RAP Energy solutions for a changing world

Teaching The Duck To Fly

Full paper available at:
http://www.raponline.org/document/download/id/6964

Clean Energy States Alliance

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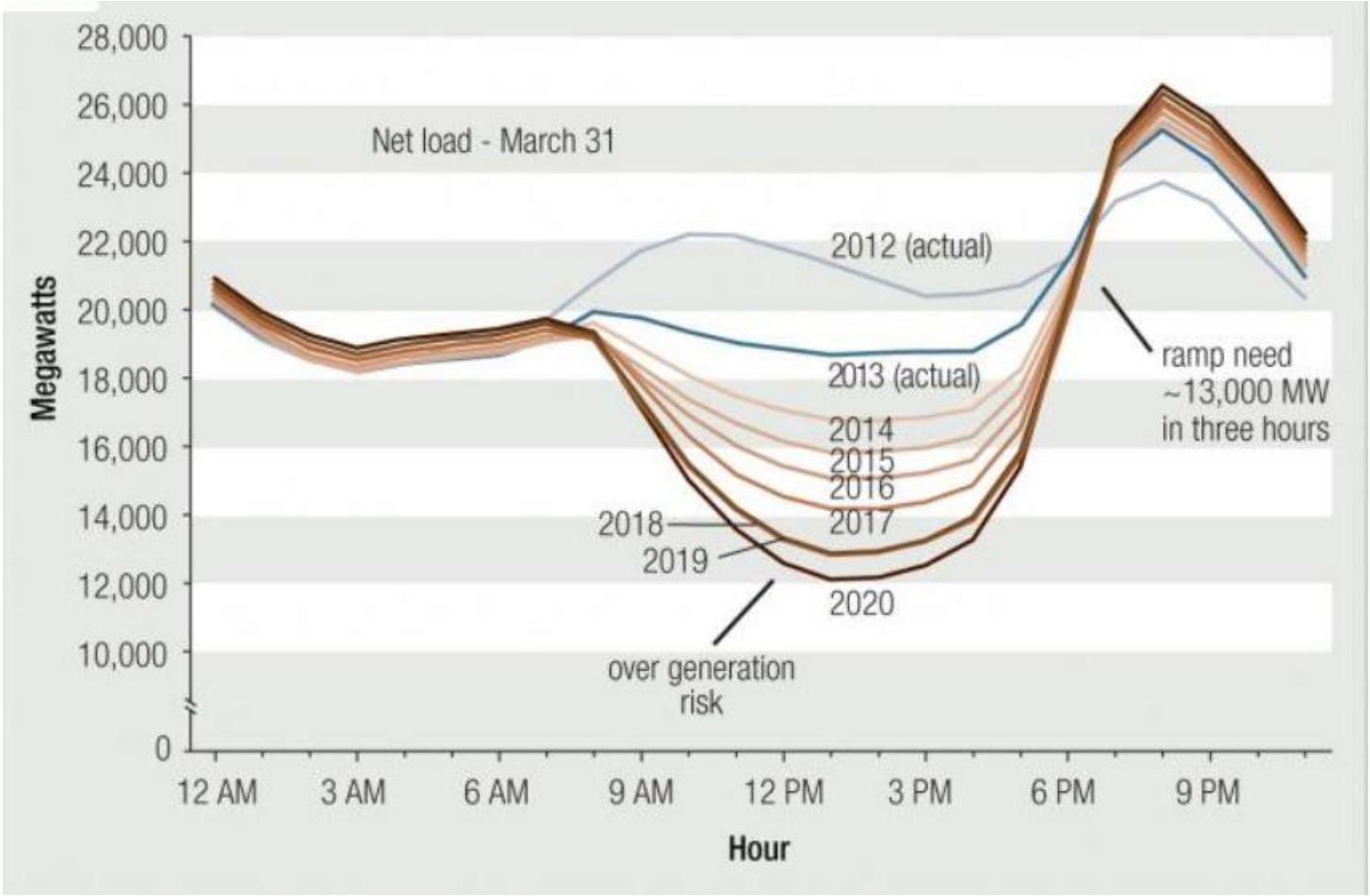
The California ISO "Duck Curve":
Increasing solar means steep afternoon ramping.



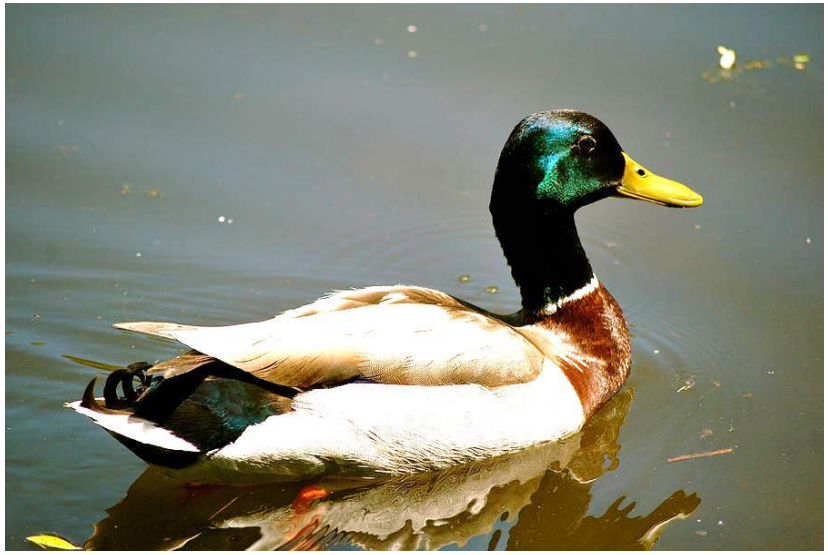
What Causes This Challenge?

Variable Loads: we've had those forever.

Wind: Variable supply.

Solar: Predictably NOT available for late PM peak demand.

Guess What: Ducks Can Fly



A duck in water has very much the shape of the CAISO graphic. The “fat body” floats, and the tall neck breathes.

A duck in flight stretches out its body and straightens its neck in order to reduce wind resistance.

Our job is to straighten this duck out.

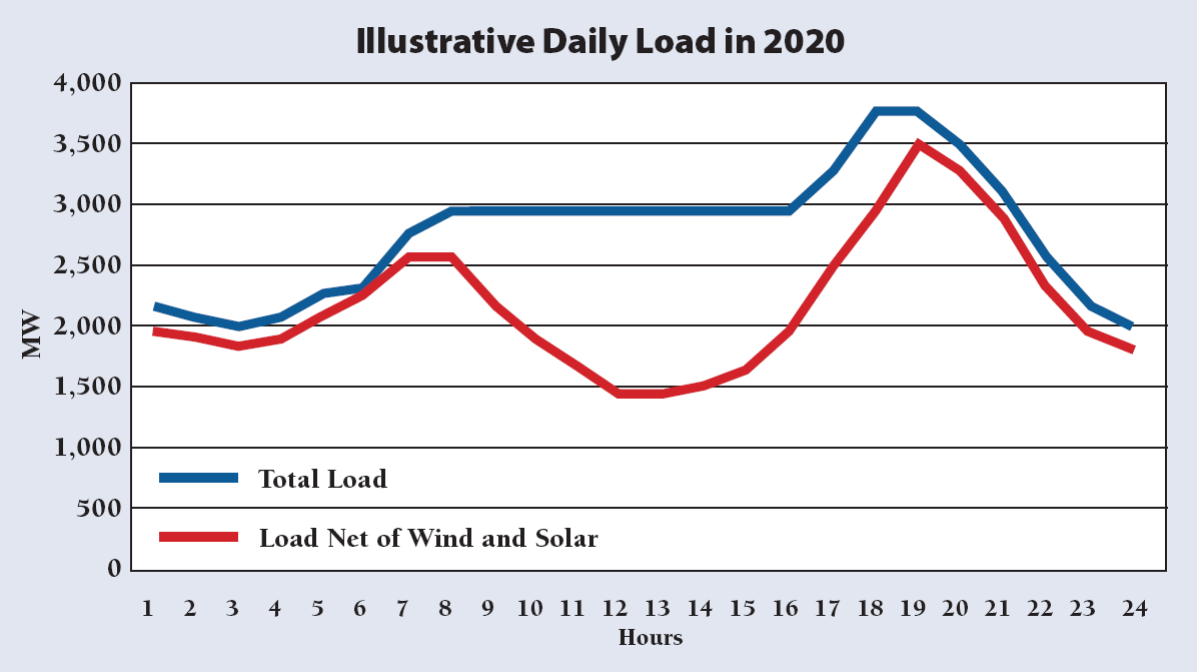
Ten Strategies To Align Loads to Resources (and Resources to Loads) with Illustrative Values for Each

1. Targeted energy efficiency
2. Orient solar panels
3. Use solar thermal with storage.
4. Manage electric water heat
5. Require new large air conditioners to include storage
6. Retire older inflexible power plants
7. Concentrate rates into "ramping" hours
8. Deploy electricity storage in targeted locations
9. Implement aggressive demand response programs
10. Use inter-regional exchanges of power

Not every strategy will be applicable to every utility.

