RAP® Energy solutions for a changing world

Teaching the Duck to Fly

Adapting Loads to Resources, and Resource to Loads

RAP Webinar

March 3, 2016

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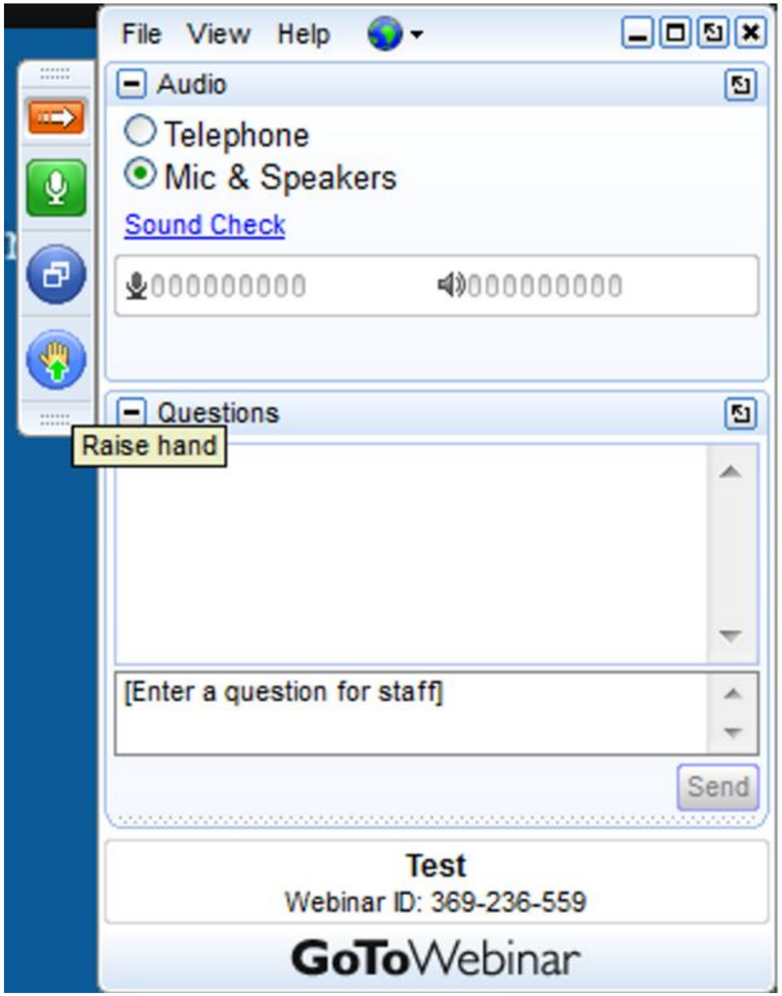
The Regulatory Assistance Project (RAP)®

Housekeeping

Please send questions through the Questions pane.

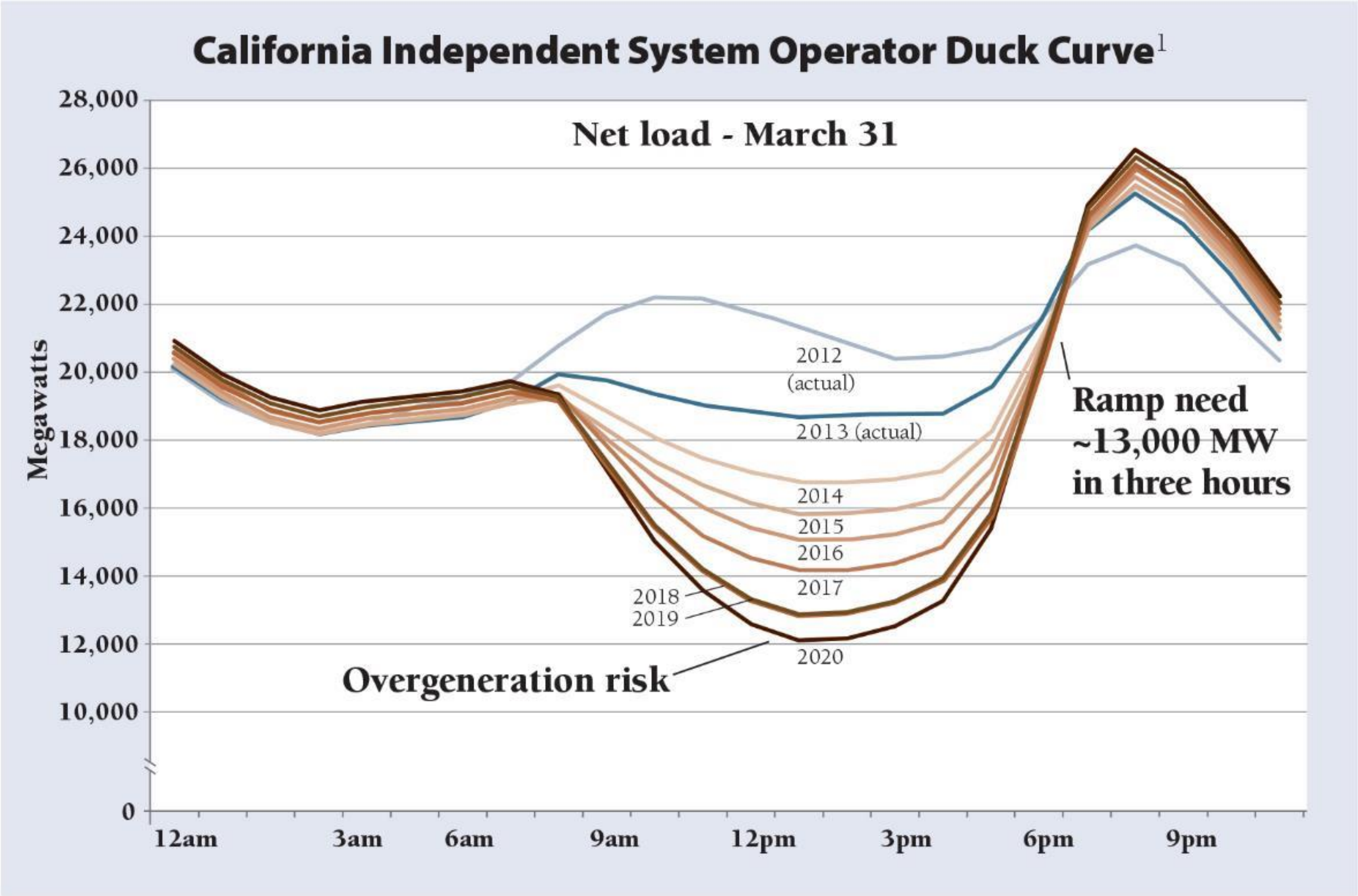


Our Experts

Jim Lazar

Carl Linvill

What's a "Duck Curve?"



Why is this an issue?

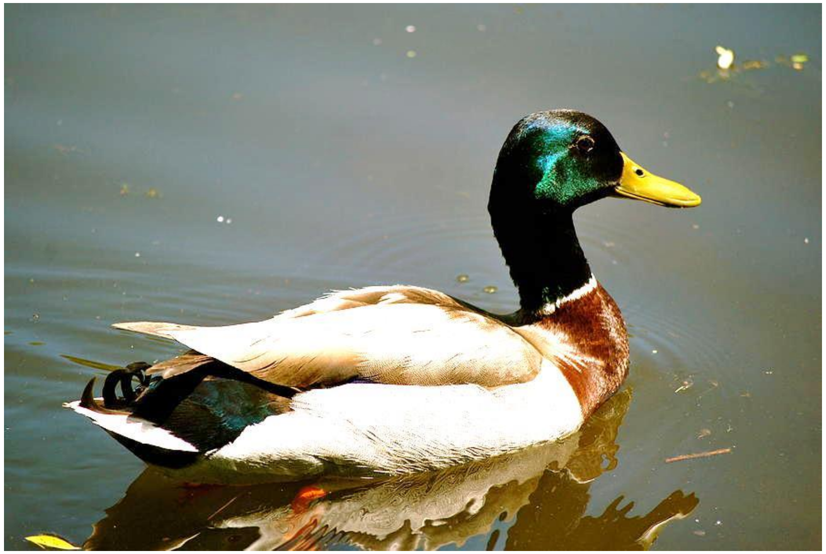
Solar helps meet daytime load.

Loads still rise in the early evening.

Compounded by wind coming and going.

How Do Utilities Manage This Now?

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.

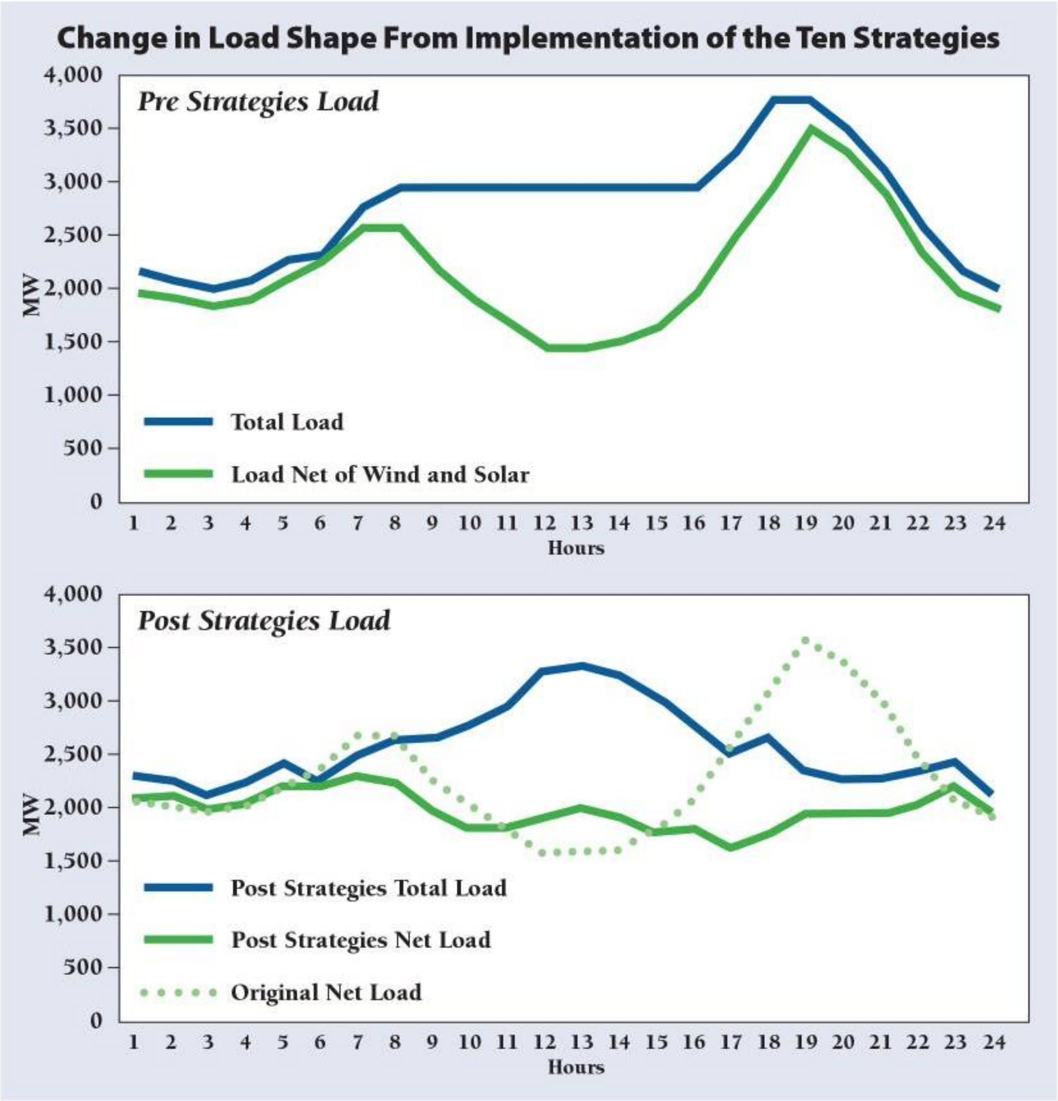
Ten Strategies To Align Loads to Resources (and Resources to Loads) with Illustrative Values for Each

1. Targeted energy efficiency
2. Peak-oriented renewables
3. Manage water pumping
4. Grid-integrated water heating
5. Storage air-conditioning
6. Rate design
7. Electricity storage in key locations
8. Demand response
9. Inter-regional exchanges
10. Retire inflexible older generating units

Not every strategy will be applicable to every utility.

