amperage respectively) ratings provided by the manufacturer. Any difference will be applied as an adjustment to the population.

The LIPAedge program has established the following rules for its operation:

1. Control can be initiated by the utility for up to 7 days per summer season (June 1 through September 30) between the hours of 2 PM and 6 PM (4 hours total). This equates to a total of 28 hours of control per summer season.
2. Customers can override the utility control by manually adjusting the thermostat. Overrides cannot be made remotely through the customers Internet control.
3. Utility control can be accomplished by either cycling the compressor off for a fix number of minutes or adjusting the setting on the thermostat upwards by a fixed number of degrees.
4. The utility can refresh the control signal during the 4-hour curtailment period, thus requiring customers that overrode the control to override it again.

Impacts will be calculated as follows:

1. Analyze the run time data to estimate the duty cycle[1] for all participants.

2. Remove free riders[2]. The percentage of free riders is calculated by reviewing the run time data. Customers that show zero use (no air conditioning) during the summer season are free riders since no savings can be obtained from cycling their units. These customers are removed from the duty cycle analysis. However, the percentage that they represent of the total number of participants is used as an adjustment to the gross kW reduction.

3. For remaining participants, determine the average duty cycle during the controlled (curtailment) days (Controlled Duty Cycle[3]) and similar uncontrolled (Baseline Duty Cycle[4]) days.

4. Estimate Duty Cycle Reduction, by hour, as a result of the utility control:

$$Duty\ Cycle\ Reduction = Baseline\ Duty\ Cycle_i - Controlled\ Duty\ Cycle_i$$

   Where i = one of the hours during the curtailment period

5. Average all the individual duty cycle reduction estimates to derive an average reduction for all participants

6. Estimate Average Connected Load[5] for all participants

7. Calculate Gross kW Reduction, by hour, as follows:

$$Gross\ kW\ Reduction_i = Average\ Connected\ Load * Duty\ Cycle\ Reduction_i$$

8. Calculate Net kW Reduction, by hour, as follows:

$$Net\ kW\ Reduction_i = Gross\ kW\ Reduction_i * Free\ Riders * Propagation^{6}$$

An example of how these equations might solve is as follows:

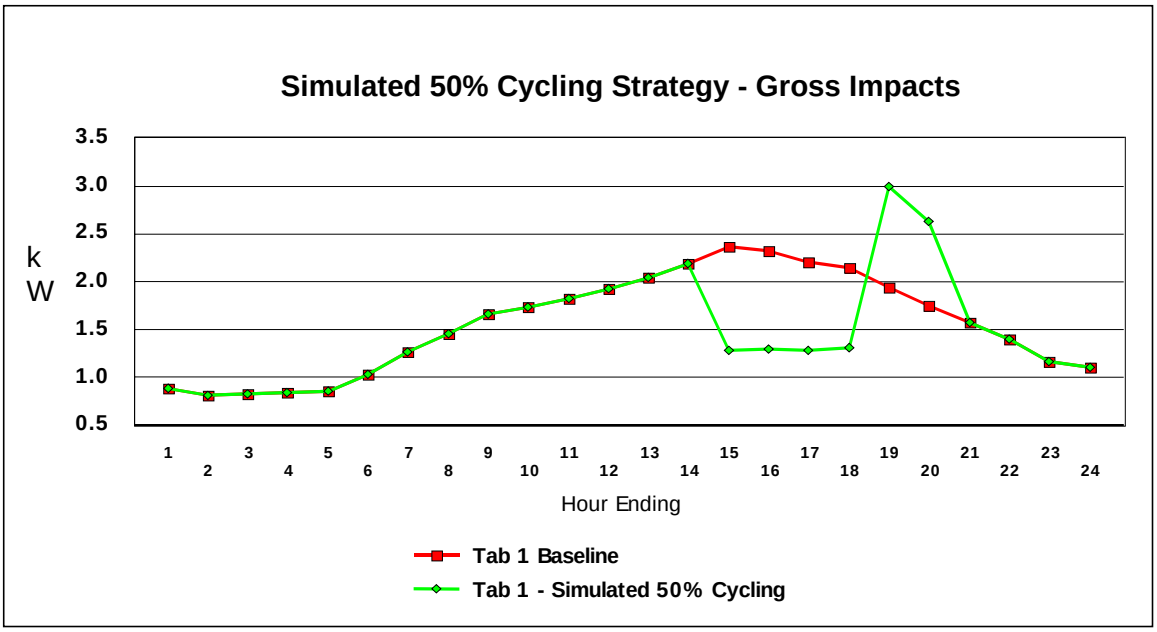
$$Duty\ Cycle\ Reduction = Baseline\ Duty\ Cycle_i - Controlled\ Duty\ Cycle_i$$
$$\mathbf{.323} \qquad \mathbf{.753} \qquad \mathbf{.431}$$

$$Gross\ kW\ Reduction_i = Average\ Connected\ Load^{7} * Duty\ Cycle\ Reduction_i$$
$$\mathbf{1.10} \qquad \mathbf{3.41} \qquad \mathbf{.323}$$

$$Net\ kW\ Reduction_i = Gross\ kW\ Reduction_i * Free\ Riders * Propagation$$
$$\mathbf{1.063} \qquad \mathbf{1.10} \qquad \mathbf{0.976} \qquad \mathbf{0.990}$$

Where *i* = the average of the 4 hour period between 2 and 6 pm.

Graphically, the analysis might look as follows:


Simulated 50% Cycling Strategy - Gross Impacts
kW
3.5
3.0
2.5
2.0
1.5
1.0
0.5
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24
Hour Ending
Tab 1 Baseline
Tab 1 - Simulated 50% Cycling

Duty cycle - defined as the fraction or percent of time per defined interval (e.g. one hour) that the CAC compressor was running. For example, a duty cycle of 0.75 (75%) during the hour ending 4 PM means that the CAC compressor was operating for 45 minutes for that hour.

[1] Free riders - defined as customers that do not use their CAC system at all during peak summer weather. A free rider is indicated by zero duty cycles over all peak-like days.

[2] Controlled Duty Cycle includes the effects of customers who overrode the control.

[3] Baseline Duty Cycle is similar to the Controlled Duty Cycle from the perspective of selecting similar days (e.g., weekdays) with similar temperature (e.g., over 90 degrees).

[4] Average Connected Load is obtained on-site directly from the customer's equipment. These estimates will be adjusted, as necessary, to reflect the results of the on-site metering of 200 randomly selected units. .

[5] Propagation is defined as the percent of units that do not receive the utility control signal. Since only a 1-way signal is required for utility control, this percentage is expected to be near zero.

[7] Weighted average of 2 on to 8 ton CAC units, averaging 3 tons.