Our Starting Point: A California Utility's Projected "Duck"

4,000 MW Peak Demand; 2,000 MW Minimum Demand;
2012: 73% Daily Load Factor; Max 1-hour ramp: 400 MW
Forecast: 2,500 MW of wind and solar added 2012 – 2020;
Predicted 2020: 63% Load Factor; Max 1-hour ramp: 550 MW



Strategy 1: Targeted Energy Efficiency

Focus efforts on EE measures with afternoon peak orientation: Lighting / AC

Kitchen lighting is a great example.

Central Air Conditioning is a huge opportunity.

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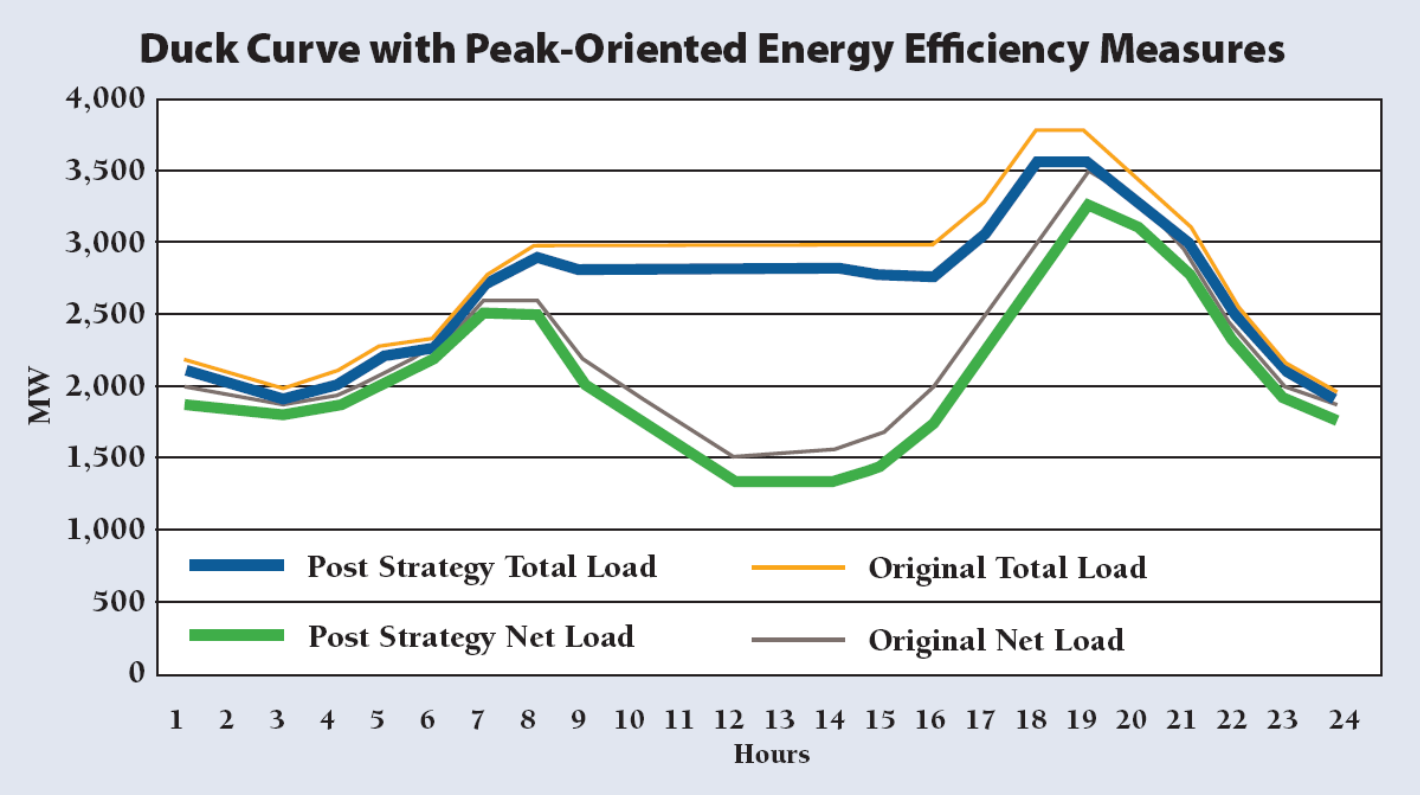
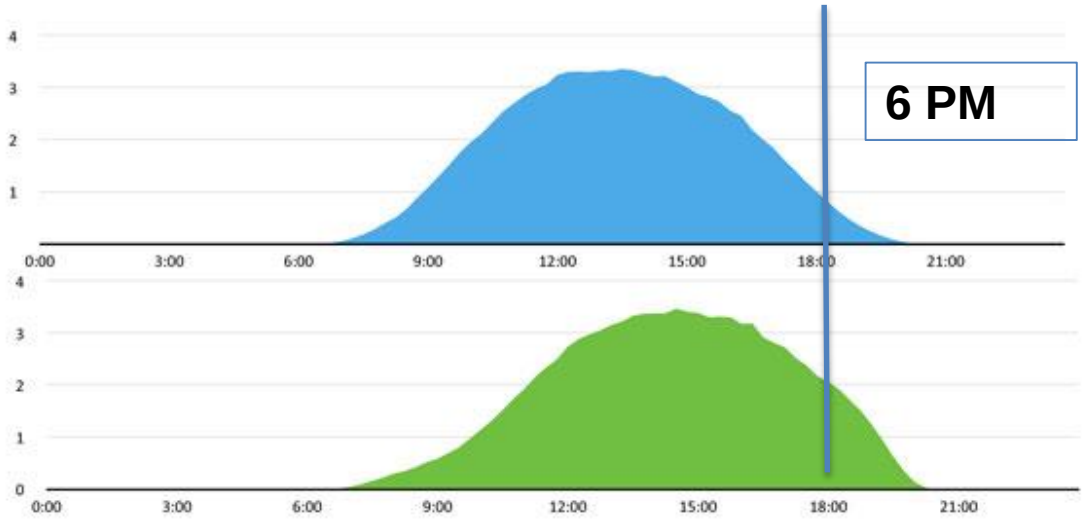


Strategy 2: Orient Solar Panels to the West

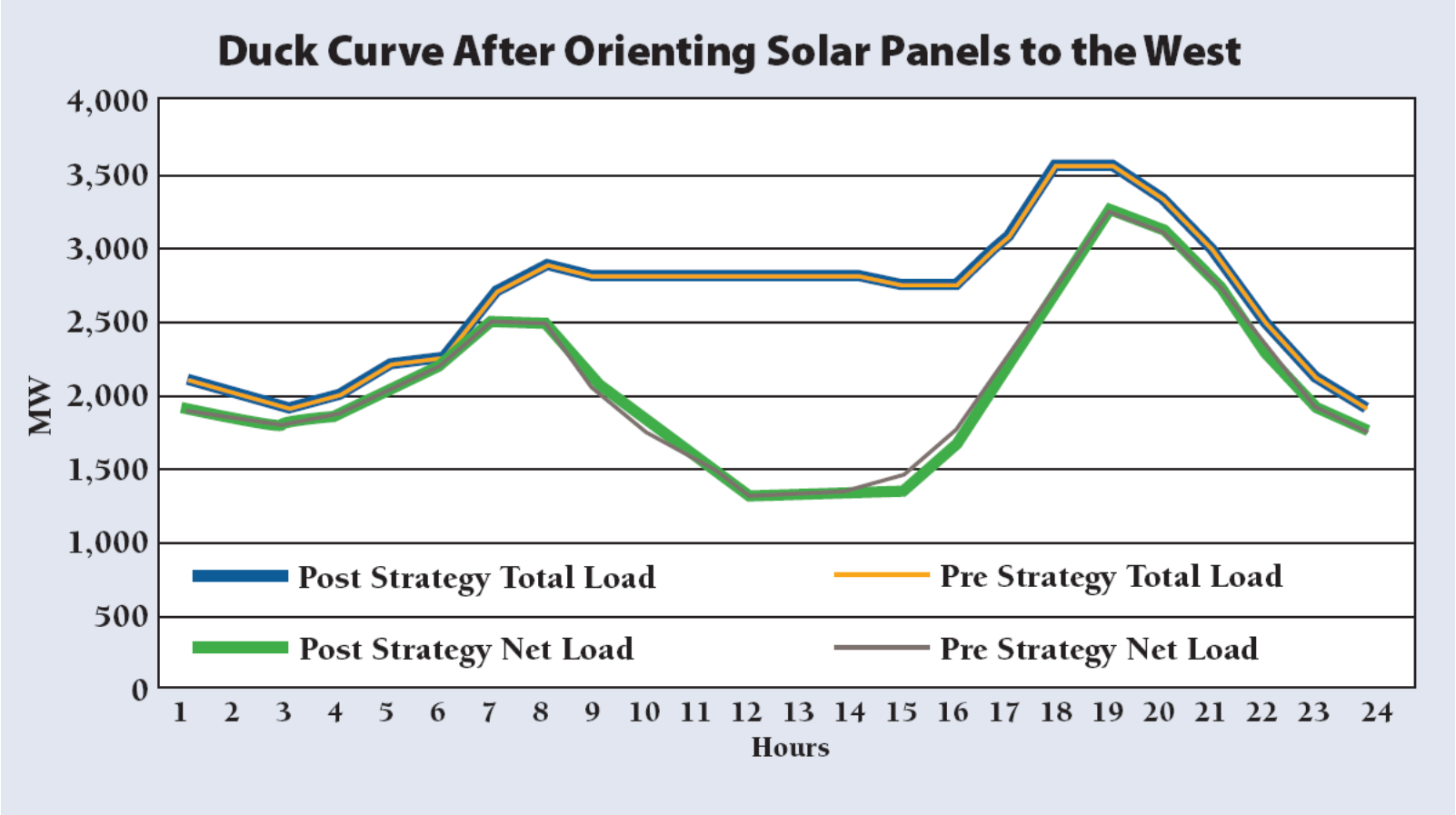
Fixed-axis solar panels produce a more valuable output if oriented to the West.