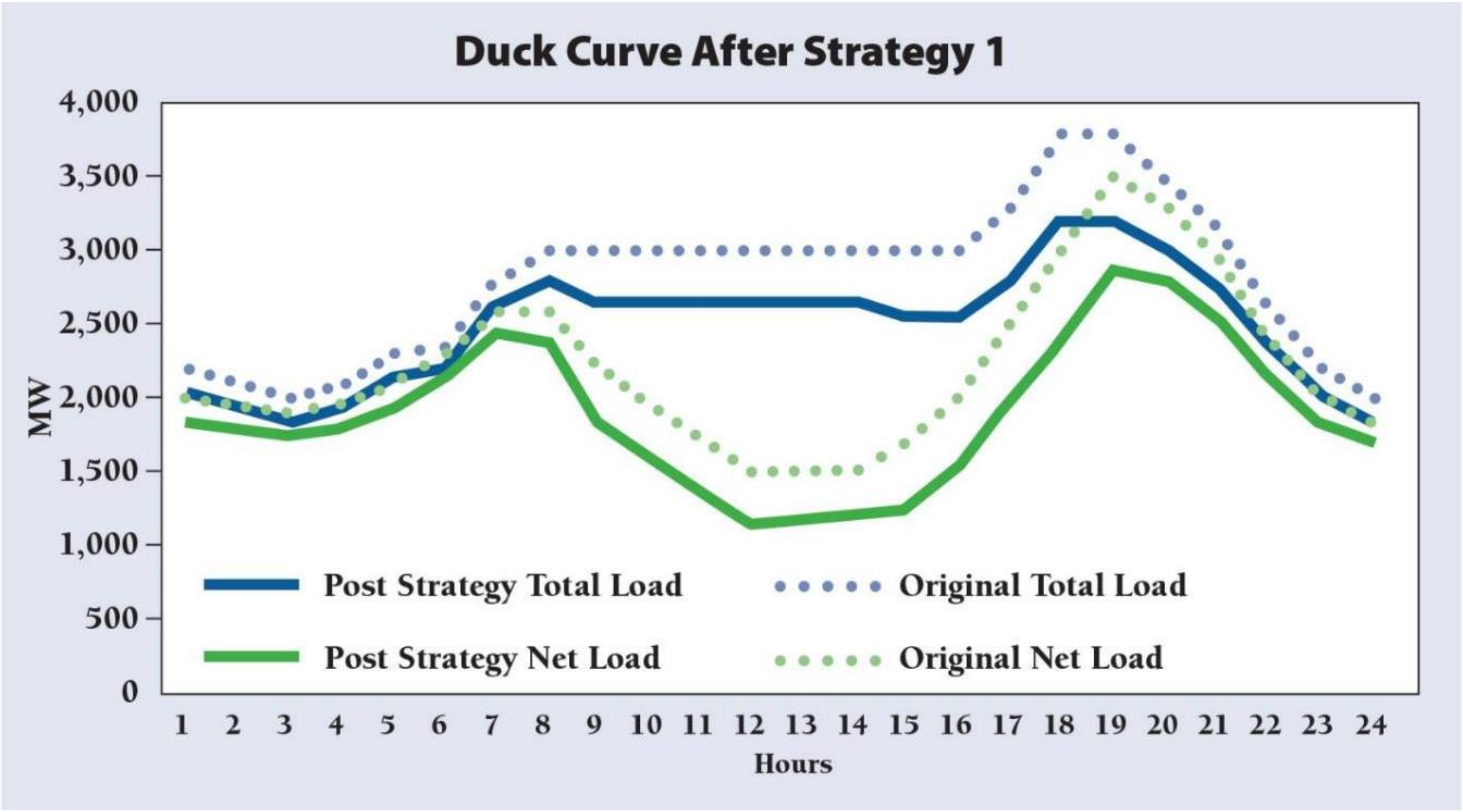
The Objective:

An End-State Flatter than the Pre-Solar Load



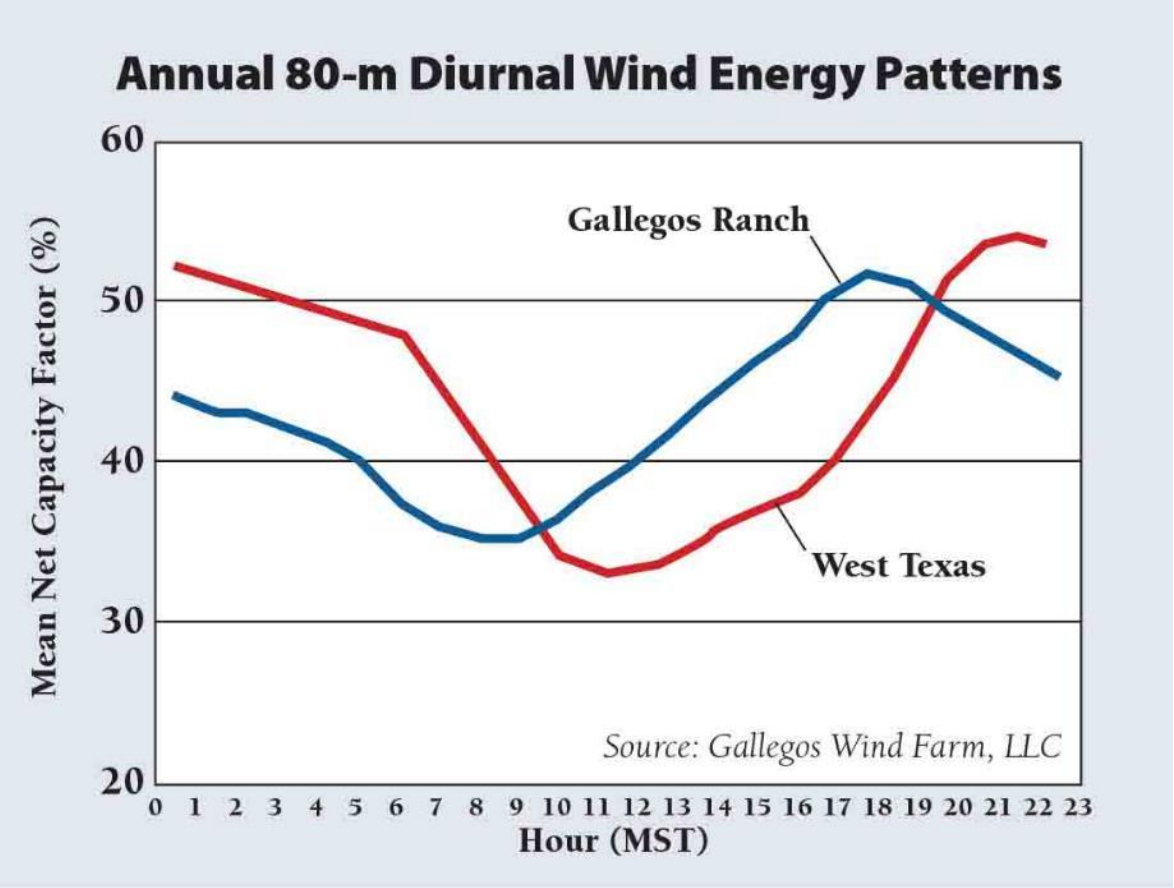
Strategy 1: Targeted Energy Efficiency

Load Lower at All Hours – But savings are concentrated in peak periods

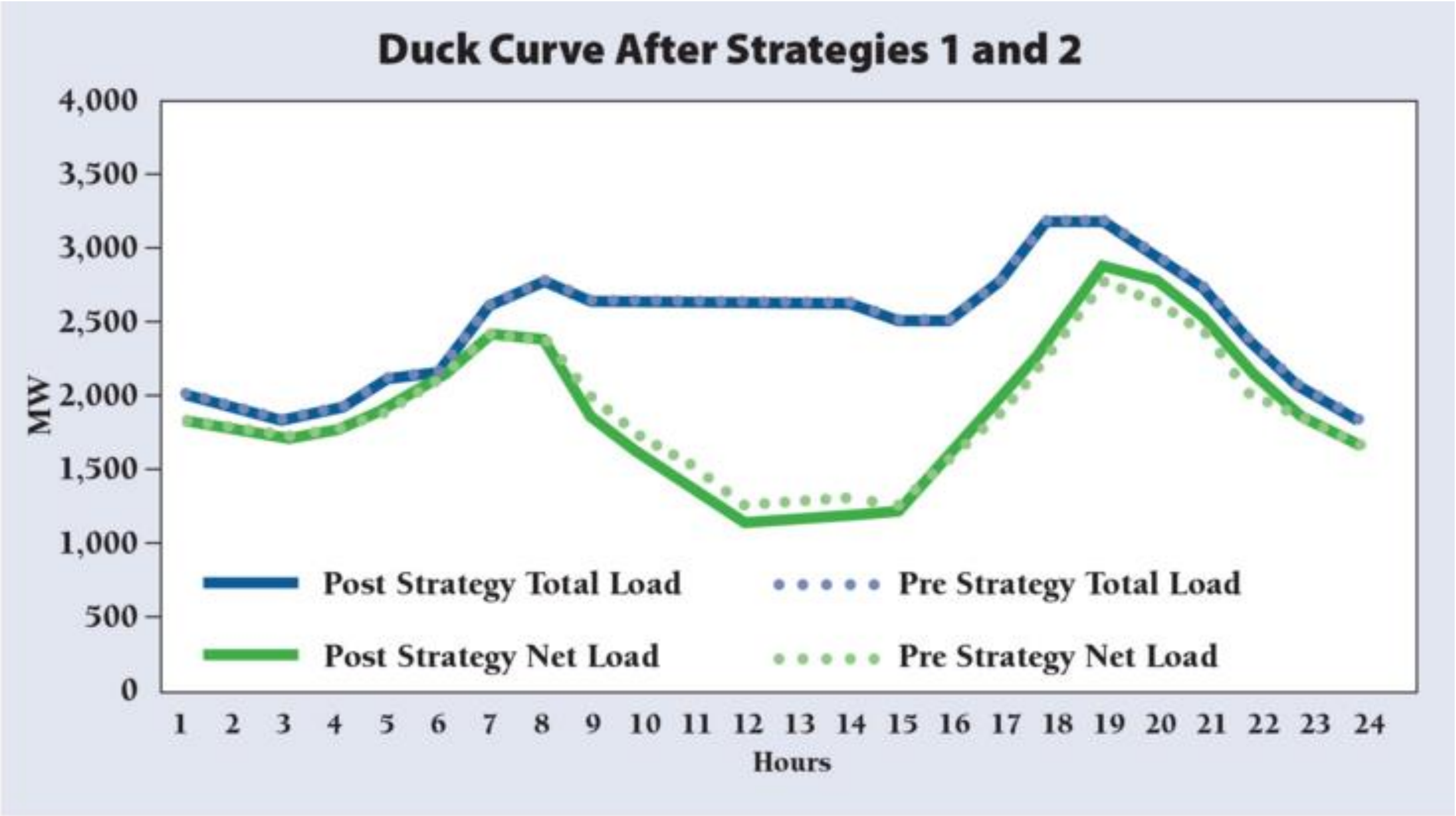


Strategy 2: Peak-Oriented Renewables

- Late-afternoon wind
- Hydro re-dispatch
- Solar/thermal
- West-facing solar



Slightly Lower Net-Load at Peak

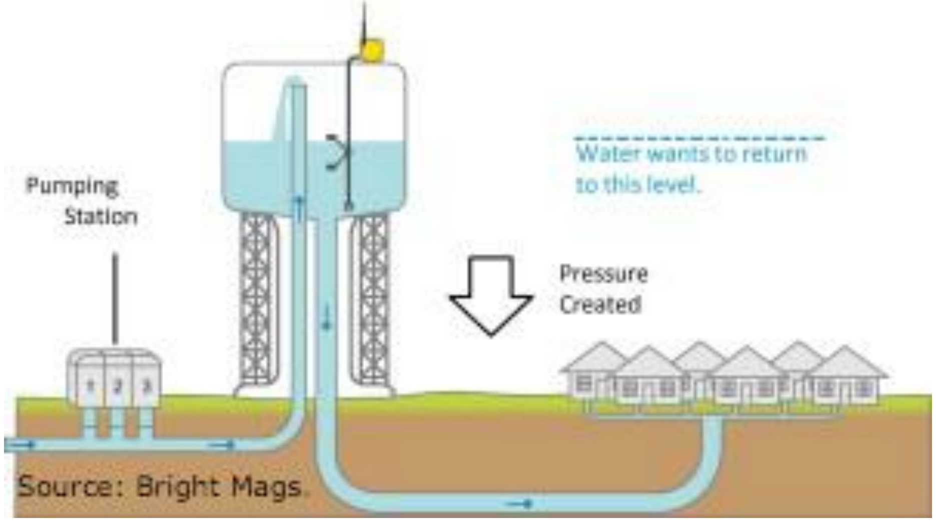


Strategy 3: Manage Water Loads

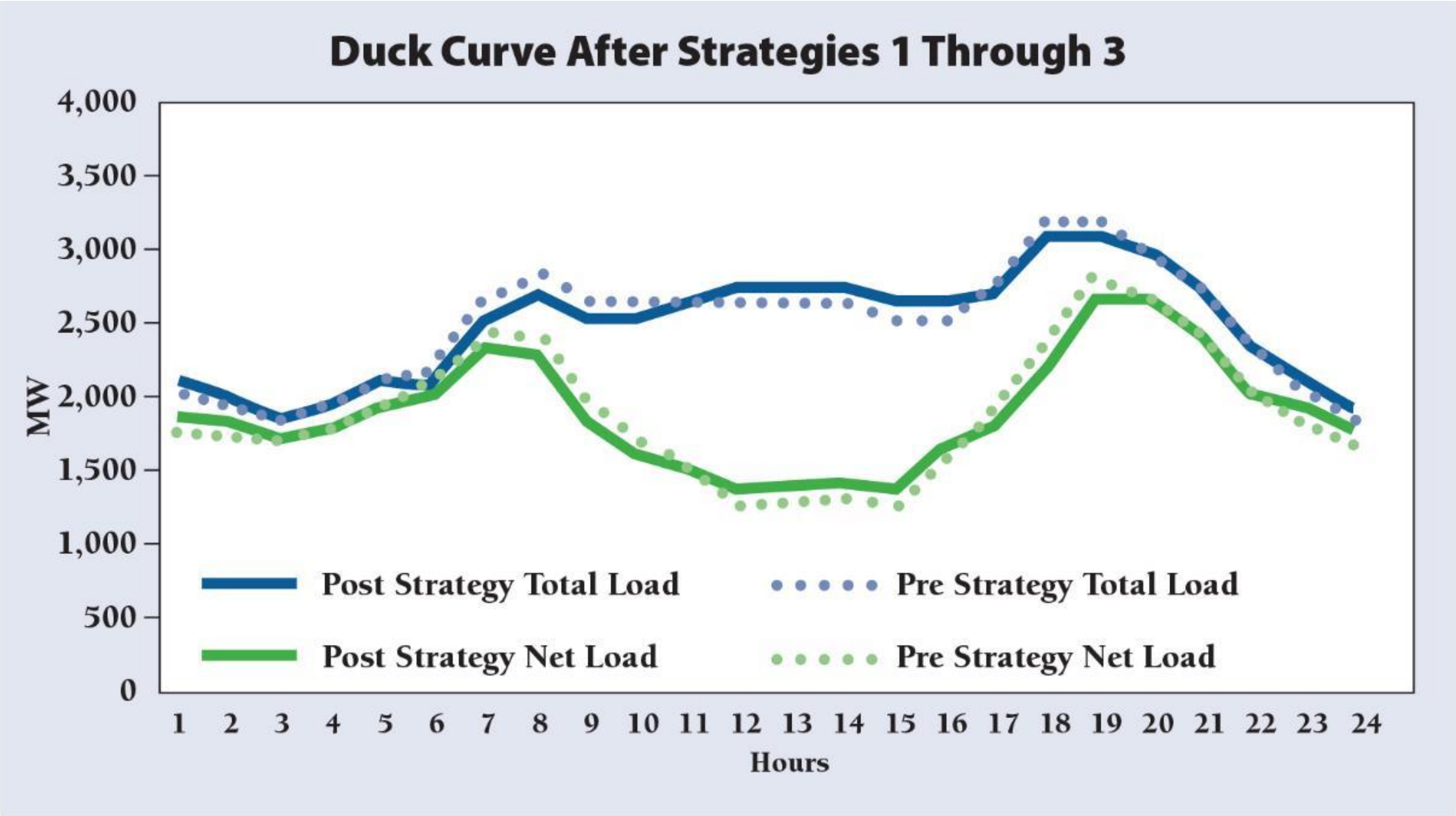
7% of national electricity usage.

Water and wastewater systems have storage.

It may be cost-effective to augment the tanks and reservoirs.



Load After Strategy 3

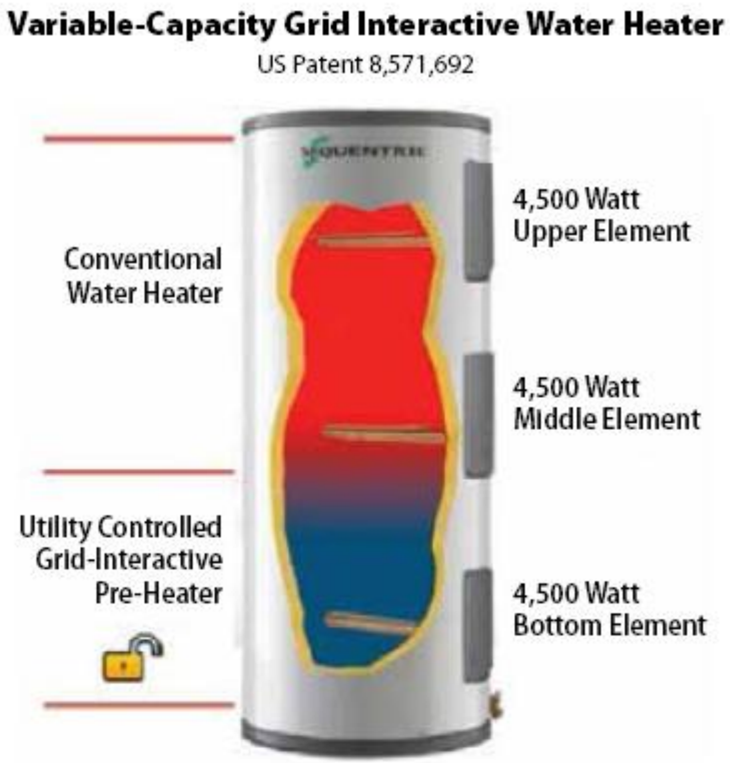


Strategy 4: Water Heating

14% of residential usage.

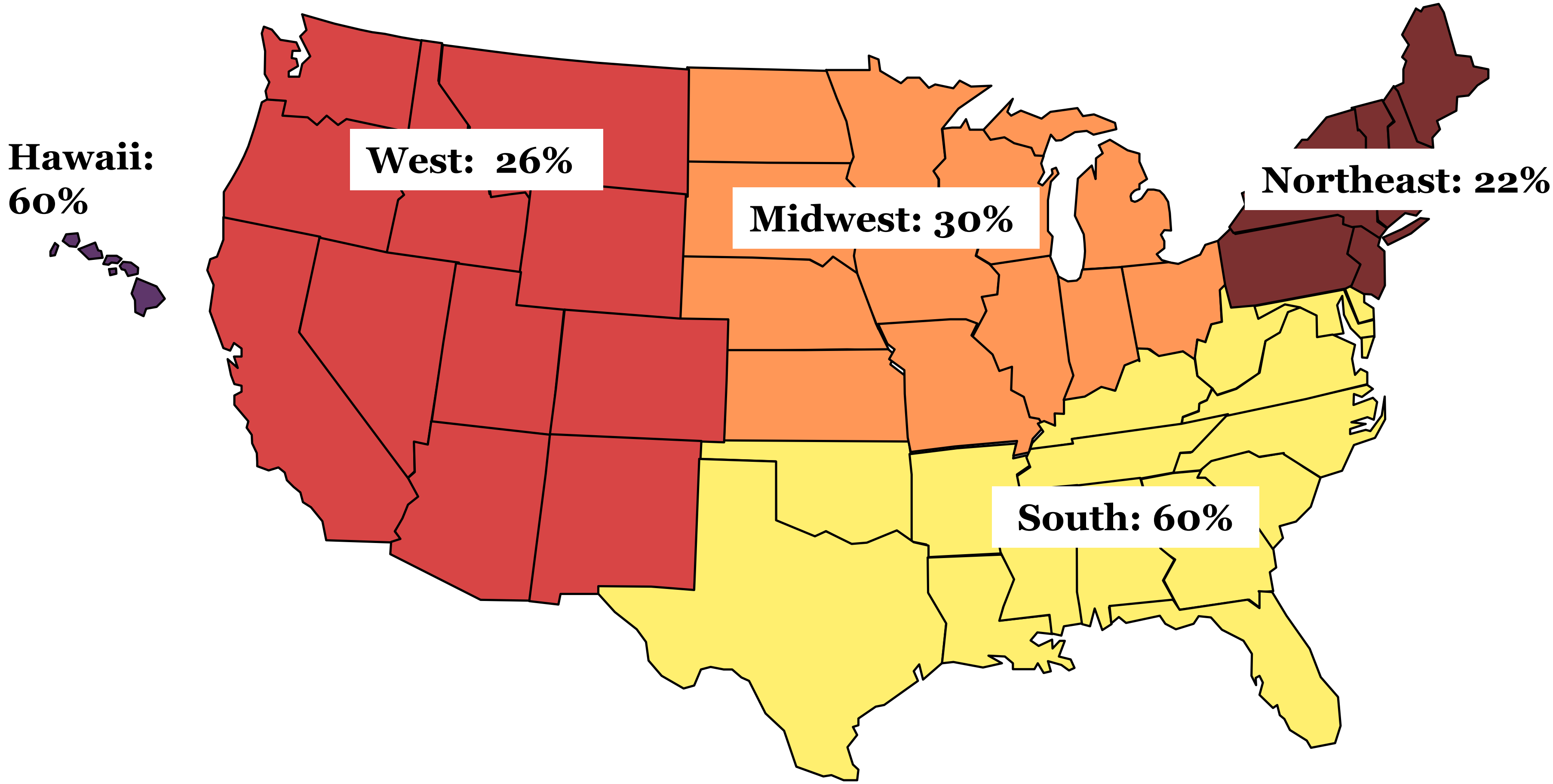
Every water heater is a thermal battery.

