RAP Energy solutions for a changing world

# Teaching The Duck To Fly

RAP Webinar
February 5, 2014

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# About Jim Lazar

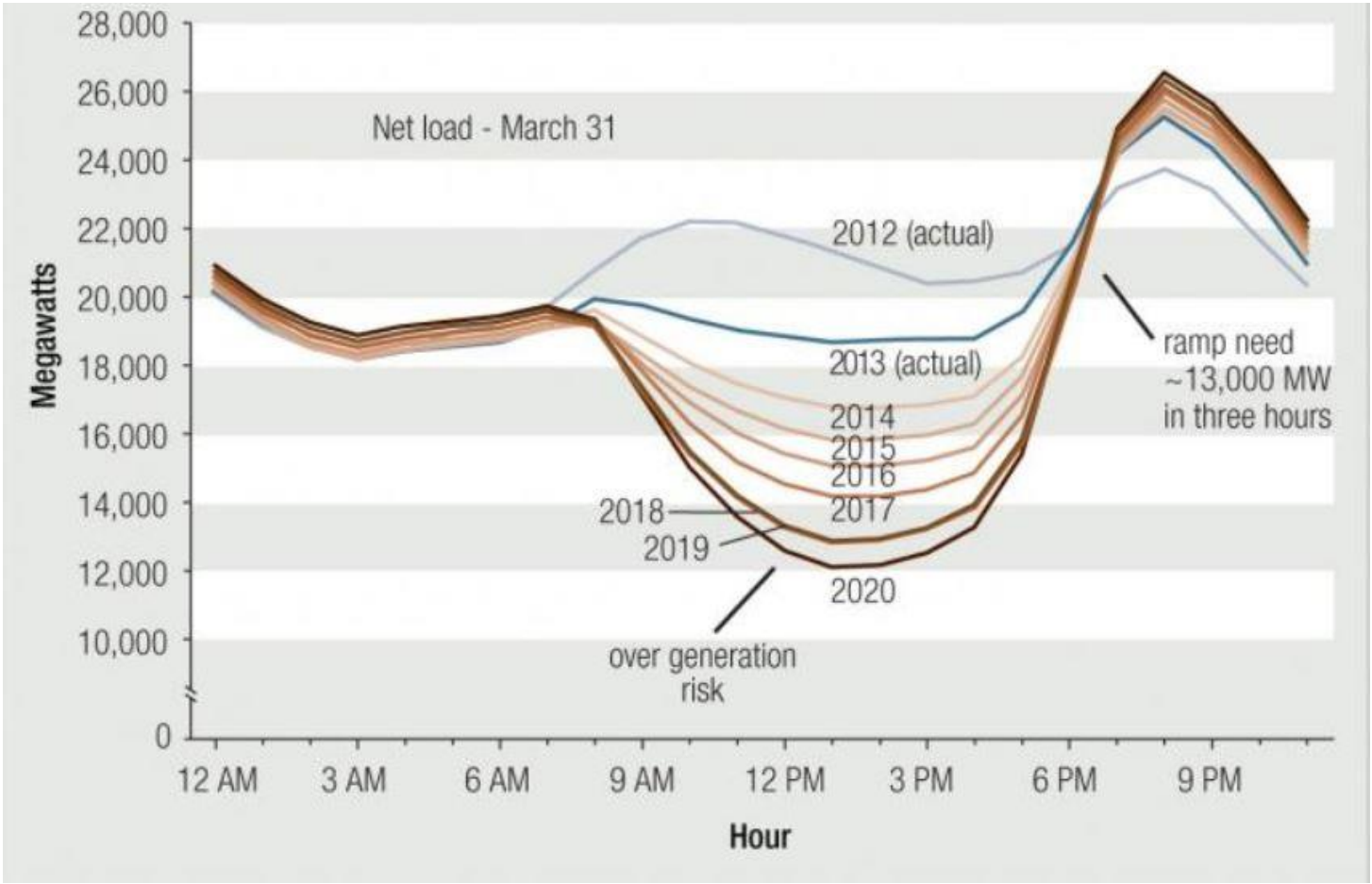
Consulting Economist specializing in utility rates and resource planning since 1979.

Founding member of Regional Technical Forum of NW Power Council

RAP Senior Advisor since 1998

Author / Co-author of 11 RAP publications, including **Teaching The Duck To Fly**

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



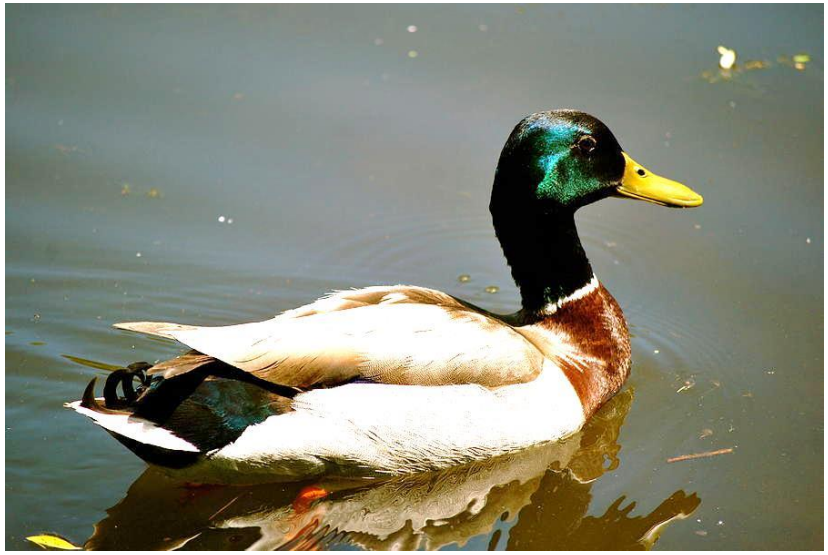
# What Causes This Challenge?

**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.**

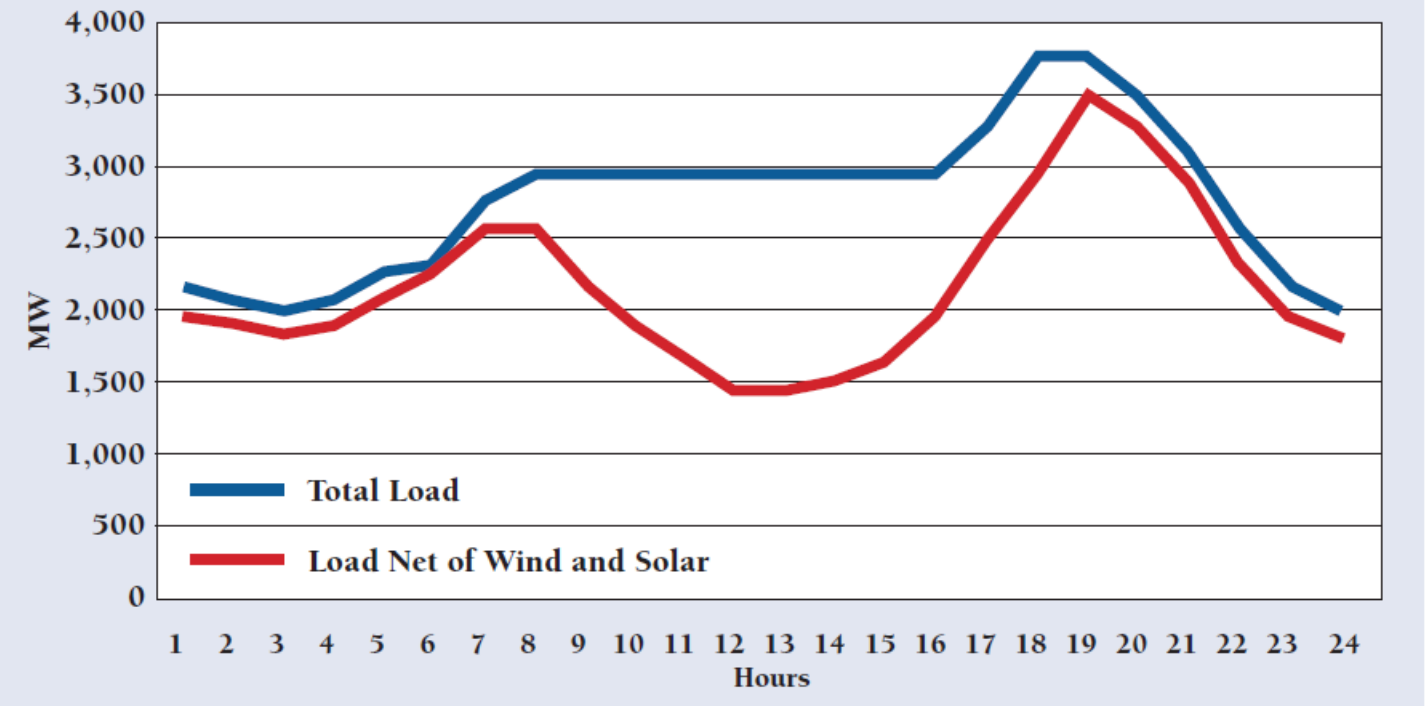
# Ten Strategies To Align Loads to Resources (and Resources to Loads) with Illustrative Values for Each

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 demand charges into “ramping” hours
8. Deploy energy 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;**
**73% Load Factor; Max 1-hour ramp: 400 MW**
**Forecast: 2,500 MW of wind and solar added 2012 – 2020;**
**Predicted 63% Load Factor; Max 1-hour ramp: 550 MW**



# Strategy 1: Targeted Energy Efficiency

Focus efforts on EE measures with afternoon peak orientation.