Assume that one out of six systems is oriented to the West



Average daily generation profile (kW) from rooftop PV systems for south and west systems. Source: *Pecan Street Research Institute*

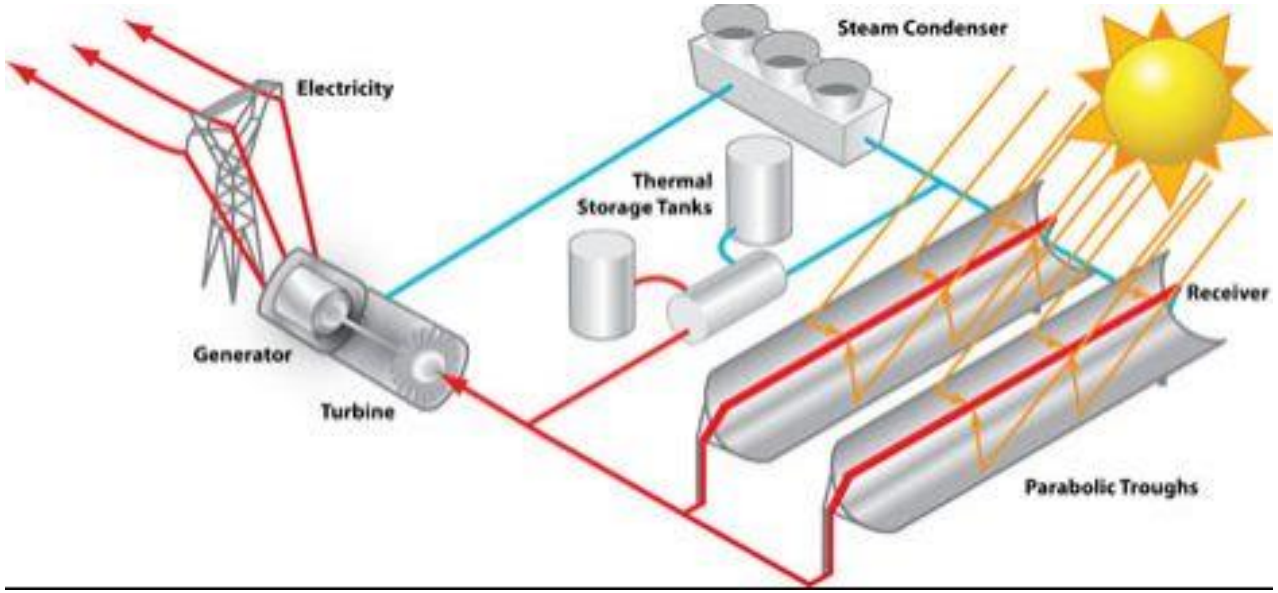
Strategy 2: Orient Solar Panels to the West



Strategy 3: Use Solar Thermal In Place of Some Solar PV

Solar thermal energy is more expensive, but can be stored for a few hours at low cost.

Use solar thermal for 7% of total solar added to system.



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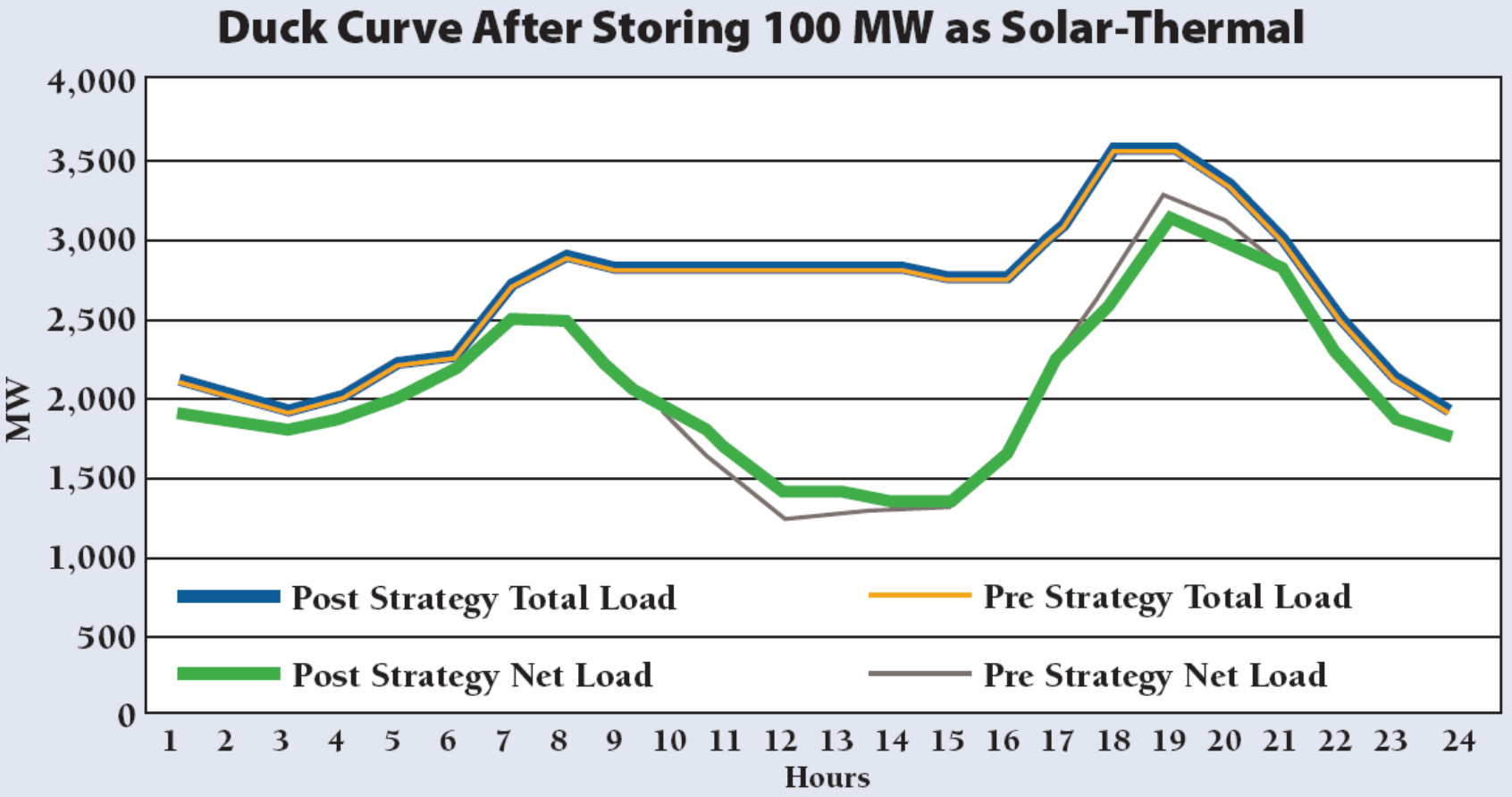