Heat the water when power is cheap; use the hot water as needed.



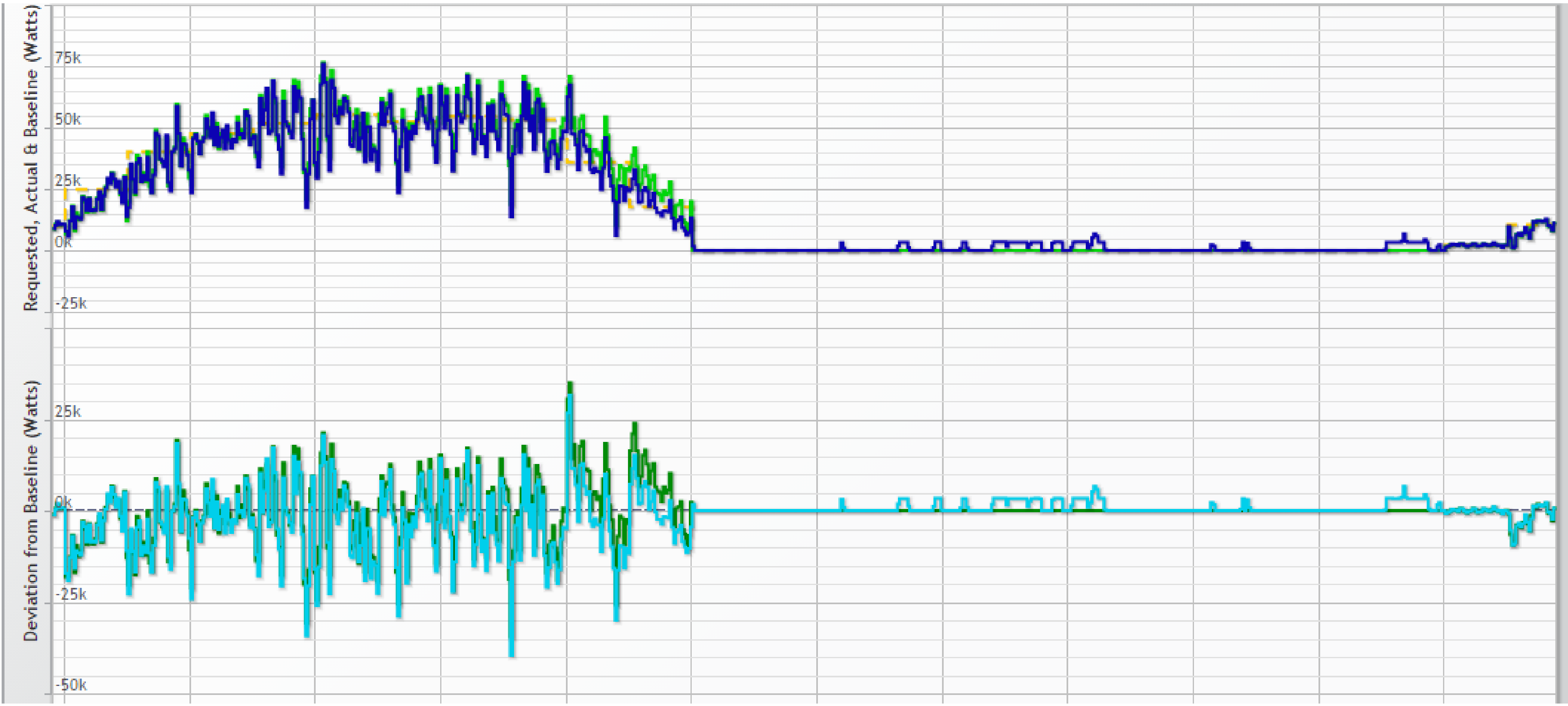
Above, Sequentric's patented variable-capacity grid-interactive water heater.

45 Million Electric Water Heaters



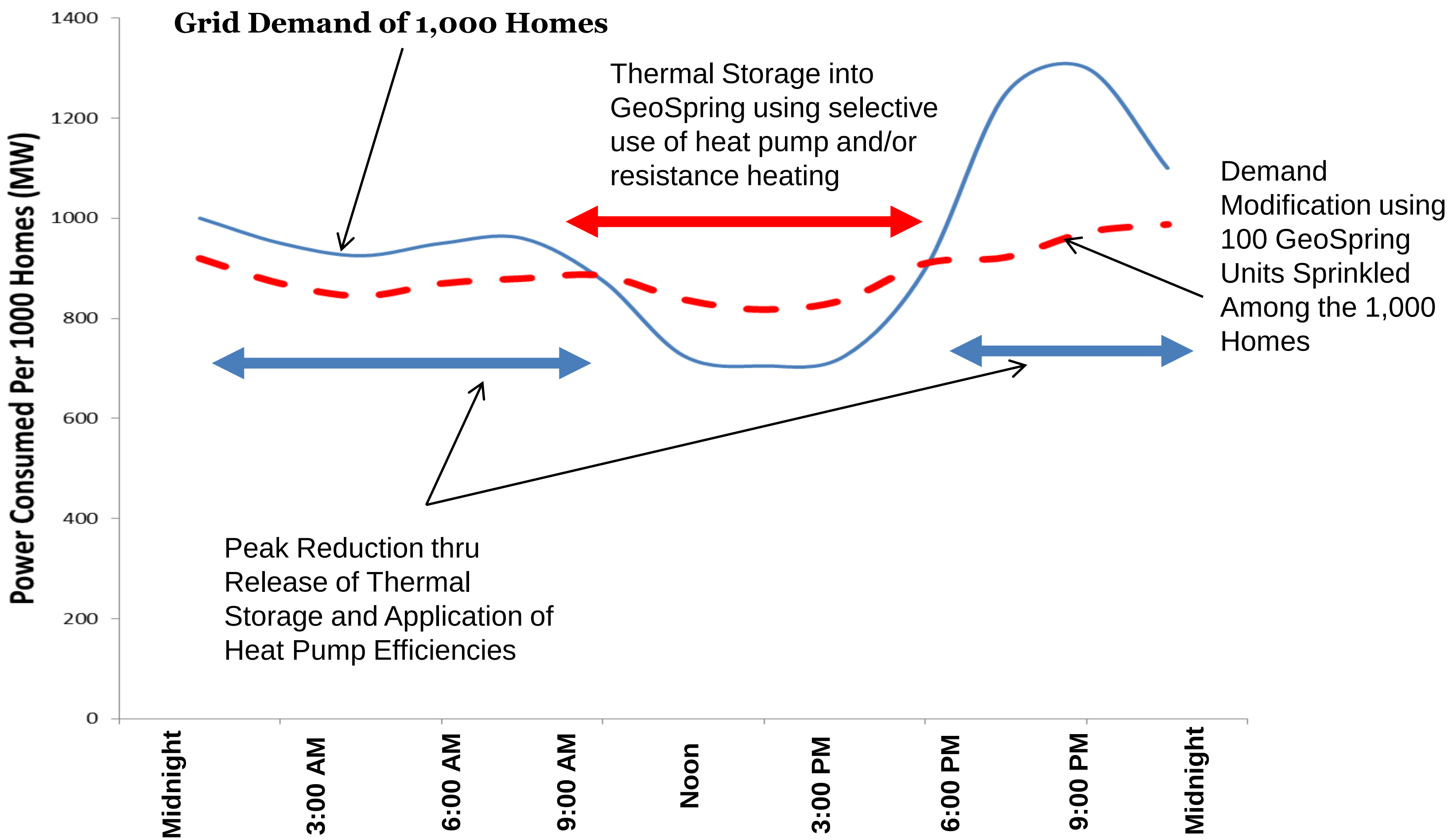
Census Housing Survey Table 2.5 (2010)