**5% of total usage by 2020;**

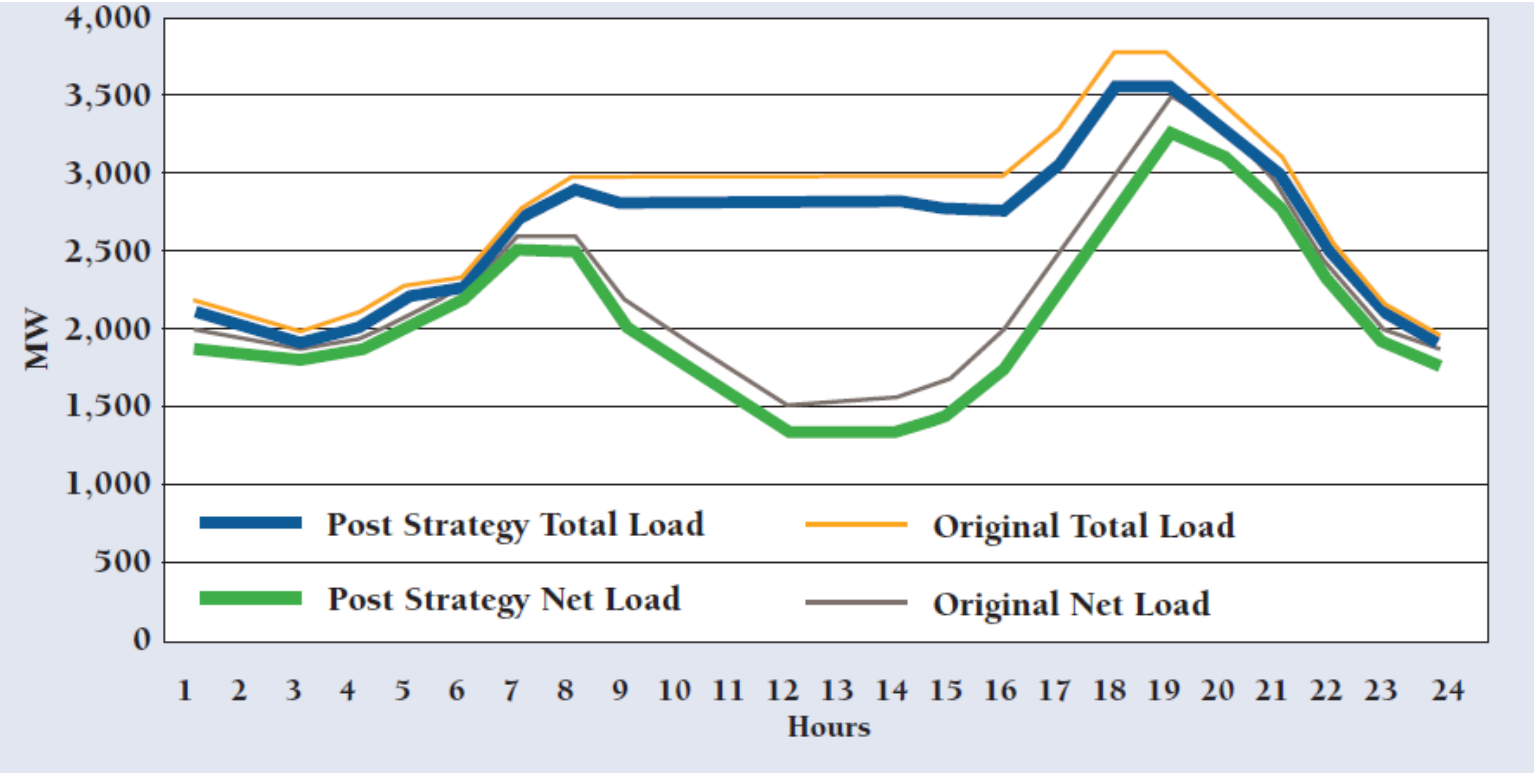
**3:1 ratio between on-peak and off-peak savings.**

**Kitchen lighting is a great example.**

**A/C is huge.**

# Strategy 1: Targeted Energy Efficiency

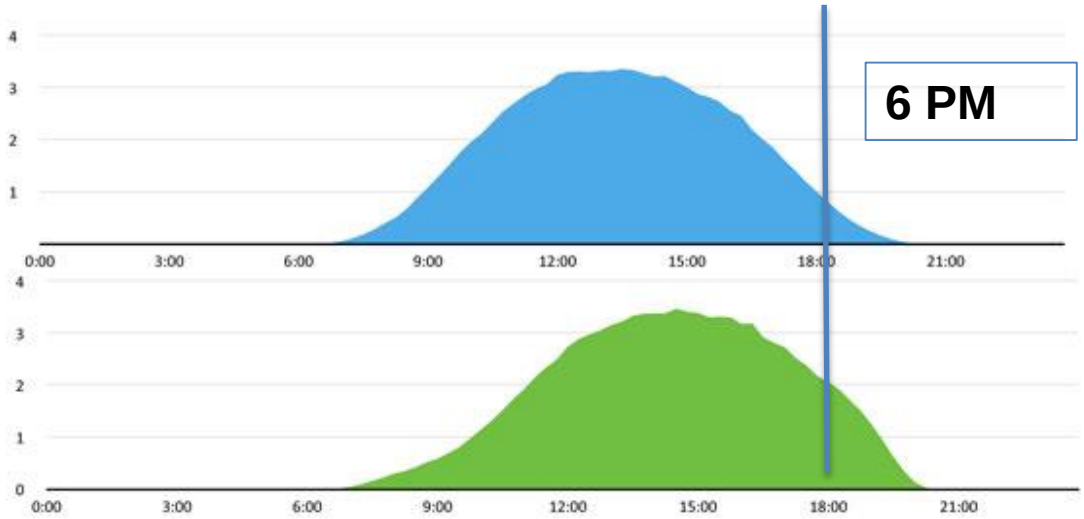
Focus efforts on EE measures with afternoon peak orientation.