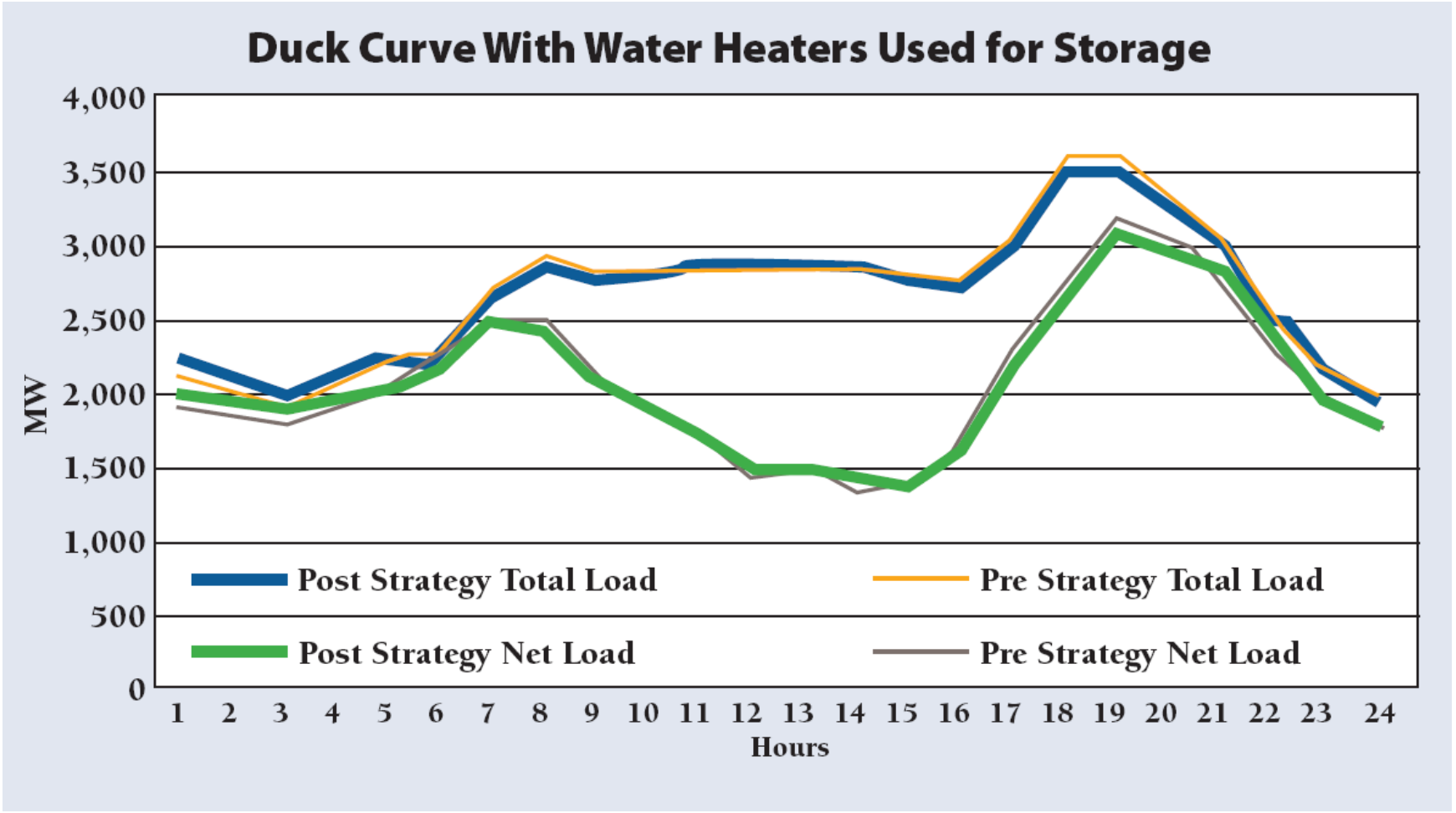
Strategy 4:
Control Electric Water Heating

Install grid control of electric water heating;

Supercharge to 140F – 170F during low-cost hours.

Assume that 10% of customers have electric water heat, and half of those are controlled by grid operator.

Strategy 4:
Control Electric Water Heating



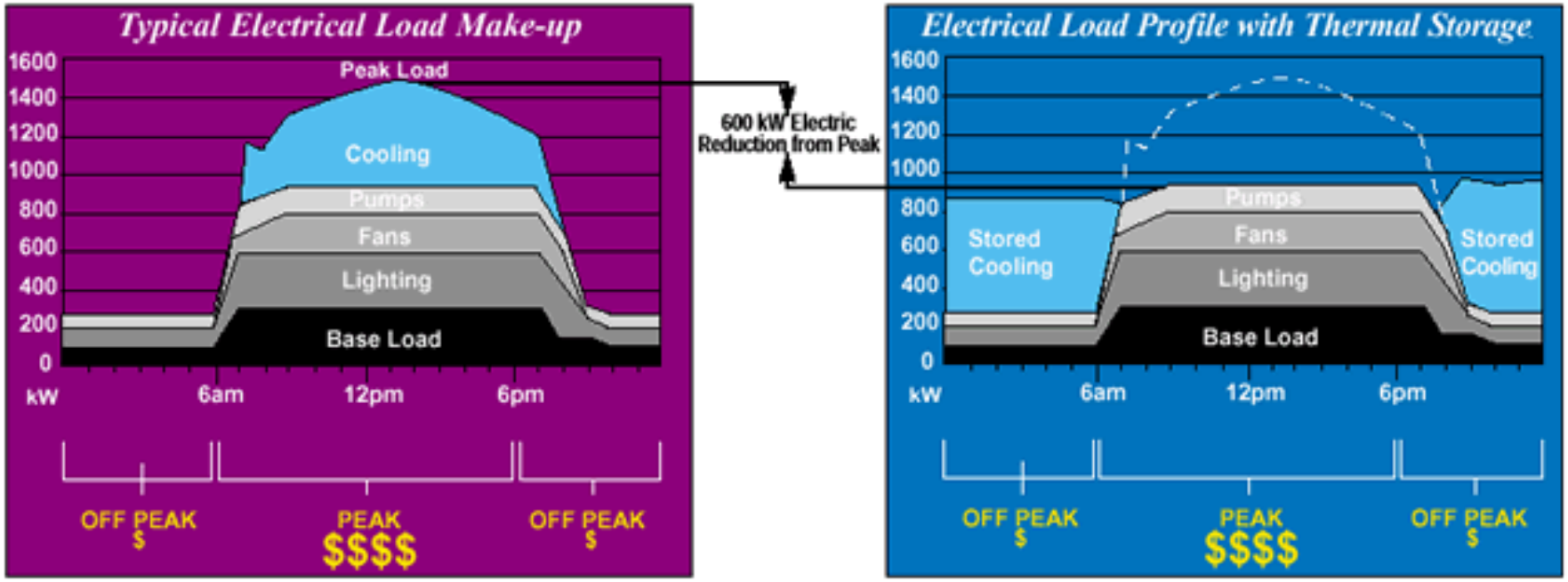
Strategy 5:
Require Storage On New AC

Require new AC units over 5 tons to include thermal (ice/water) storage, under grid control.

Move 15% of the peak commercial AC load outside of peak hours.

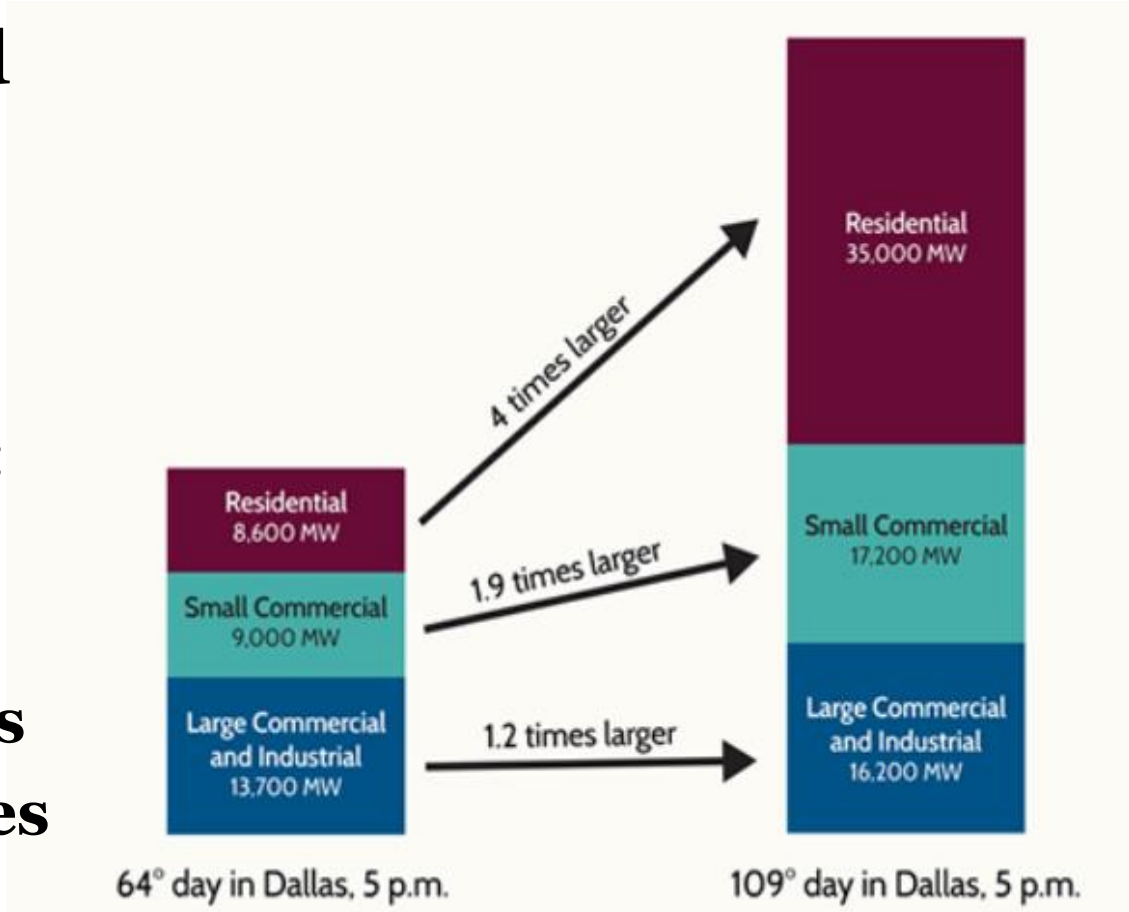
Strategy 5: Thermal Storage Could Be A Much Larger Resource

A/C chilled water or ice storage can move the entire cooling load into low-cost hours.