Hawaii GIWH Pilot: Solar Charging; Ancillary Services



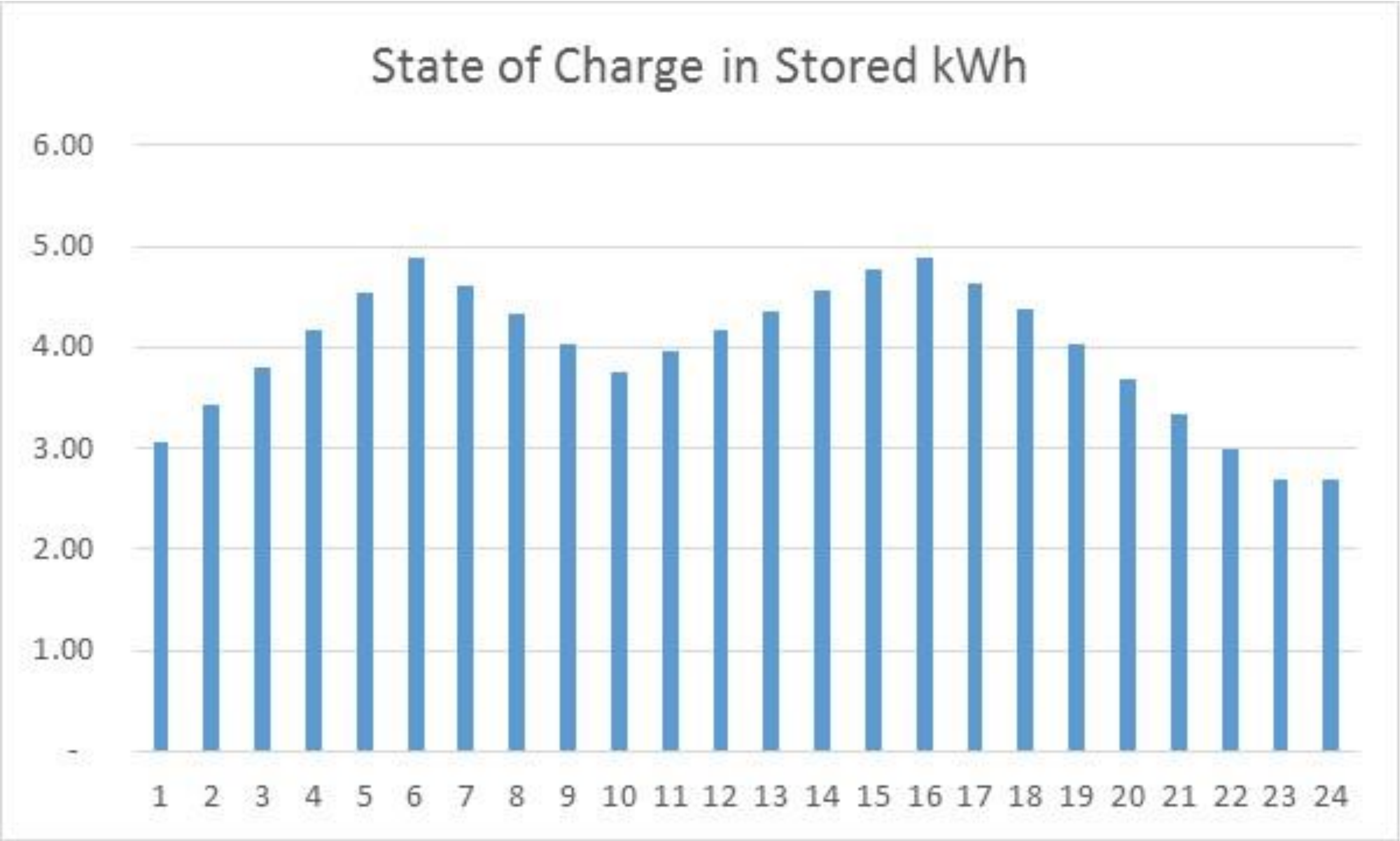
Steffes Corporation

Yes, this works with Heat Pump Water Heaters

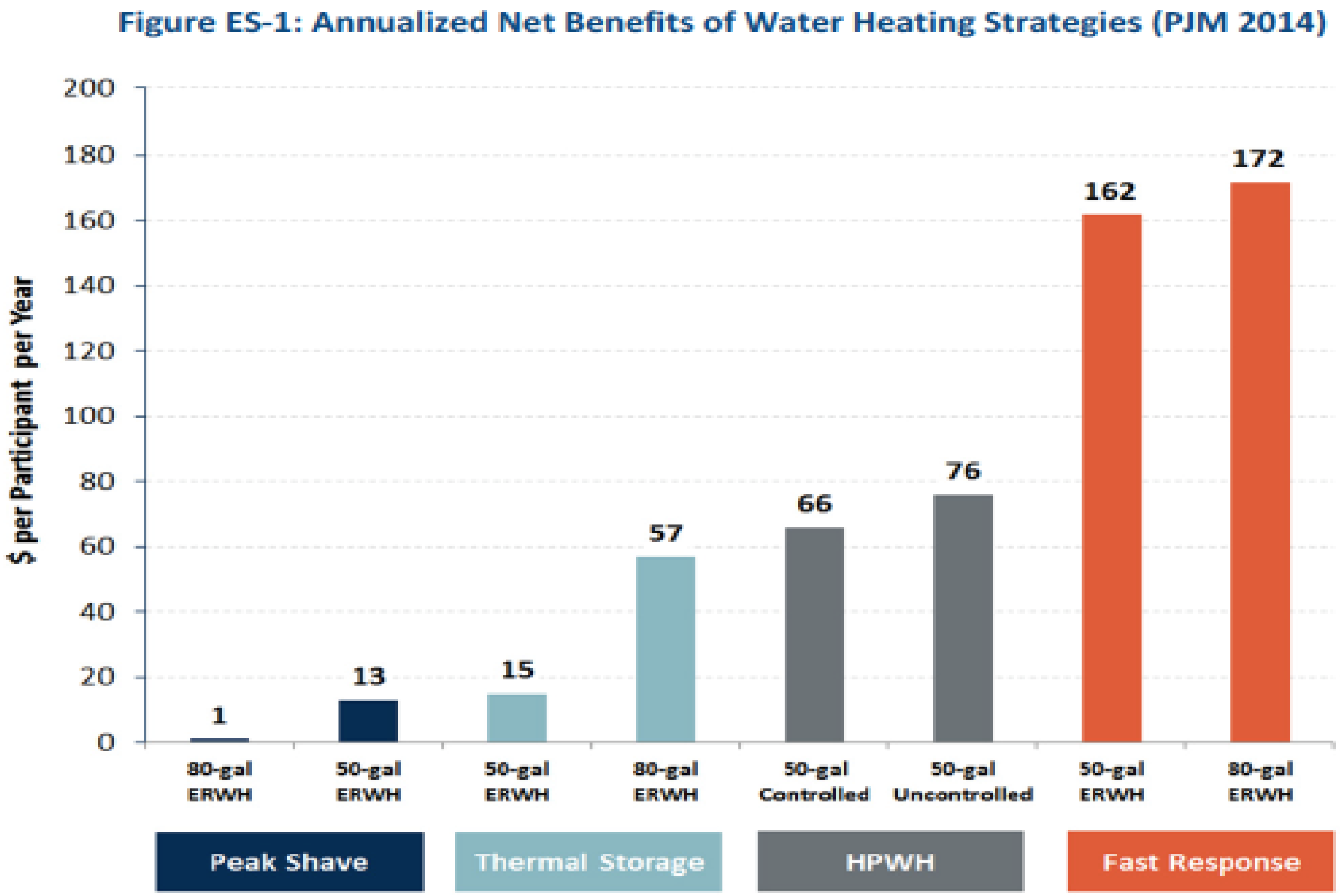


Rule #1: No Cold Showers

No, You Don't Run Out of Hot Water



New Report from Brattle / NRECA / NRDC / PLMA



Total Theoretical National Potential

Average Use / Water Heater: 4,522 kWh/year

=

output of ~2.2 kW wind or solar

X

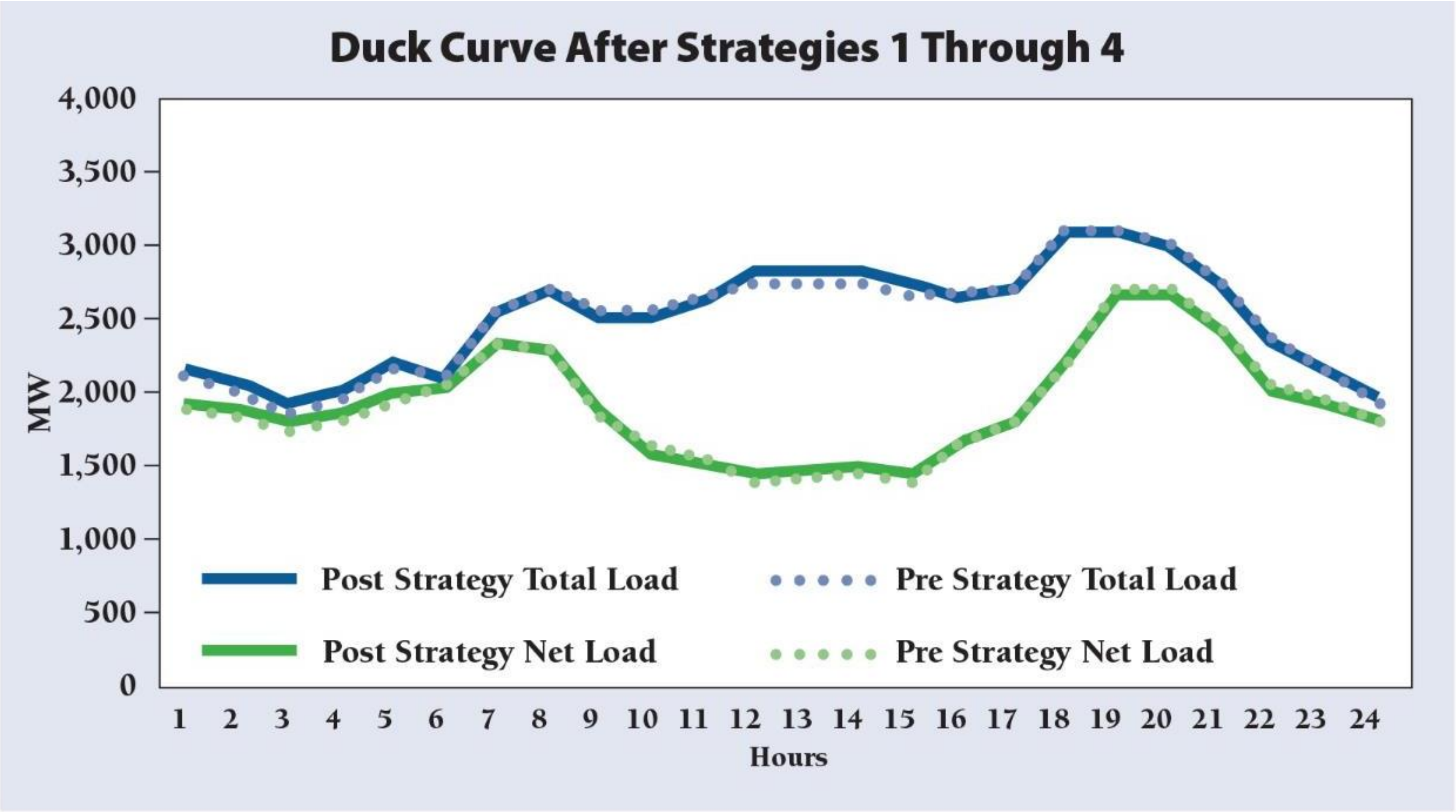
45 million water heaters

=

~100,000 MW of wind and solar on the system

Current: 75,000 MW

Load After Strategy 4



Questions?

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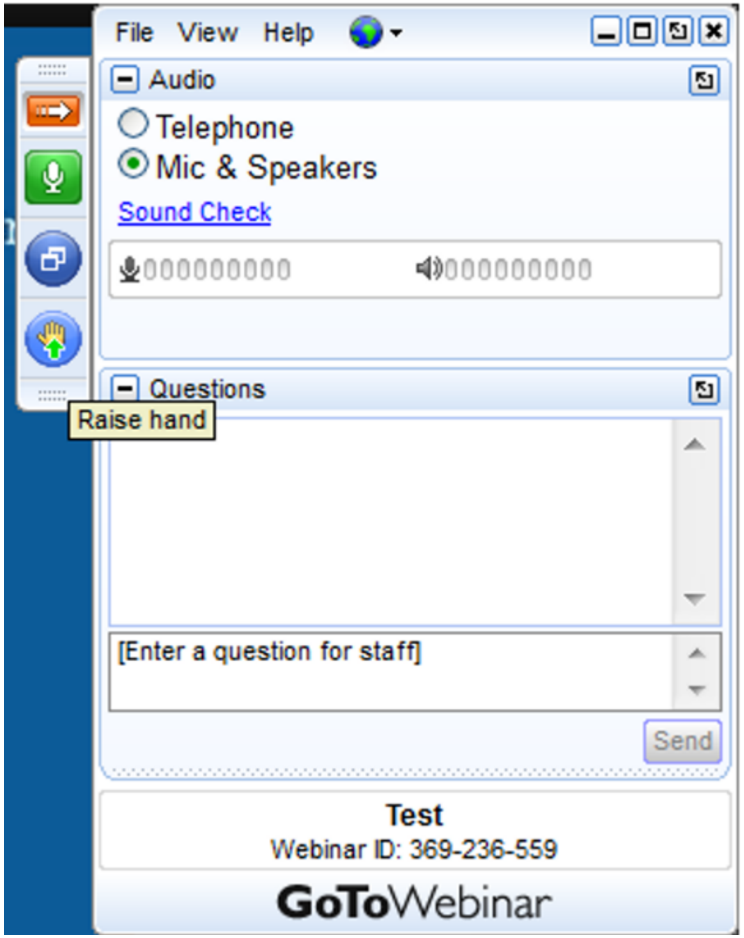
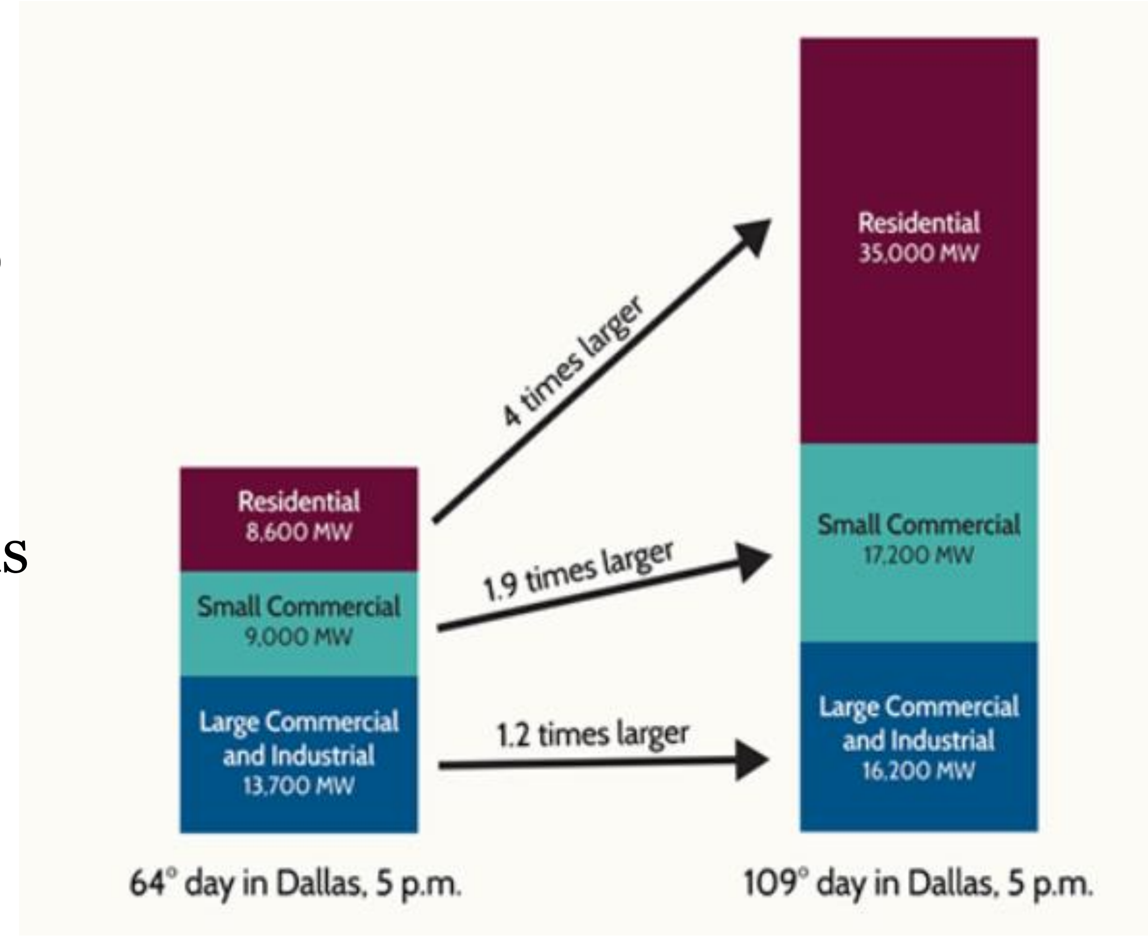