# Strategy 2: Orient Solar Panels to the West

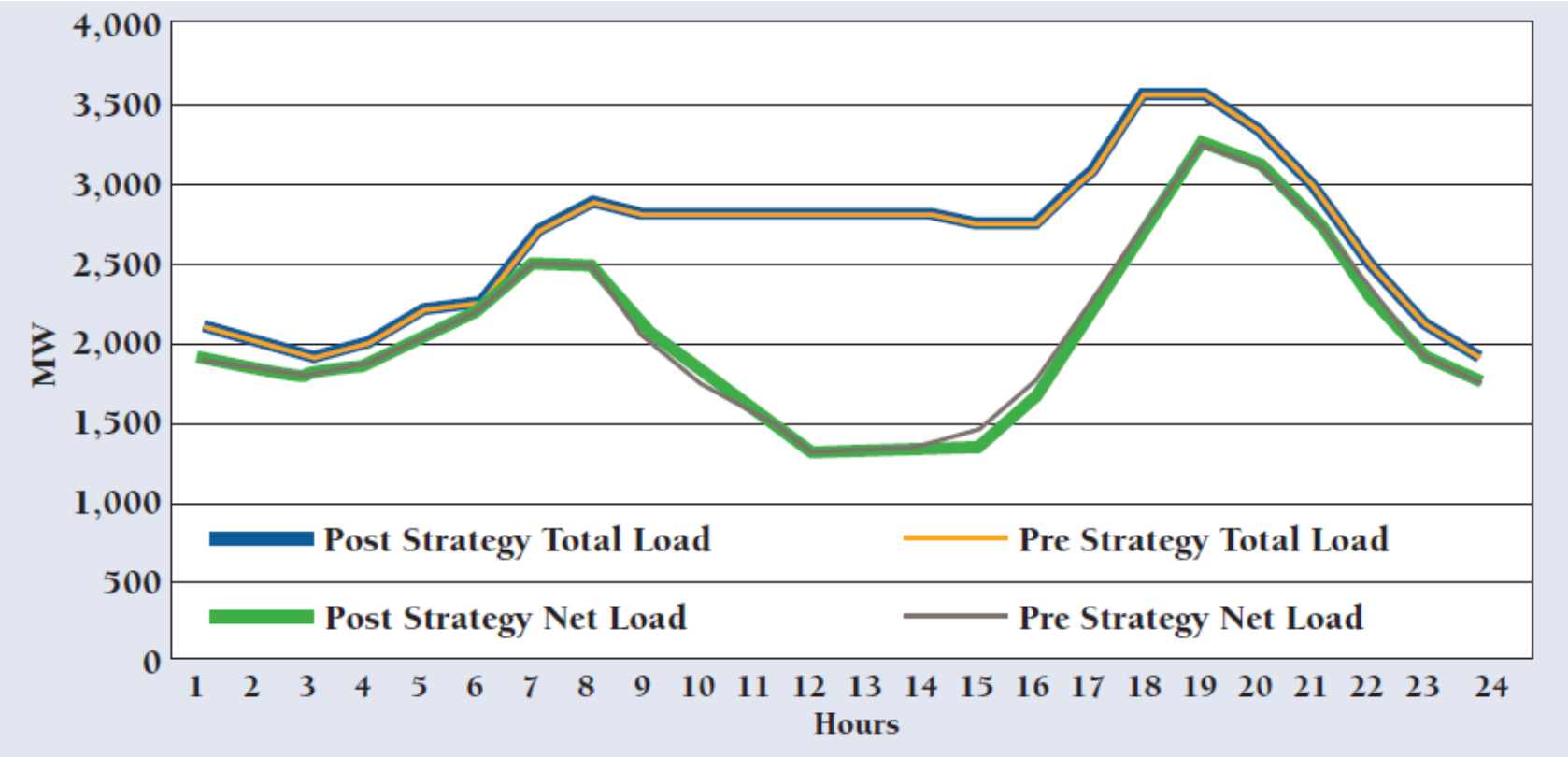
Fixed-axis solar panels produce a more valuable output if oriented to the West.

**100 MW shift out of AM into PM hours, out of ~700 total rooftop solar assumed.**




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

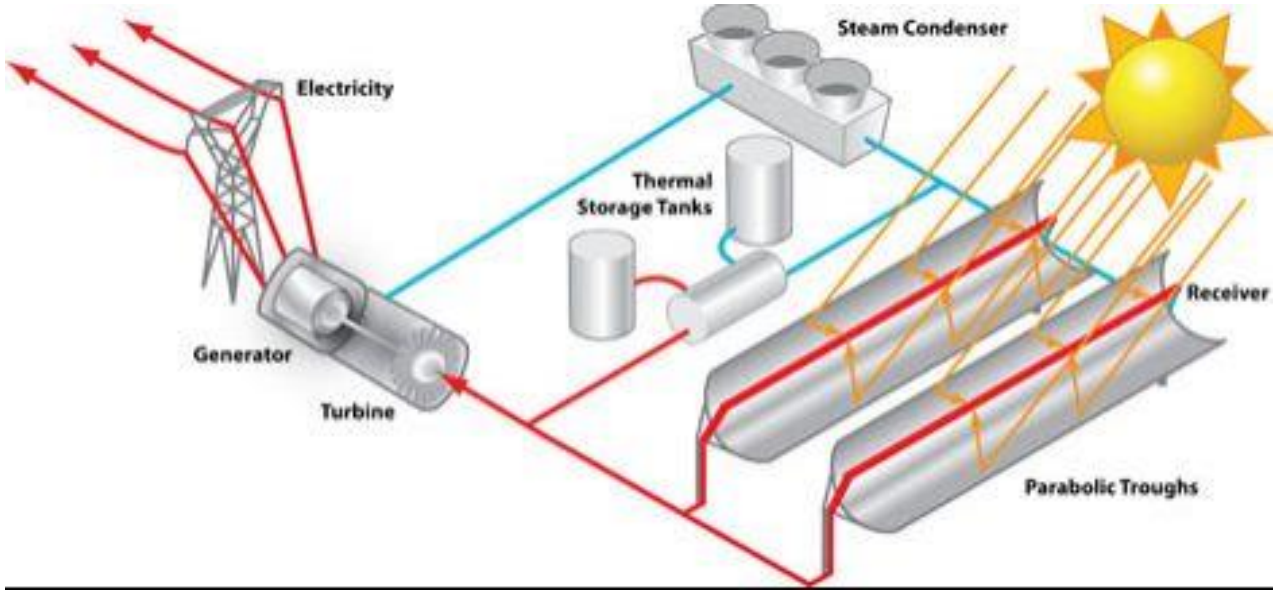
# Strategy 2: Orient Solar Panels to the West



# 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.

**Substitute 100 MW of solar thermal for 100 MW of utility-scale PV, out of 1,500 MW of utility-scale solar total assumed.**