Strategy 5: Air Conditioning Storage A/C is ~30% of Peak Demand

- **Commercial load doubles;**
- **Residential load up 4X.**
- **Implementation:**
  - **Appliance standards**
  - **Service standards**
  - **Retrofit incentives**



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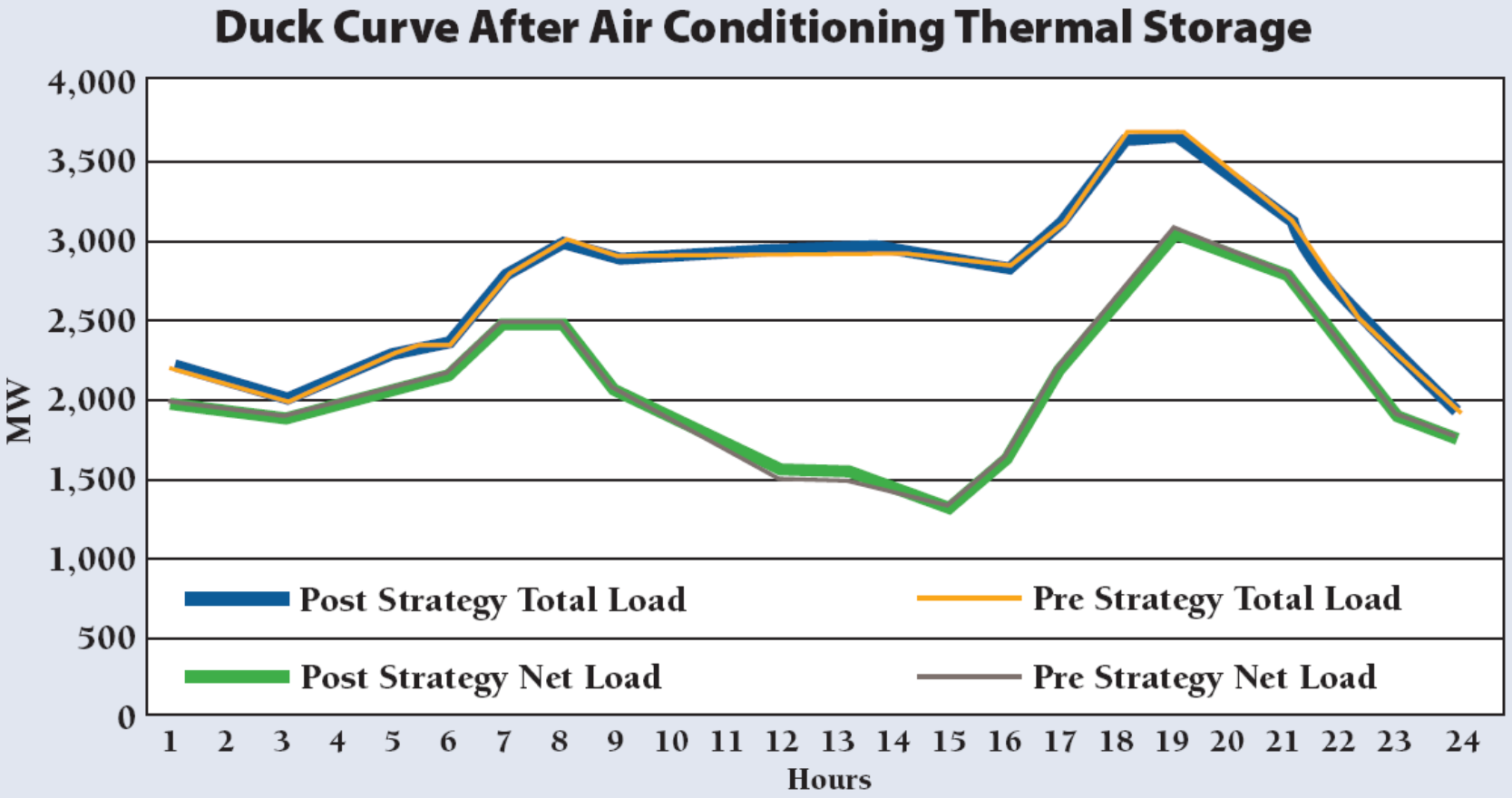
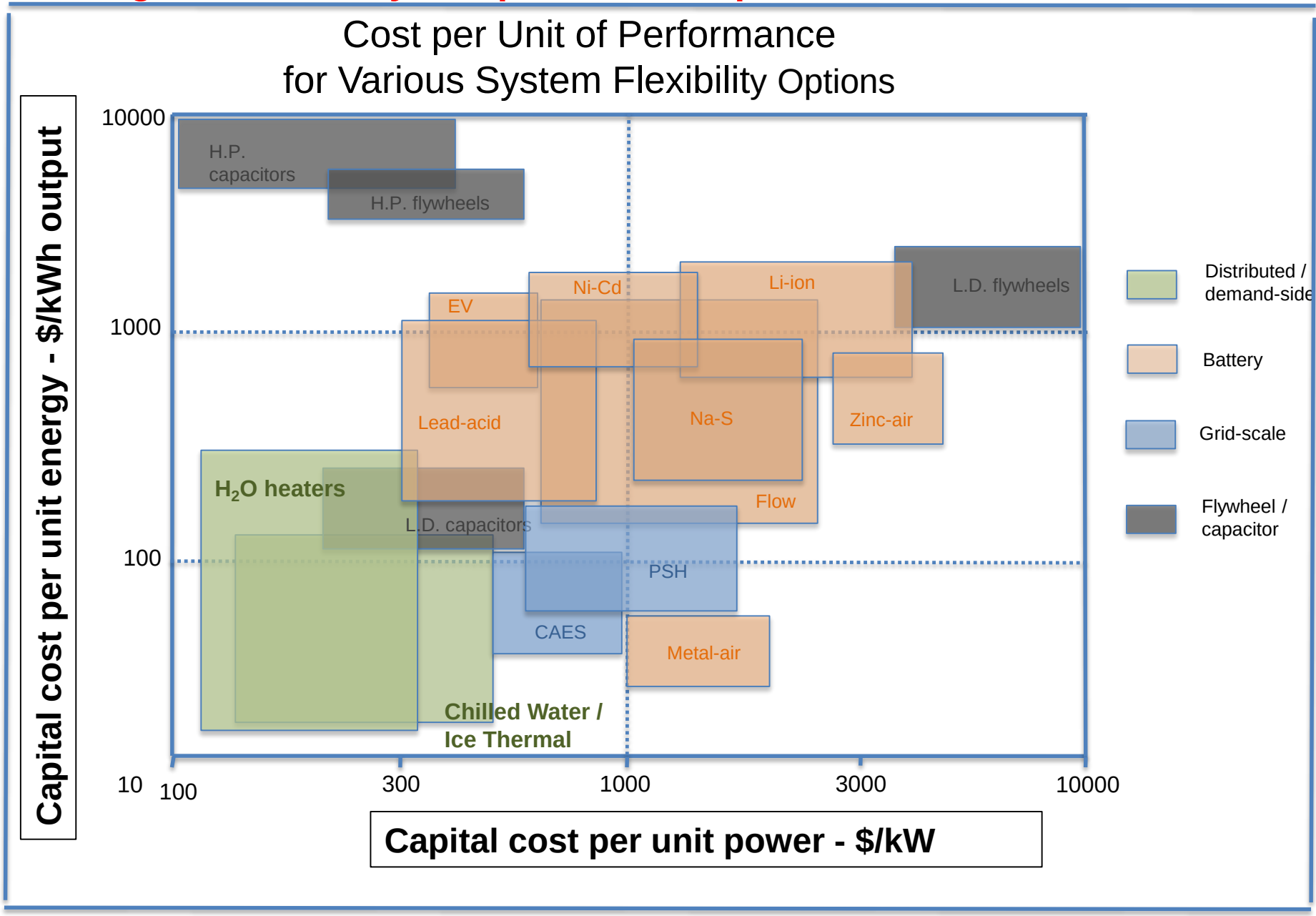
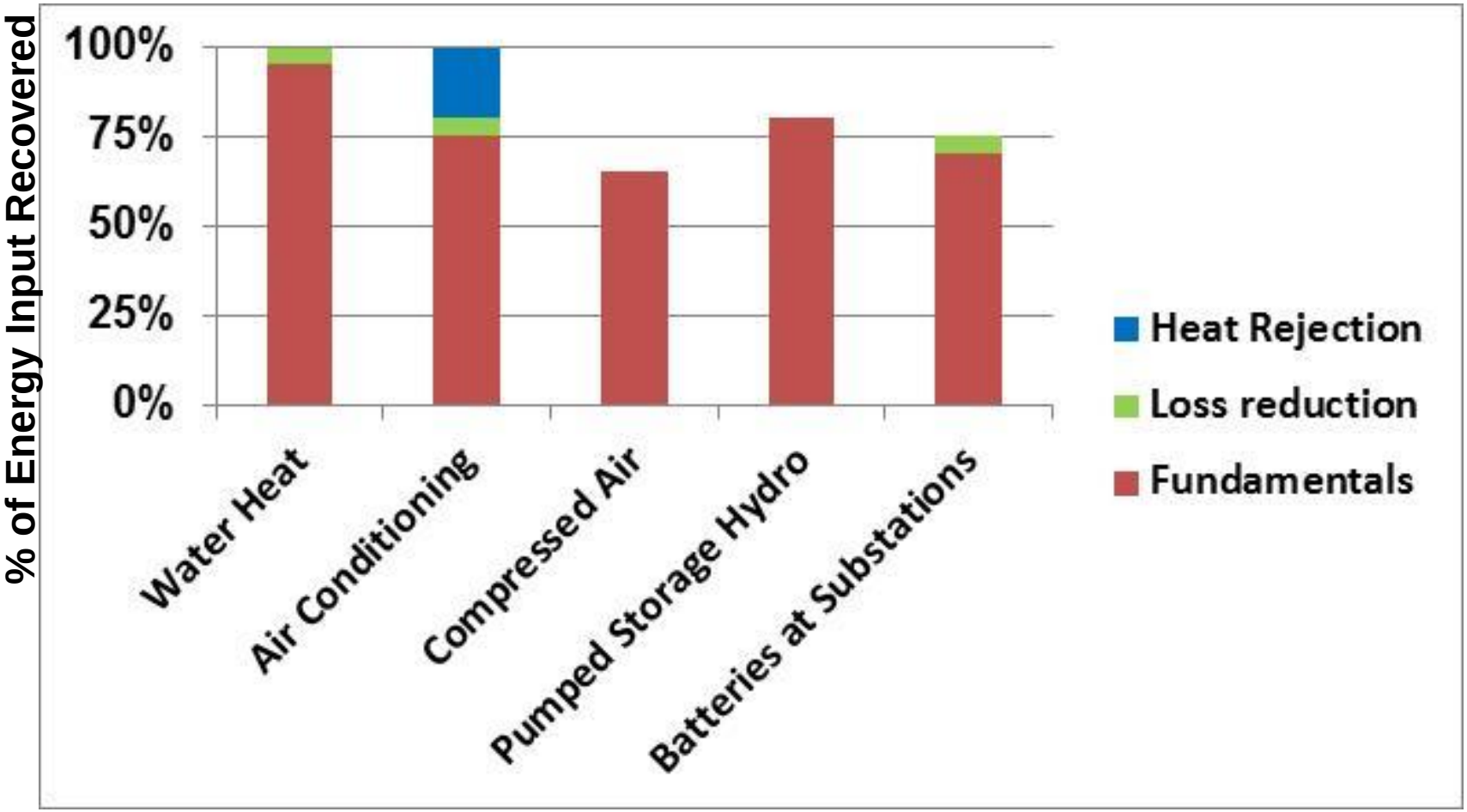