Strategy 5: Air Conditioning Storage A/C is ~30% of Peak Demand

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



We Can Store "Cool" as Ice (in fact, most of us already do)

Small Buildings: Unitary Storage Air Conditioning

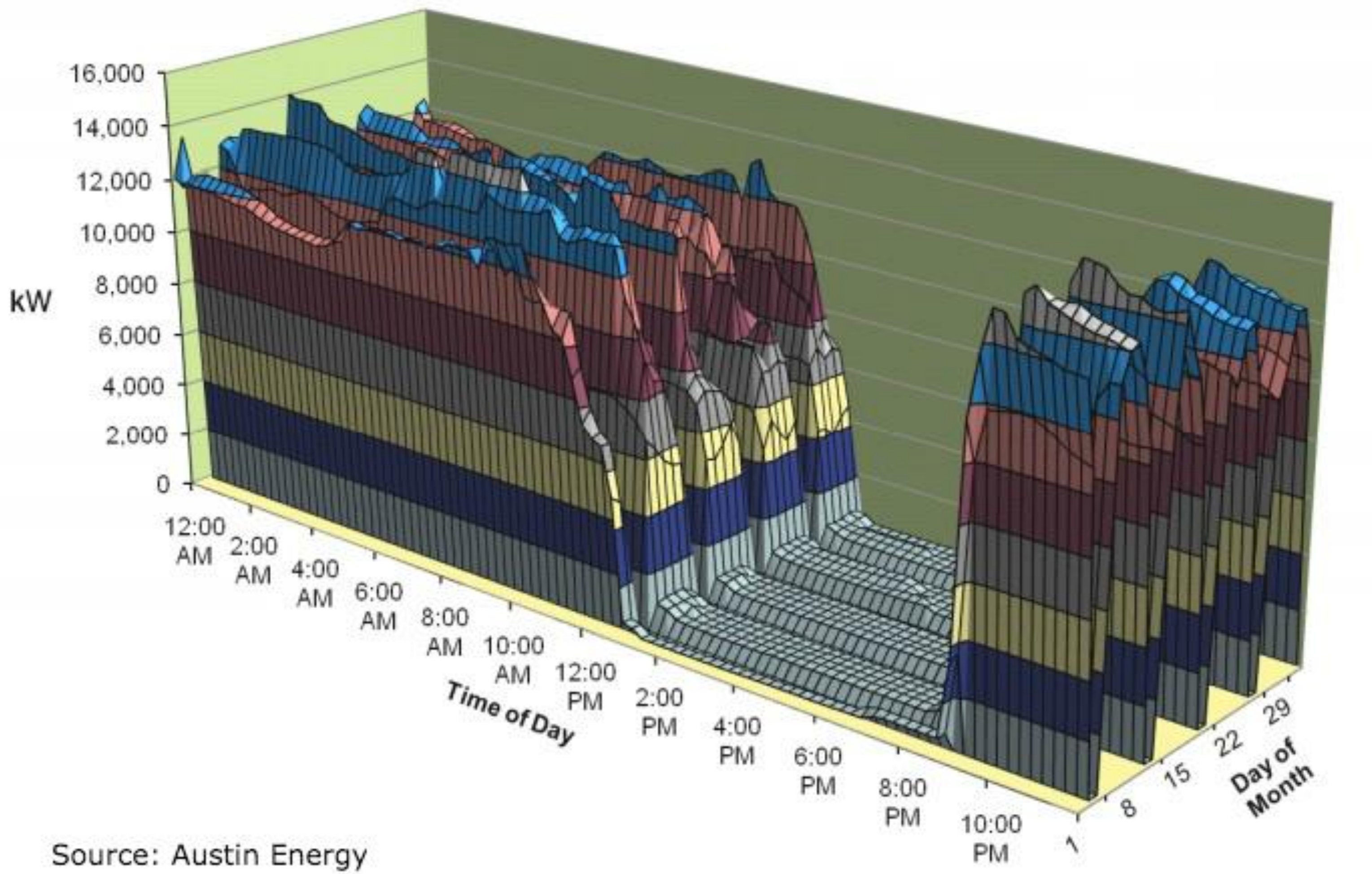
ICE ENERGY®

Large Buildings: Separate Ice Storage

Calmac

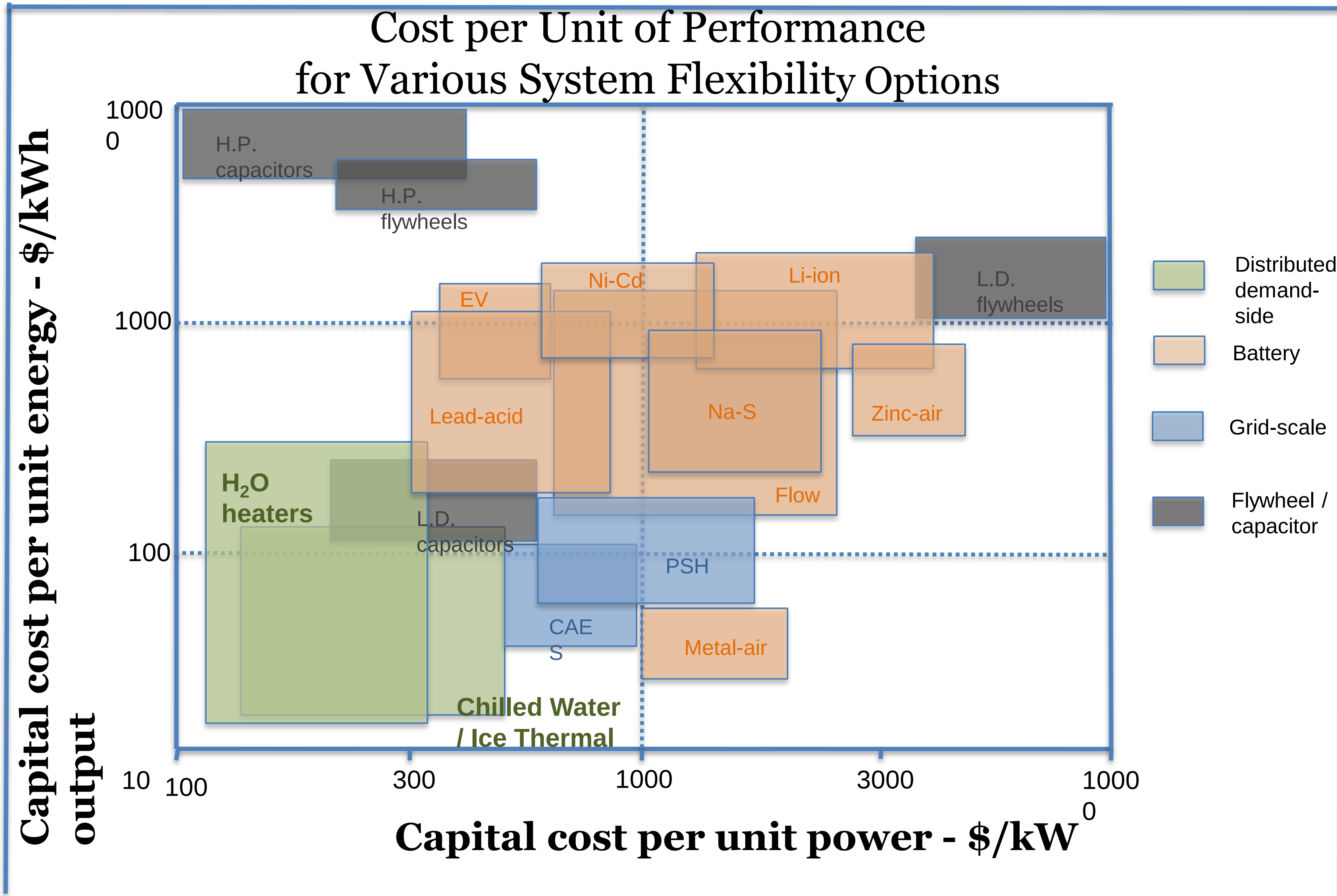
Photo: © Gunther Intelmann for Cook+Fox Architects