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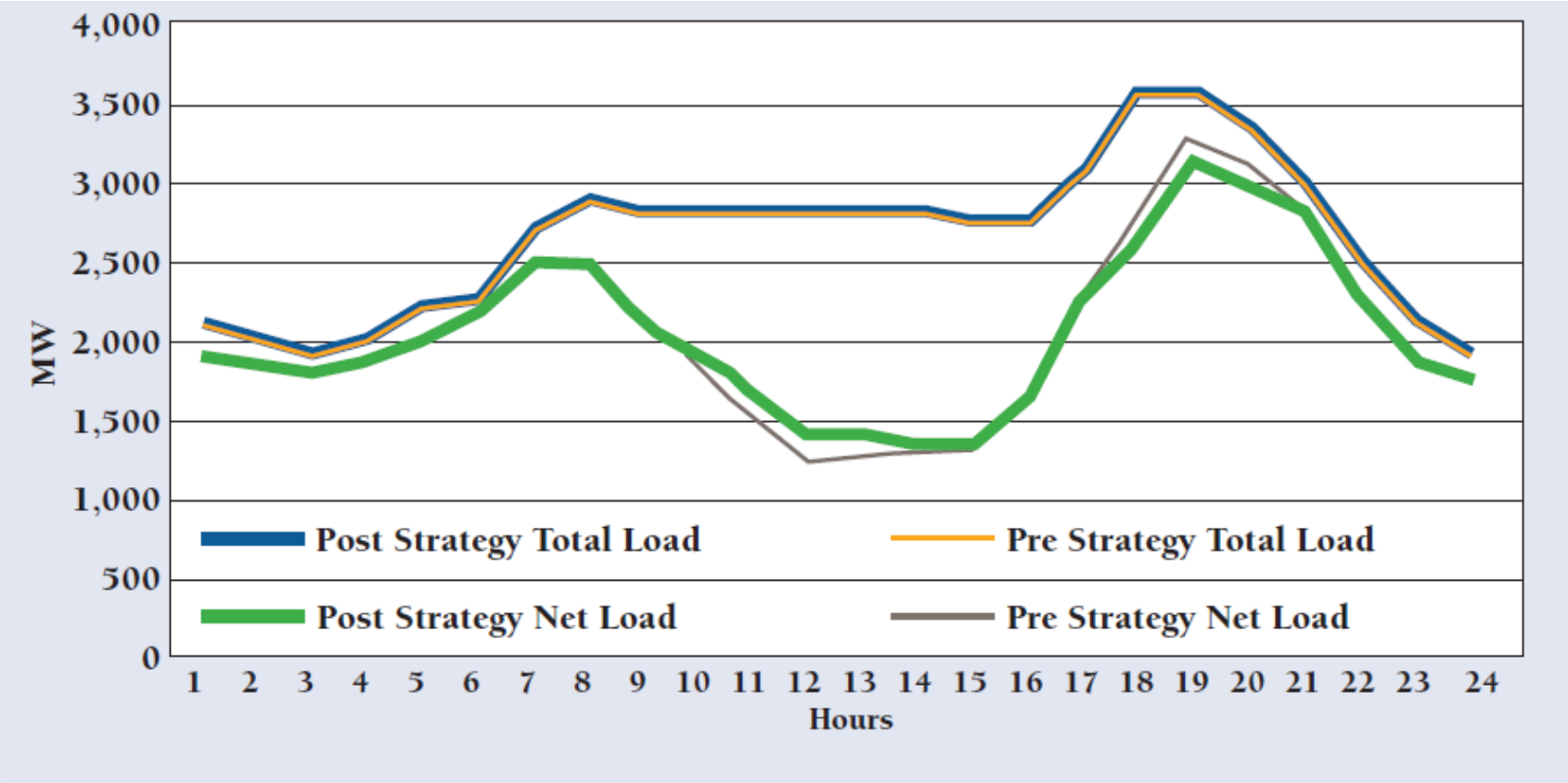
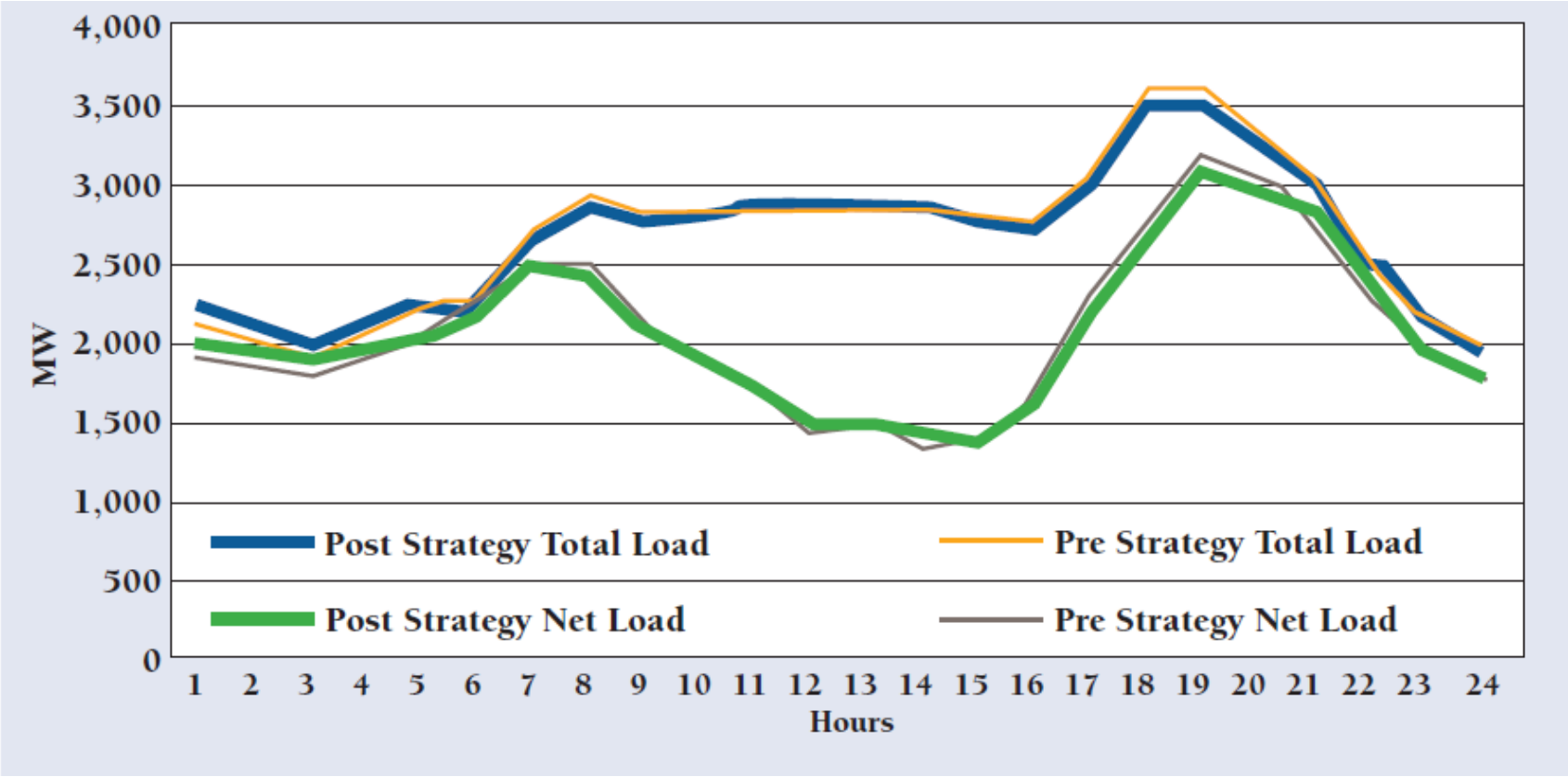


# Strategy 4:
# Control Electric Water Heating

Install grid control of electric water heating; Supercharge during low-cost hours.

**Illustrative utility has ~12% of state load; assume it can gain control over 5% of the electric water heaters in the state, for 300 MWh of load shifting.**

# Strategy 4:
# Control Electric Water Heating



# Strategy 4: Water Heat
# Total US Potential Is Huge

**45 million** electric water heaters in US

**4.4 kW** peak power per water heater

**200,000 Megawatts** total potential demand augmentation when needed

**40,000 Megawatts** to potential peak load reduction when needed.

**Up to 25 kWh** potential storage per water heater Battery bank for 25 kWh: **~$10,000**

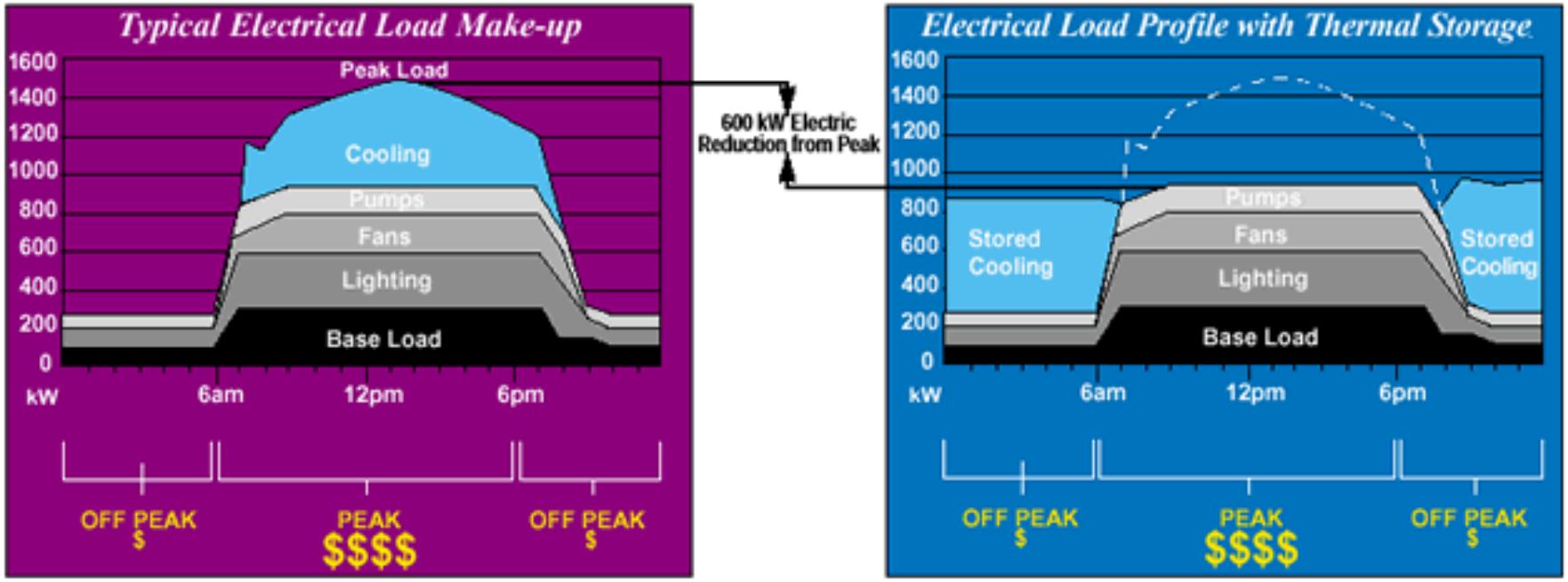
# Strategy 5:
# Require 2-hour Storage On New AC

Require new AC units over 5 tons to include at least 2 hours of storage, under grid control.