Strategies 4 &5: Very Inexpensive Compared With CAES, Batteries



Thermal Energy Storage Is More Efficient Than Electricity Storage



Strategy 6: Retire Older Inflexible Generating Plant

Older steam plants with night minimum loads and slow ramping are being replaced with gas "flex" units that ramp quickly.

GE Flex Combined Cycle Unit

Strategy 6: Retire Older Inflexible Generating Plant

No specific change attributed; assumed to be embedded in the 2020 forecast from the sample utility.

165 coal plants retired or announced for retirement since 2010.

Strategy 7:
Concentrate Rates In The Ramping Period

Concentrate utility prices into the "ramping" hours; hourly rates for large-volume customers.

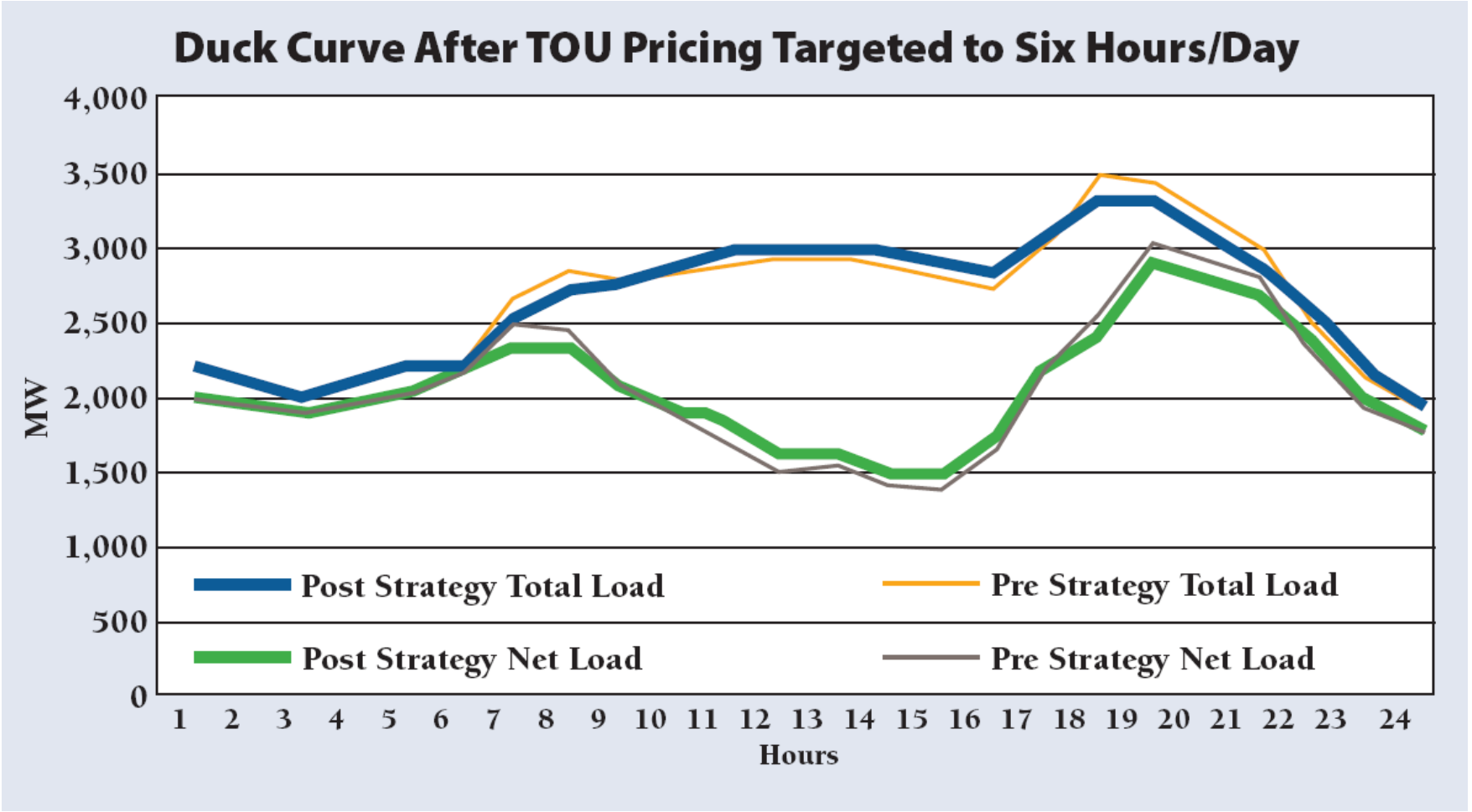
Commercial Rate
$10/month
$10/kW
$.10/kWh