Austin Energy: District Cooling System

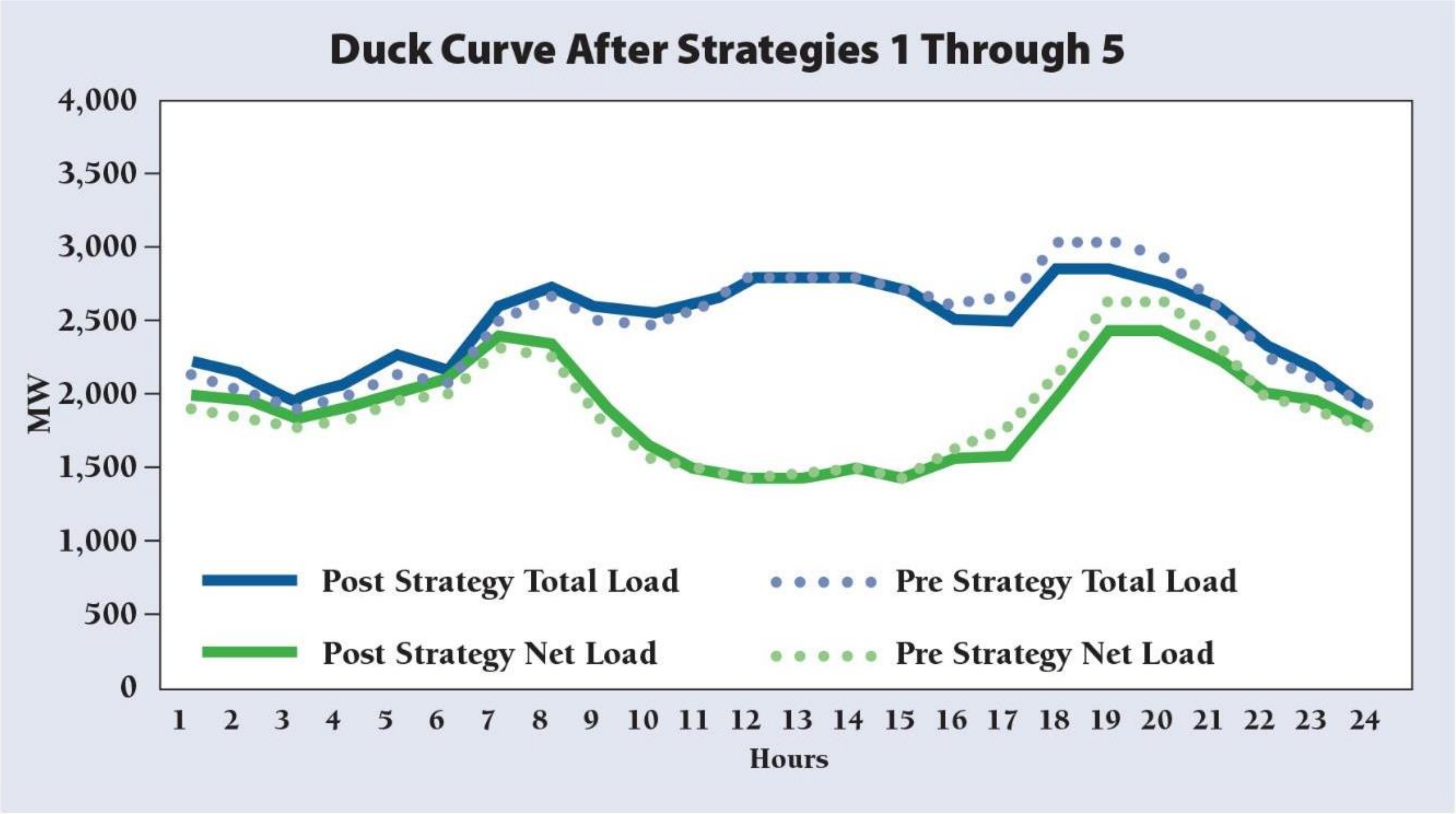


Source: Austin Energy

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



Load After Strategy 5

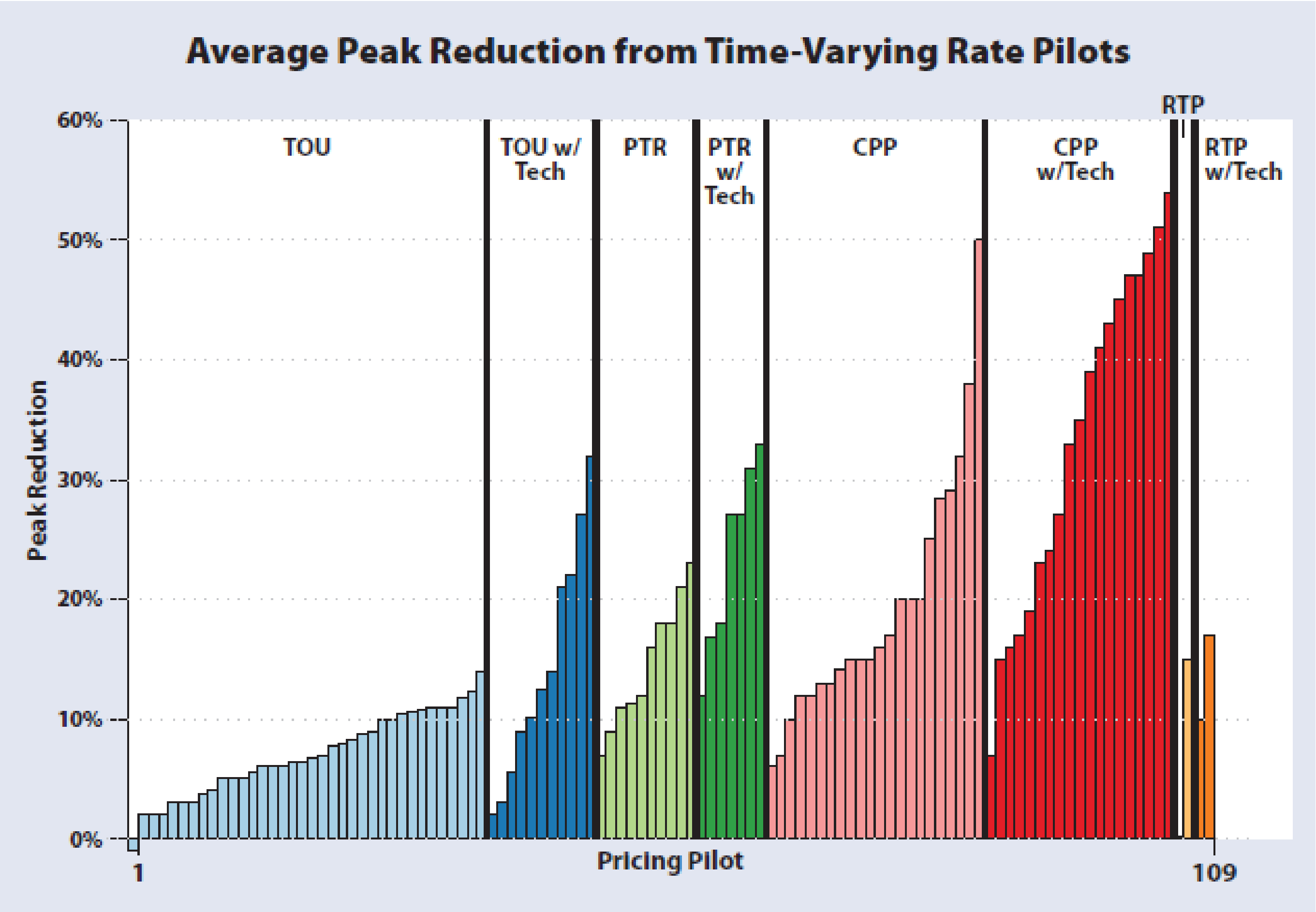


Strategy 6: Rate Design (Residential)

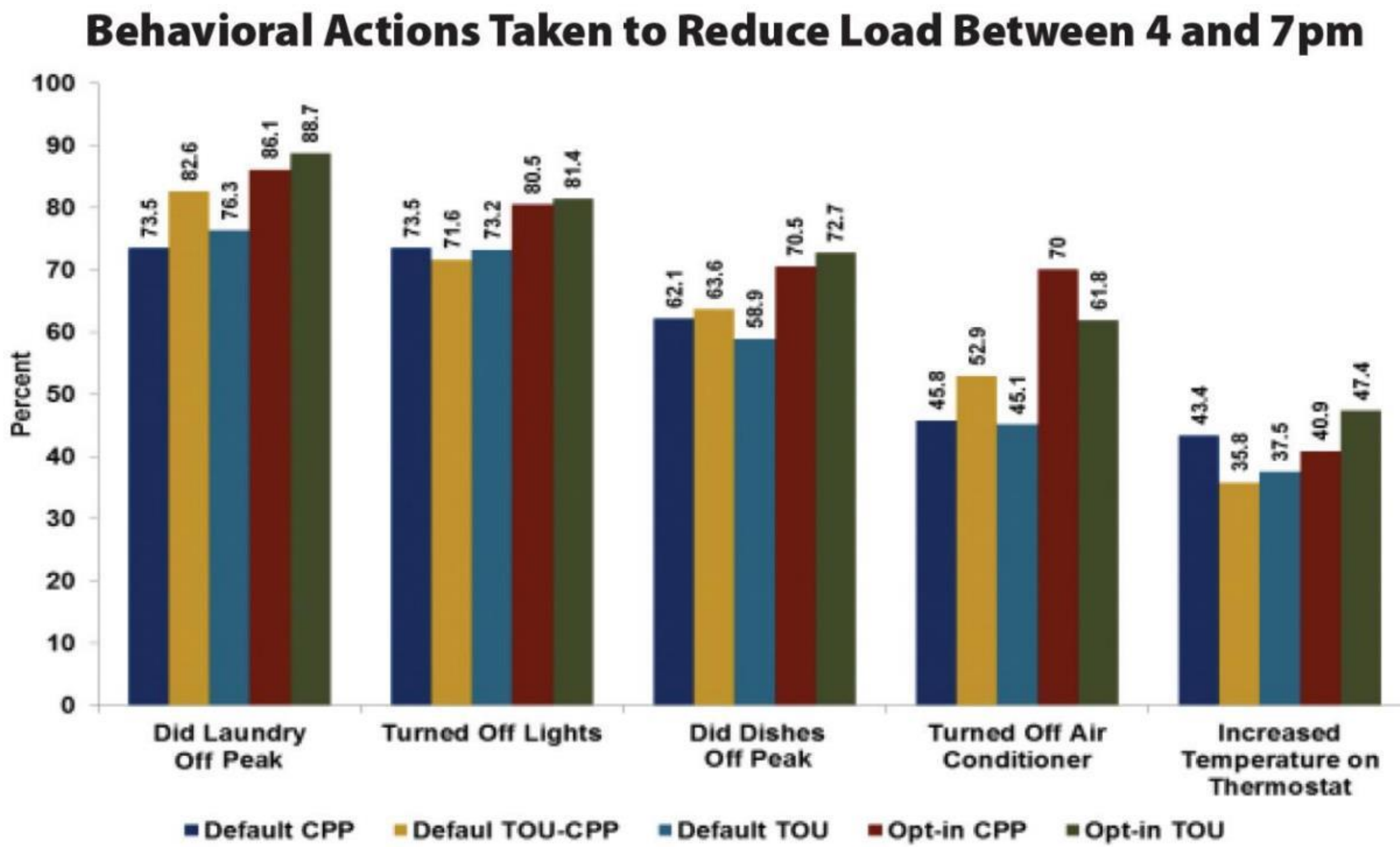
Customer-Specific Charges		
Customer Charge	$/month	$ 3.00
Transformer	$/kVA/month	$ 1.00

Bi-Directional Energy Charges		
Off-Peak	$/kWh	$ 0.08
Mid-Peak	$/kWh	$ 0.12
On-Peak	$/kWh	$ 0.18
Critical Peak	**$/kWh**	**$ 0.75**