**Move 100 MWh of AC load out of the 6 – 8 PM period into off-peak periods.**

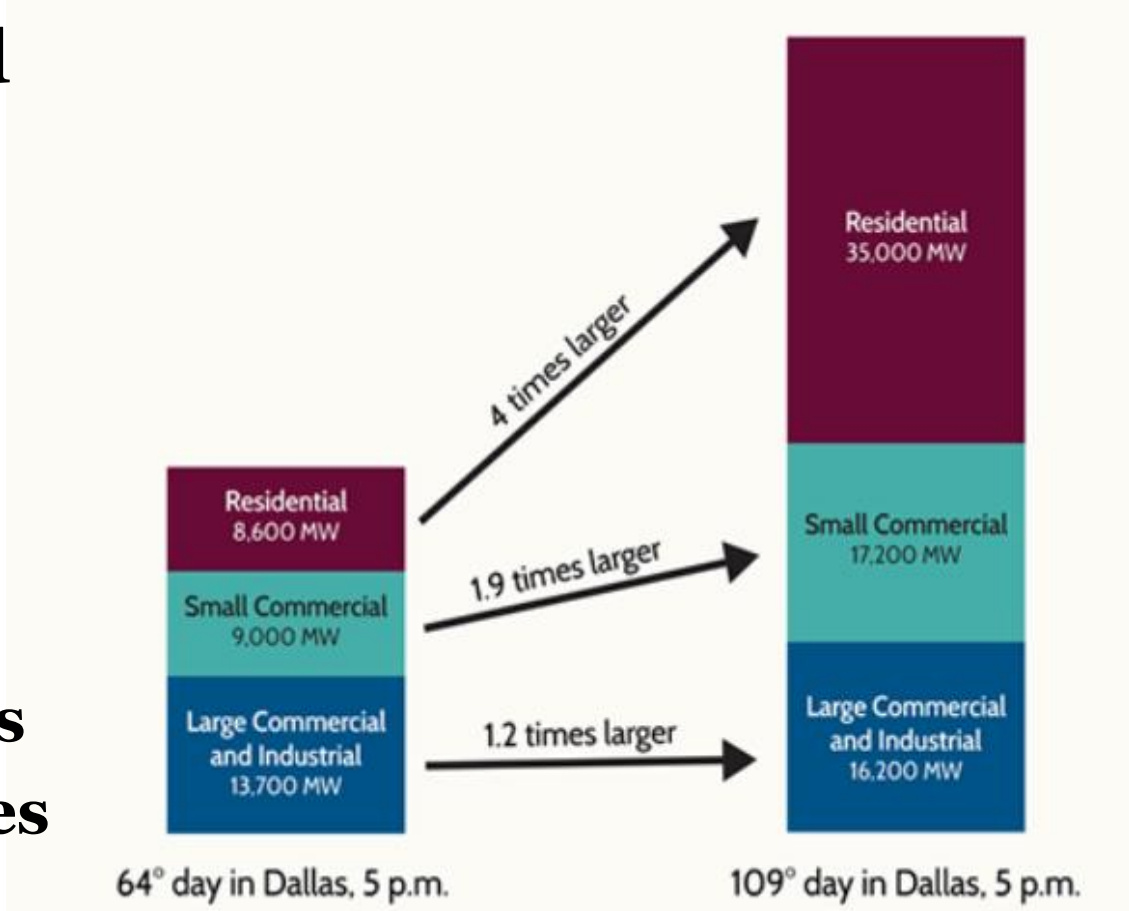
# Strategy 5: Thermal Storage Could Be A Much Larger Resource

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

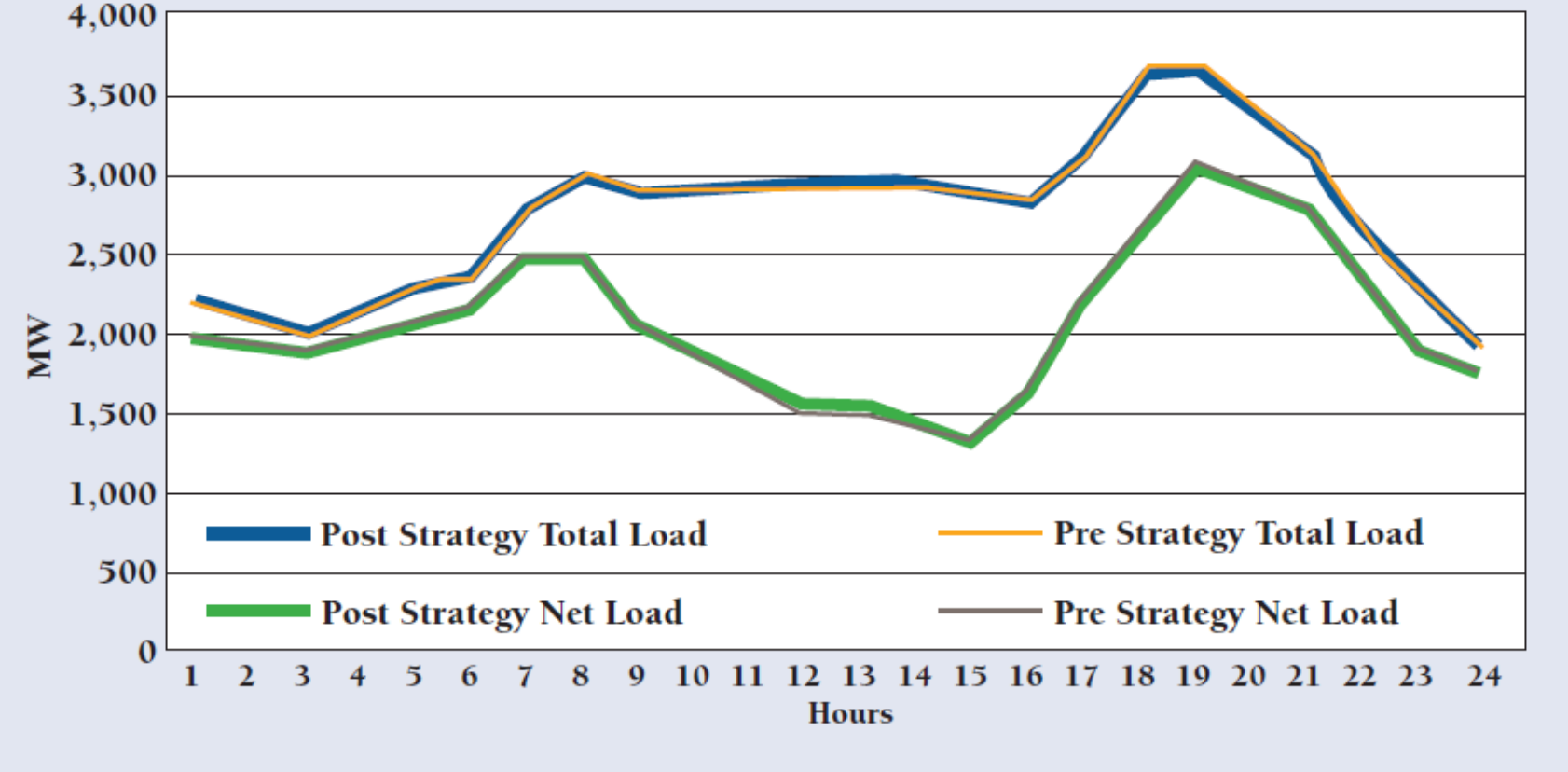


# Strategy 5: Air Conditioning Storage
# A/C is ~30% of Peak Demand

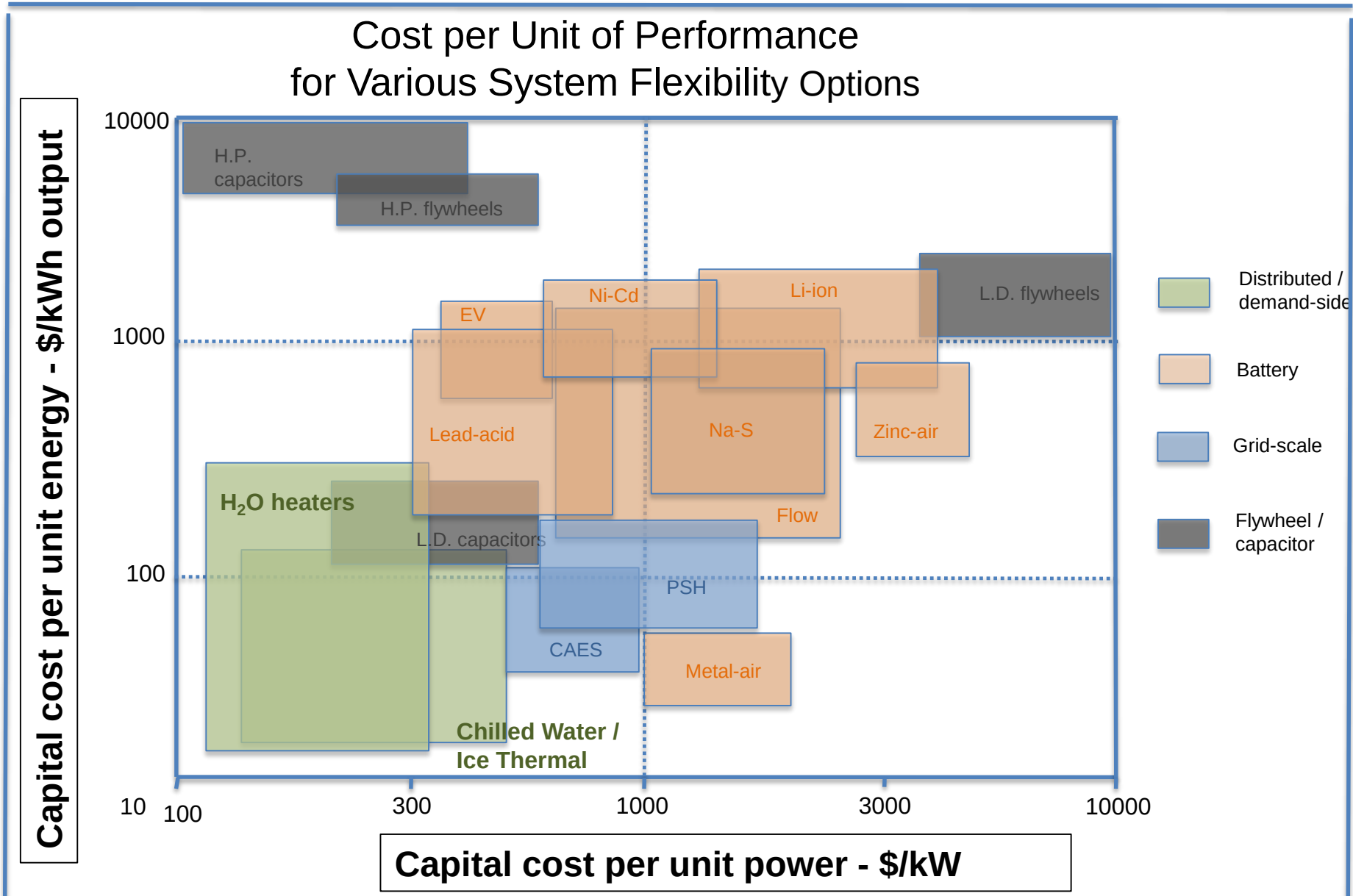
- **Commercial load doubles;**
- **Residential load up 4X.**
- **Option:**
  - **Appliance standards**
  - **Service standards**
  - **Retrofit incentives**