Future Rate?
$10/month

$2/kW *non-coincident*
$12/kW 4PM – 7 PM

$.06/kWh off-peak
$.10/kWh mid-peak
$.25/kWh on-peak

Strategy 7:
Concentrate Rates Into Ramping Period

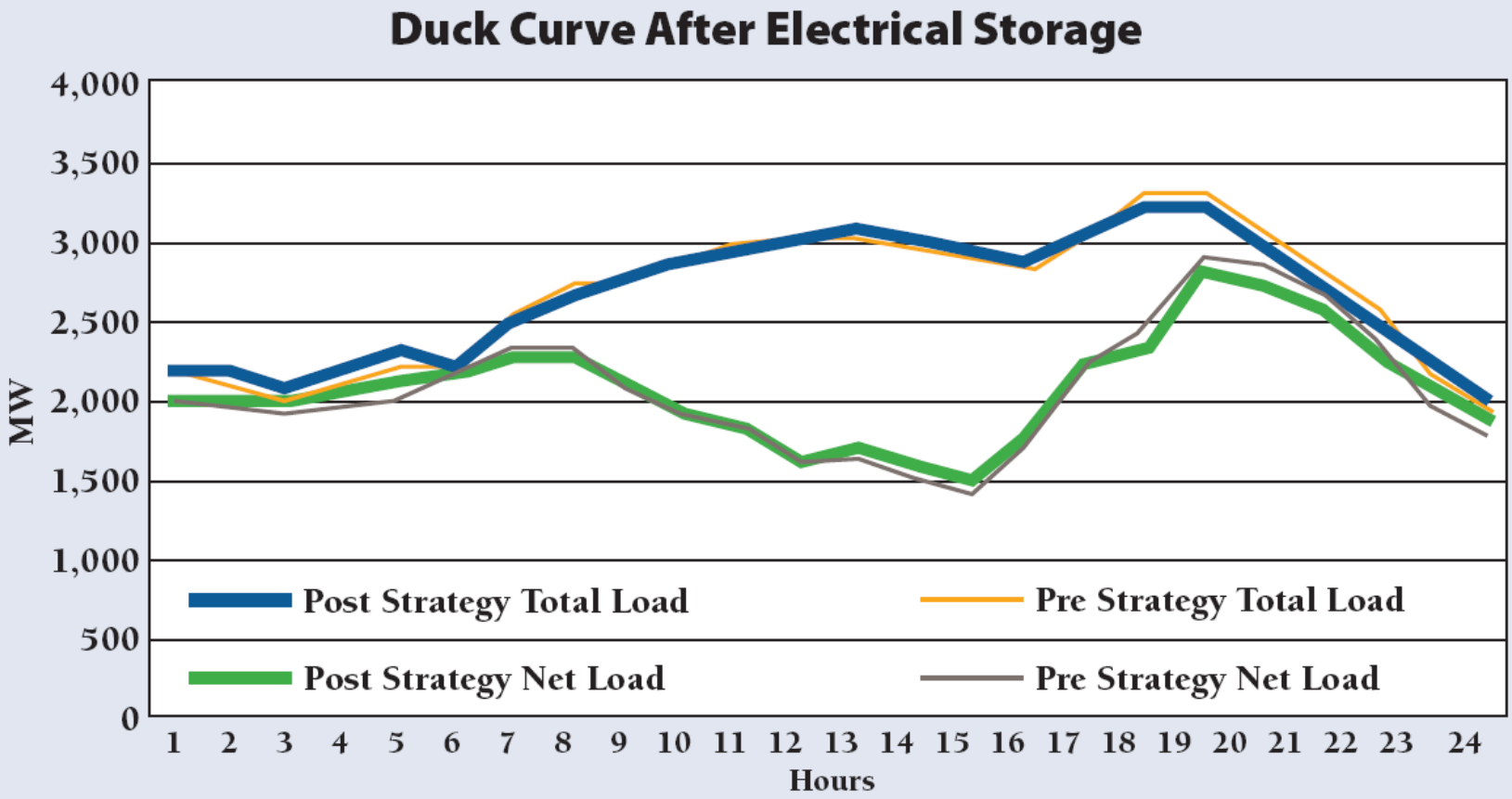


Strategy 8:
Deploy Electrical Storage Strategically

Selectively charge electric vehicle batteries; Add grid storage at strategic locations that help avoid T&D upgrade costs.

Assume: Storage equal to 1% of total load.

Strategy 8:
Deploy Electrical Storage

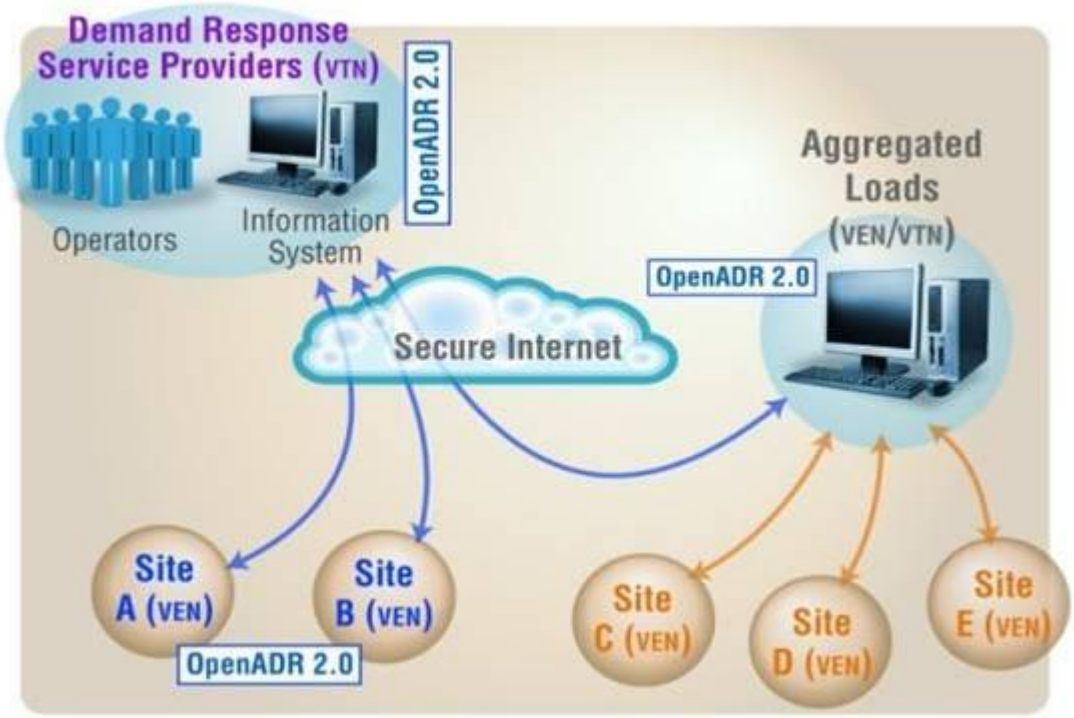


Strategy 9: Demand Response

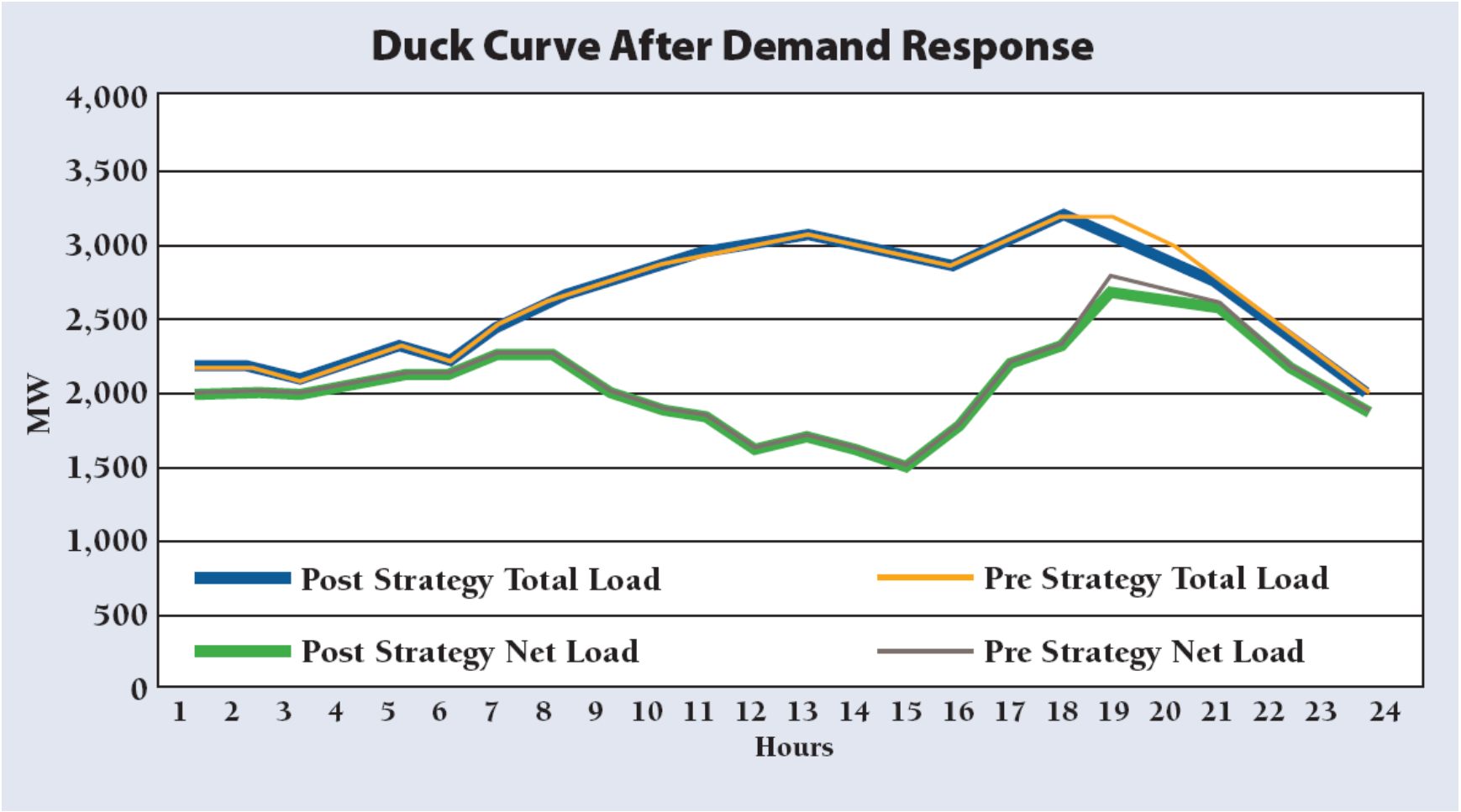
Contract with customers for curtailment on an as-needed basis when the ramp is steep.

Assume: 3% curtailment of peak demand on high-ramp days.

Currently ~8% at NEISO.