# Strategy 5:
# Require 2-hour Storage On New AC



# Strategies 4 &5: Very Inexpensive Compared With Battery/Flywheel



# 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.

# Strategy 7:
# Concentrate Demand Charges

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

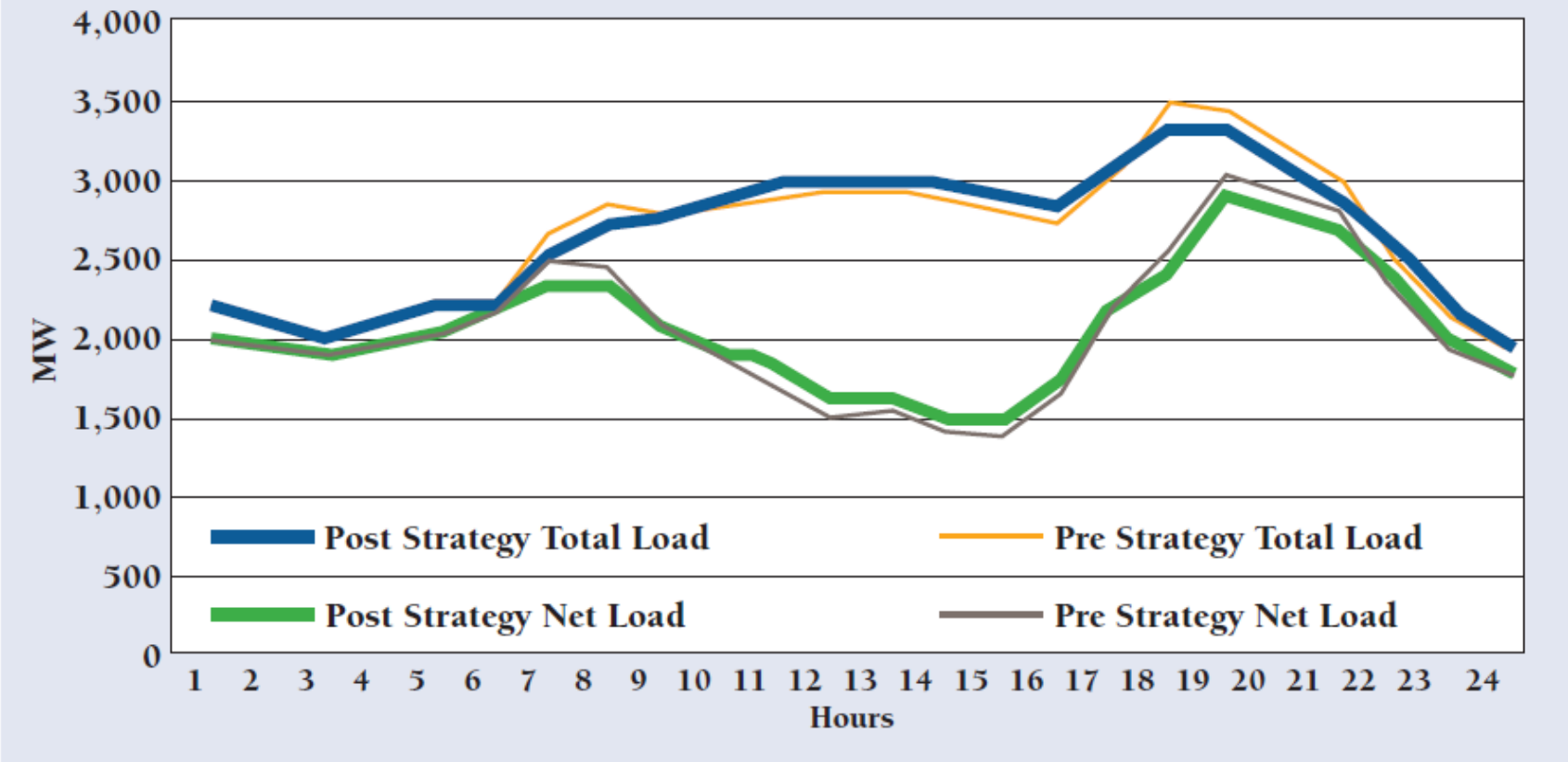
**Old Rate**
**$10/month**
**$10/kW**
**$.10/kWh**

**New 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 Demand Charges



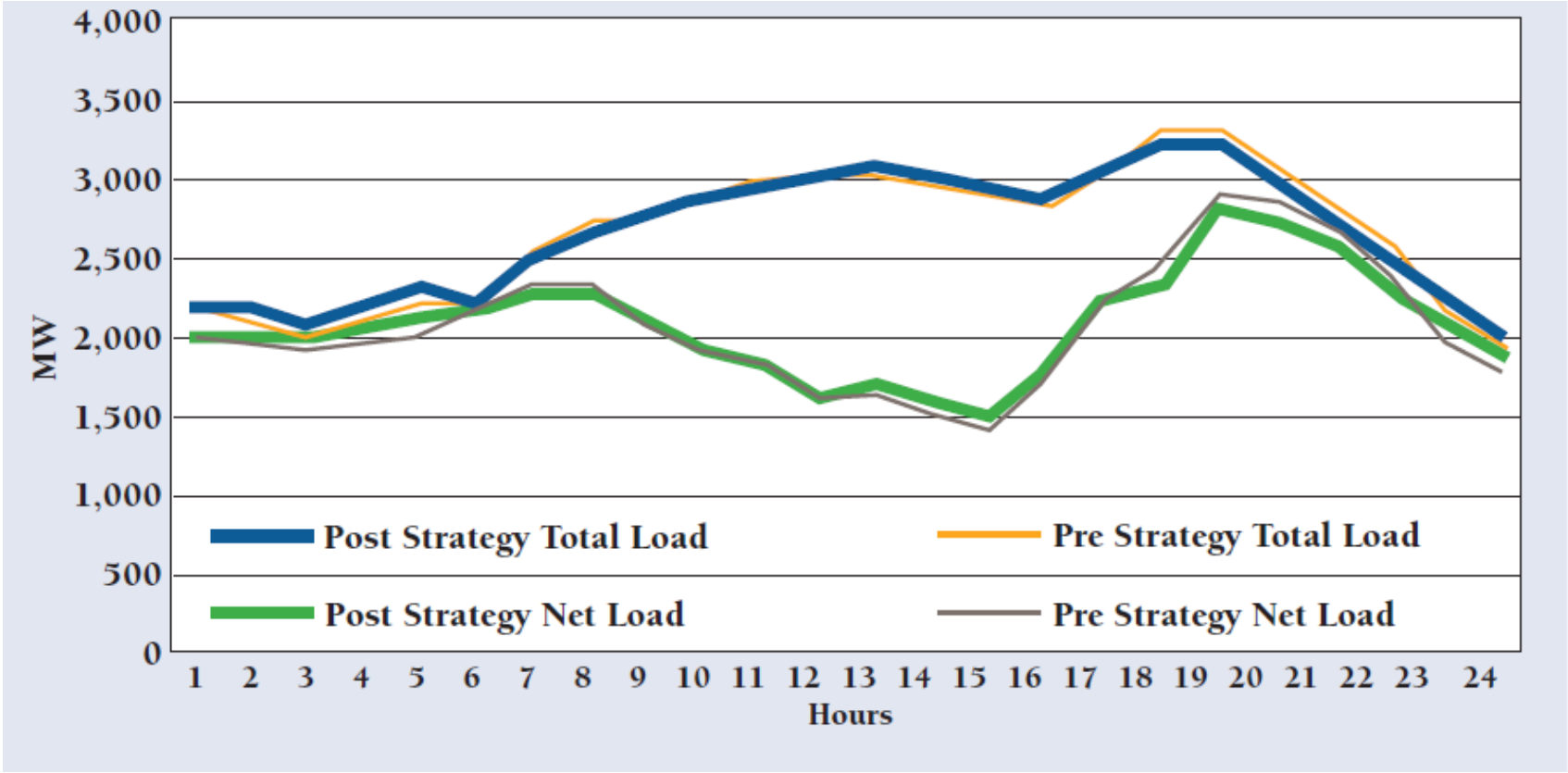
# Strategy 8:
# Deploy Electrical Storage

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

**Storage equal to 1% of total load added.**

**100 MW capacity system-wide assumed.**

# Strategy 8:
# Deploy Electrical Storage

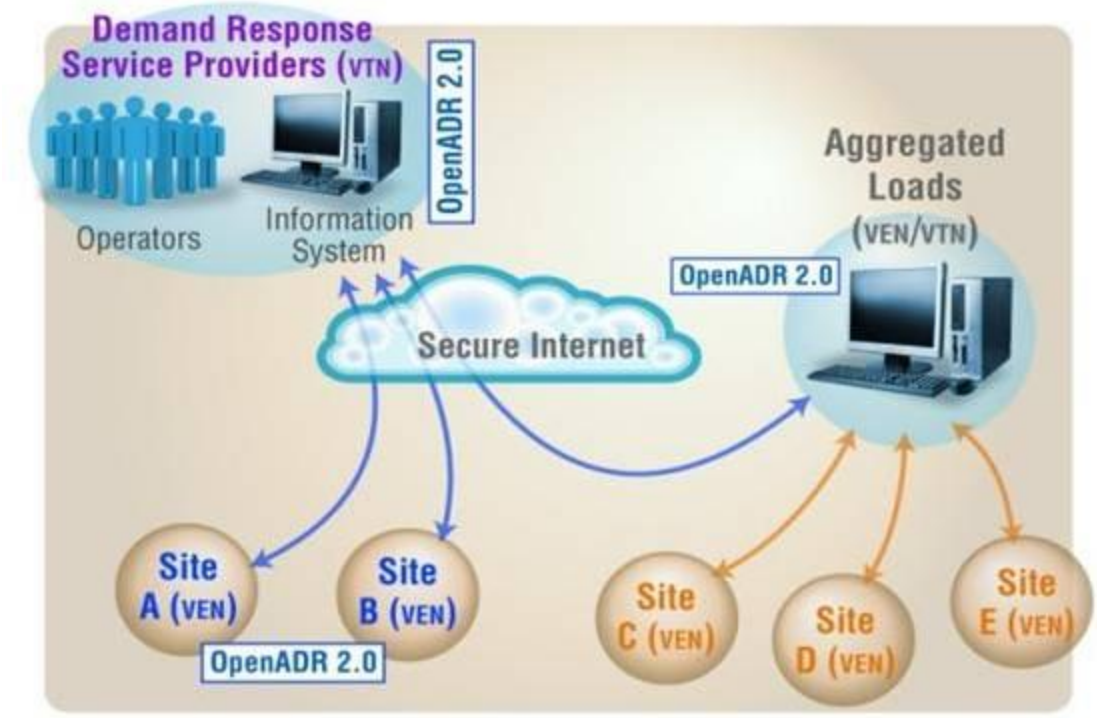


# Strategy 9: Demand Response

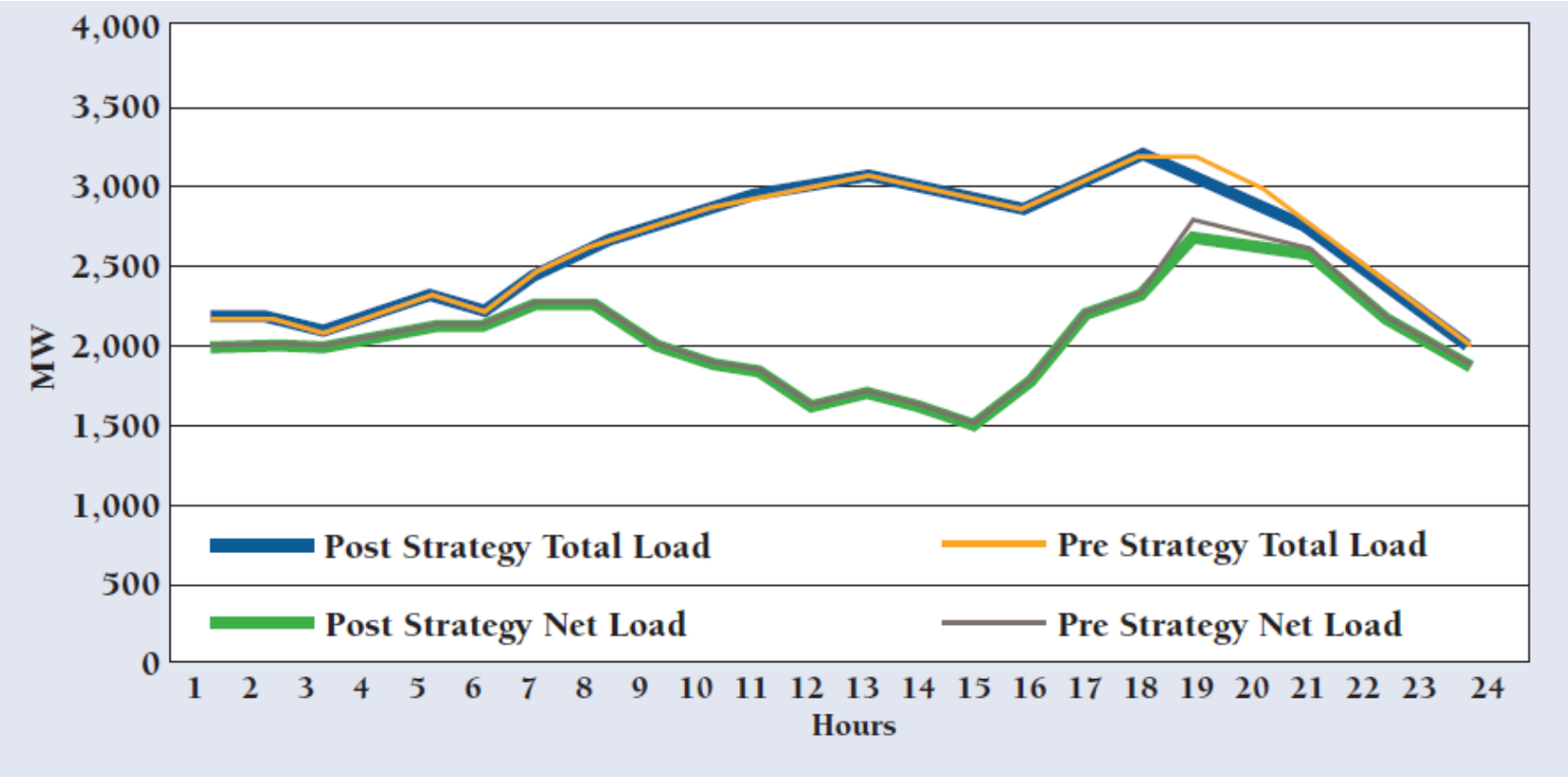
Contract with customers for curtailment on an as-needed basis when the ramp is steep.