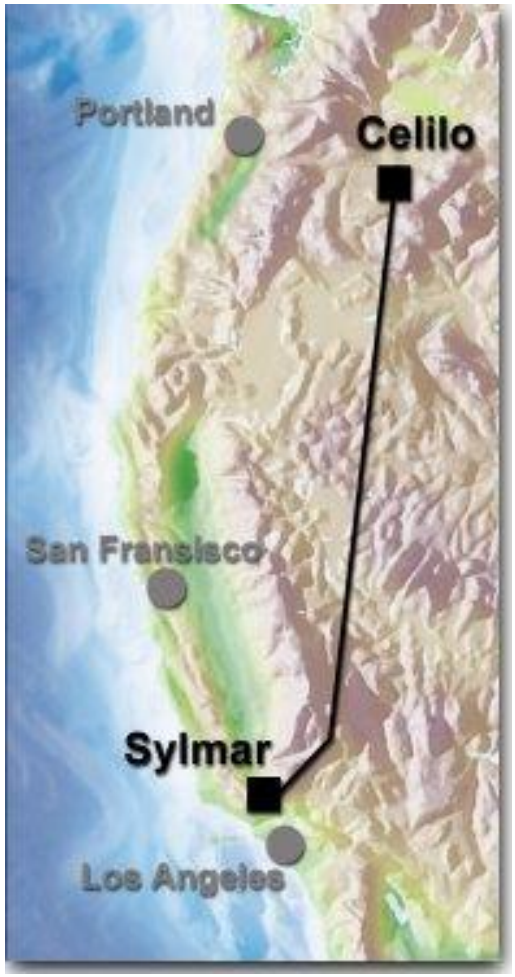
Strategy 9: Demand Response



Strategy 10:
Inter-regional Power Exchanges

Take advantage of geographical diversity of loads, and geographical diversity of output from renewable resources.

Exchange 3% of daily sales from early to late evening using the existing inter-regional interties to Arizona, Nevada, Utah, and the Northwest



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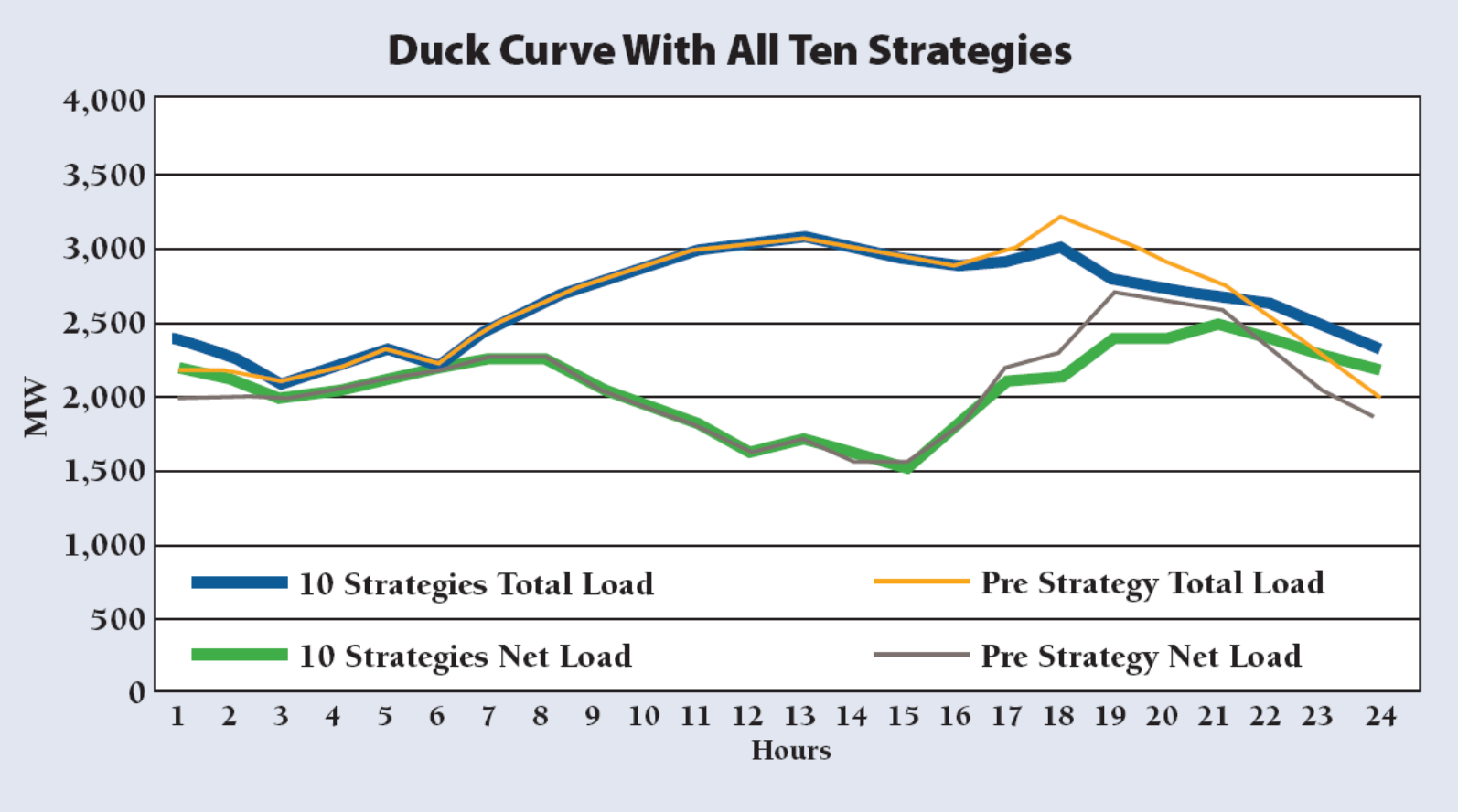


This duck is ready to spread his wings and fly.

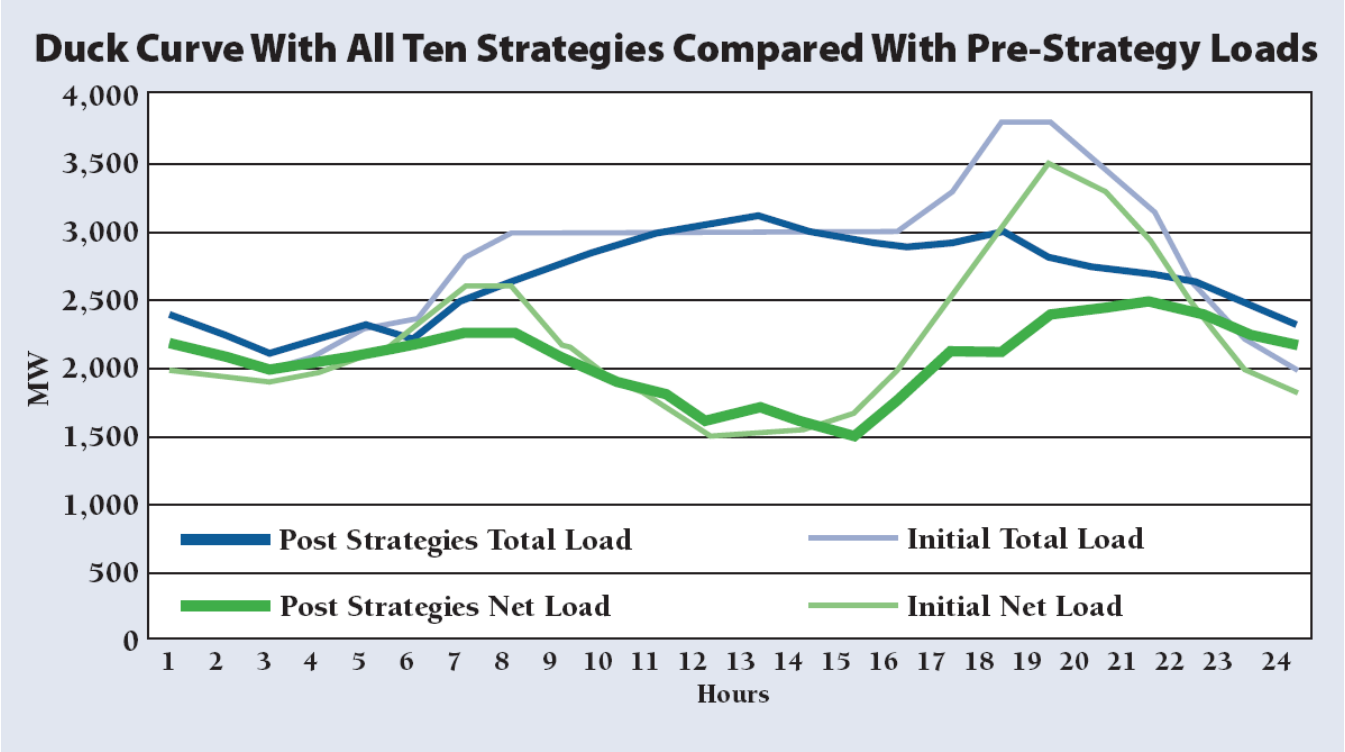
How Did We Do?

Pre-Strategy, without Solar/Wind: 73% LF

Pre-Strategy, with Solar/Wind: 63% LF

Post-Strategy, with Solar/Wind: 83% LF

Hourly Ramp: 340 MW vs. 400 today, and 550 w/o strategies



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About RAP

The Regulatory Assistance Project (RAP) is a global, non-profit team of experts that focuses on the long-term economic and environmental sustainability of the power and natural gas sectors. RAP has deep expertise in regulatory and market policies that:

- Promote economic efficiency
- Protect the environment
- Ensure system reliability
- Allocate system benefits fairly among all consumers

Learn more about RAP at www.raponline.org

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