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

**Currently ~8% at NEISO.**



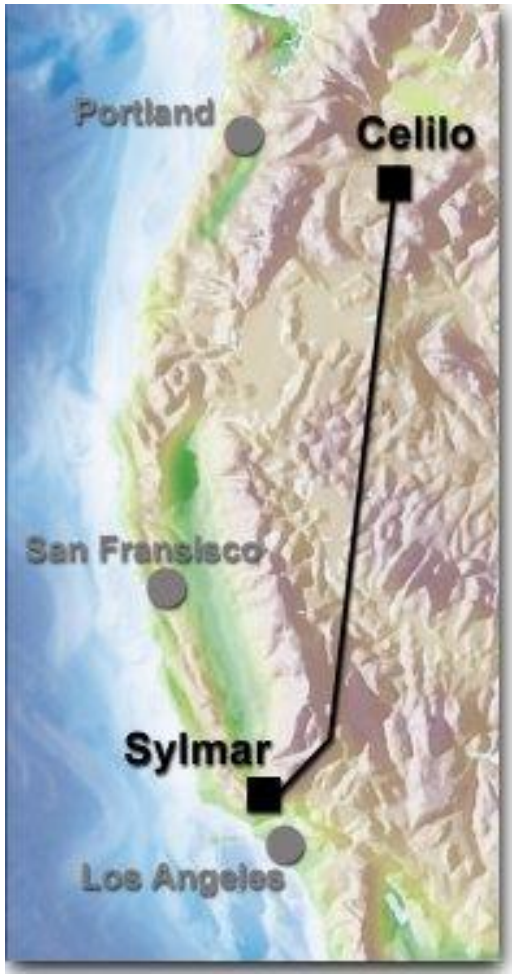
# Strategy 9: Demand Response



# Strategy 10:
# Inter-regional Power Exchanges

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

**Exchange 600 MWh per day from early to late evening using the existing inter-regional interties to Arizona, Nevada, Utah, and the Northwest**



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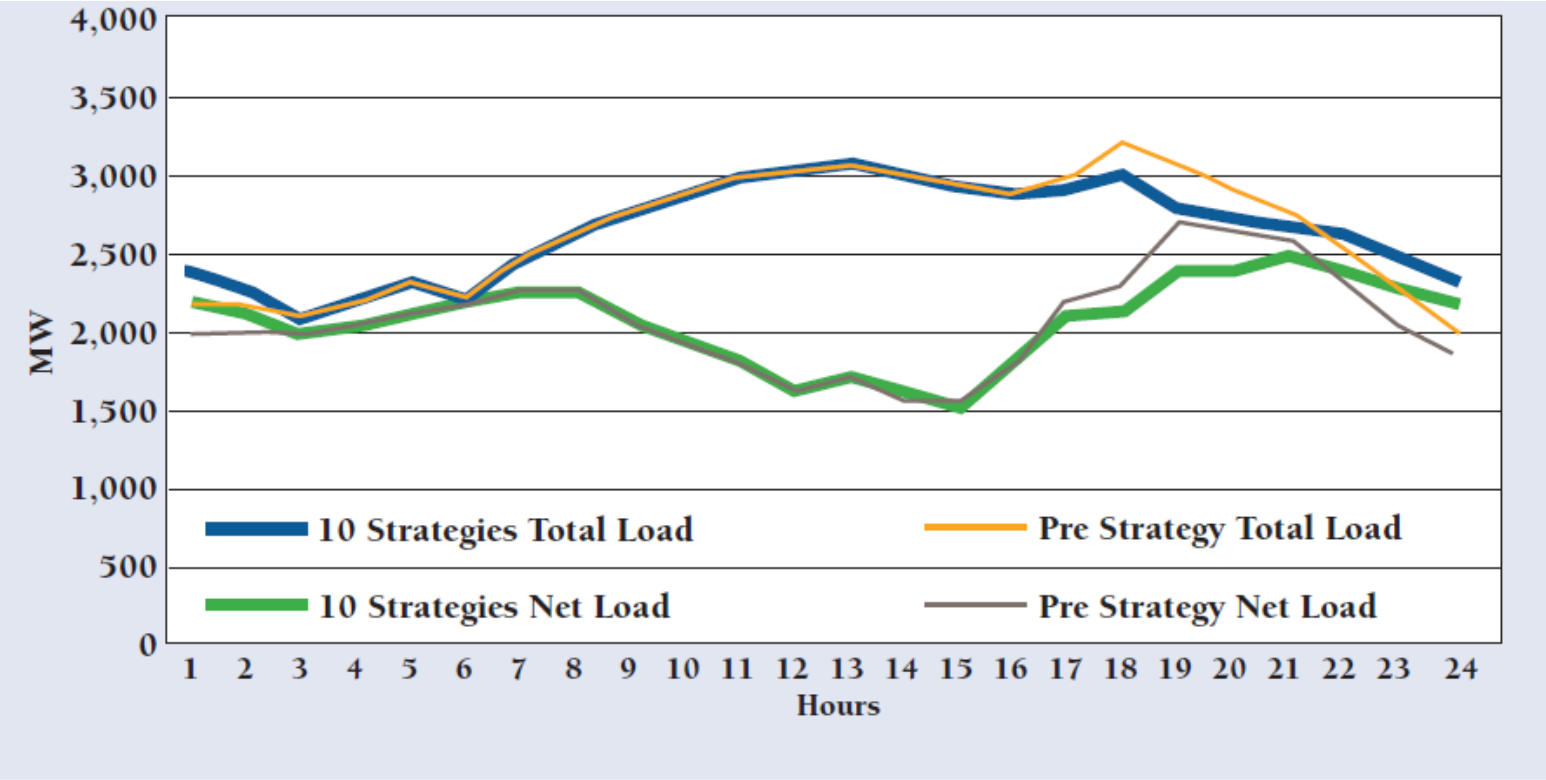



**This duck is ready to spread his wings and fly.**

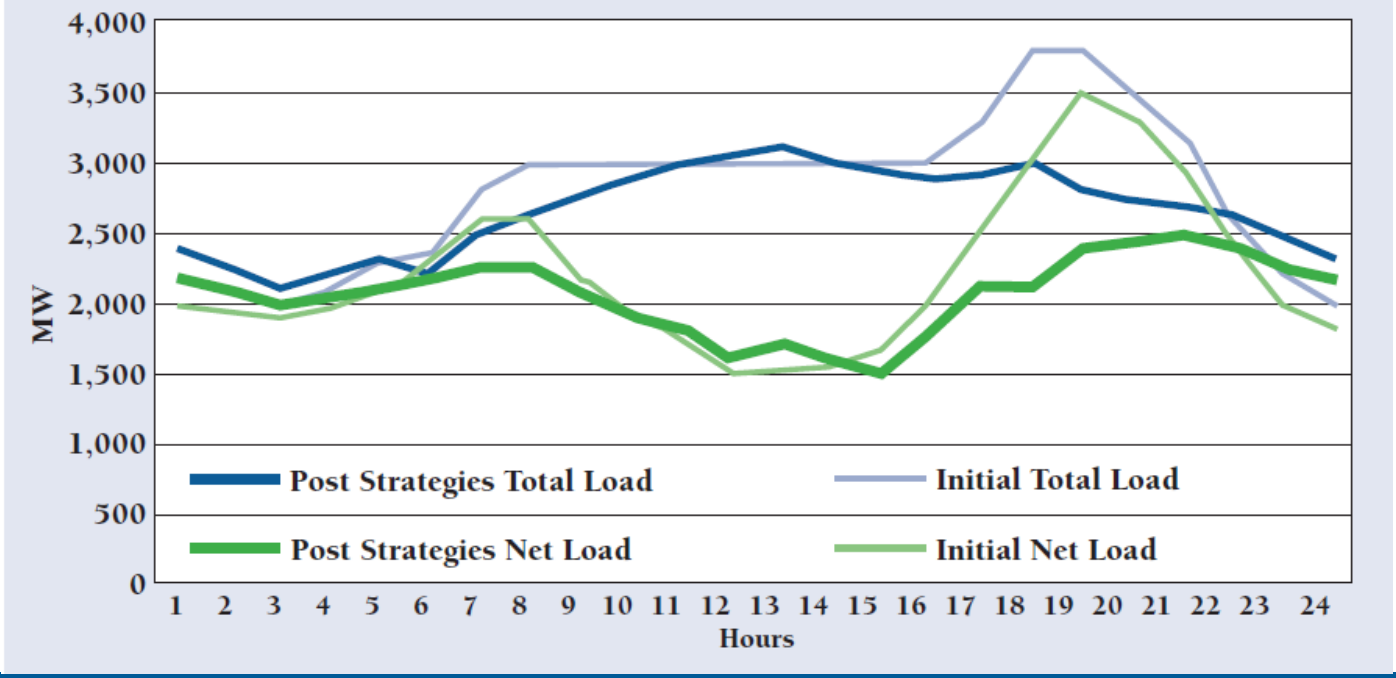
# How Did We Do?

**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**



# Teaching the Duck to Fly

# 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

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**Paper available at: http://www.raponline.org/document/download/id/6964**

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