TOU and Critical Peak Pricing Works



SMUD: Customers Actually Do Things



Energy solutions
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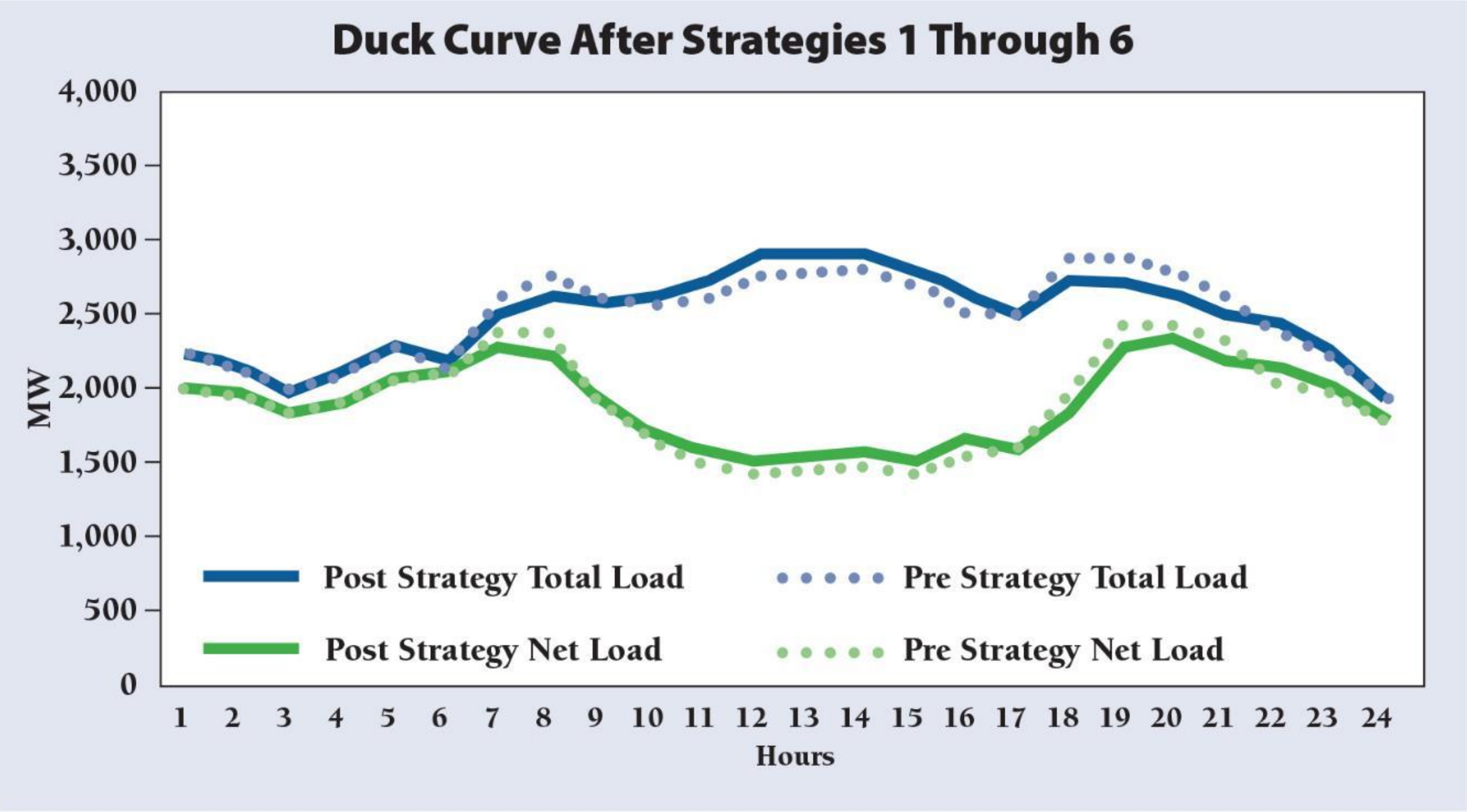
Strategy 6: Rate Design (Commercial)

Typical and Smart Rate Design Alternative for Commercial Customers

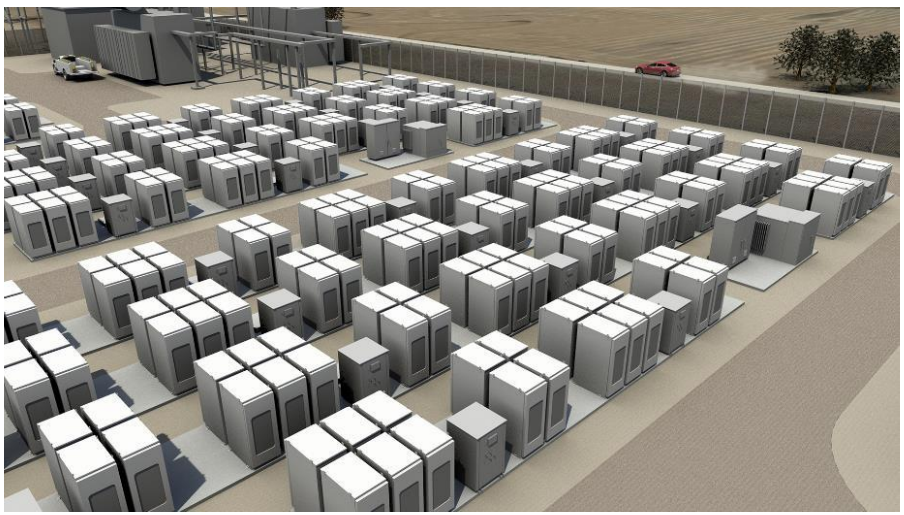
Conventional Rate Design		Smart Rate Design Alternative	
Customer Charge	$10/month	Customer Charge	$10/month
Demand	$10/kW	Demand	$2/kW
Energy		Energy	
All Hours	$0.10/kW	7-10 AM	$0.15/kW
		4-9 PM	$0.20/kW
		All Other Hours	$0.10/kW

Load After Strategy 6

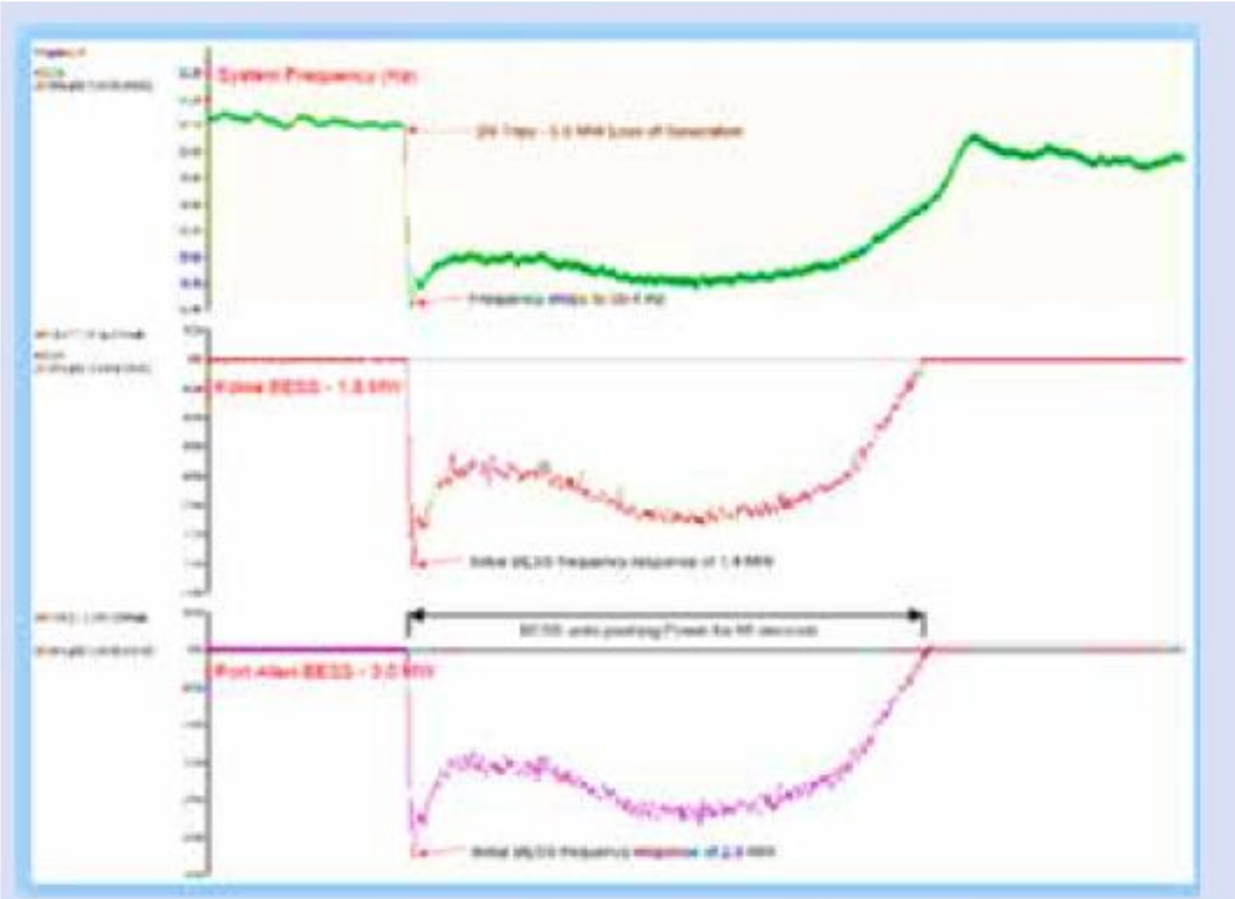


Strategy 7: Electricity Storage

Batteries Need to Do “Double-Duty” or “Triple-Duty” to be cost-effective.



Batteries Need to Do Double Duty



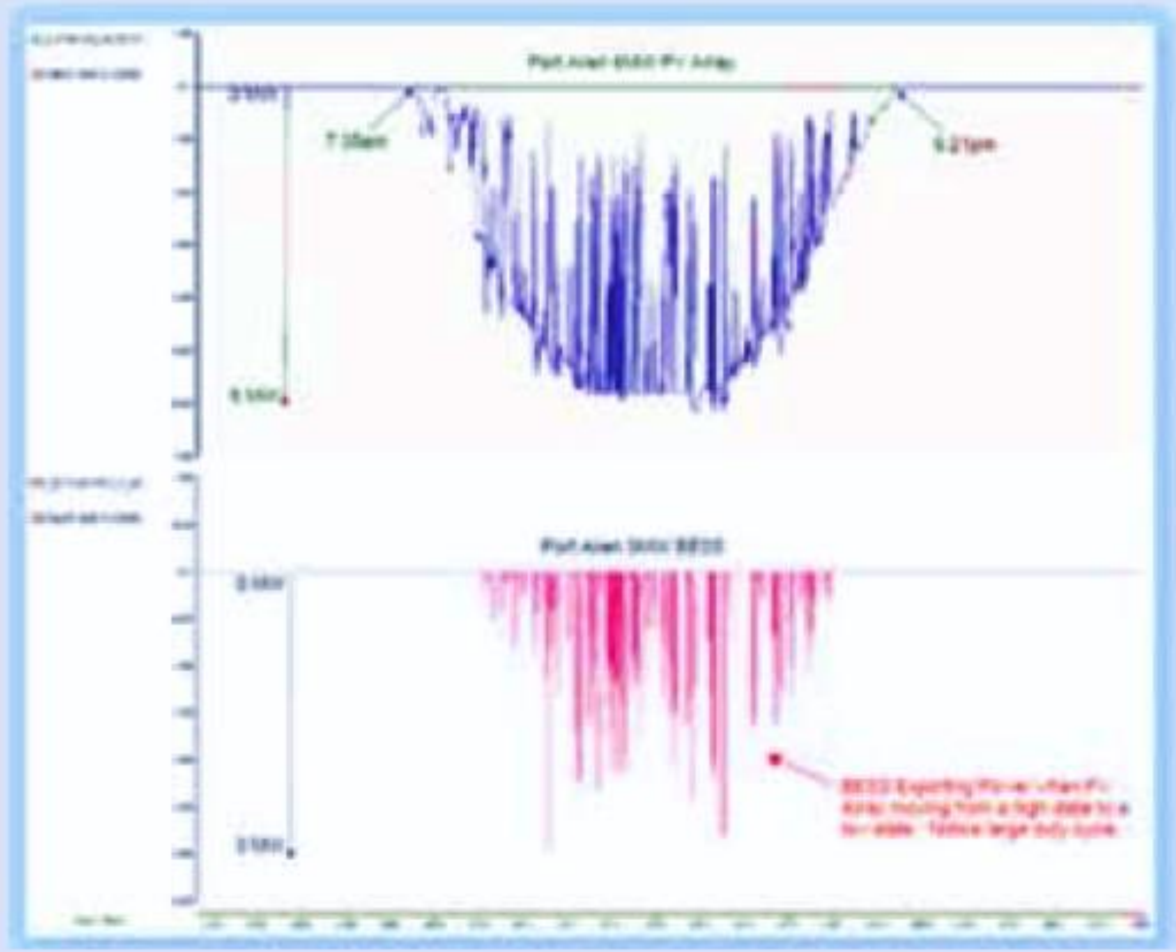
Source: Yamane, M. (2014). KIUC's Perspective.

Kauai Island Utility Coop:

Spinning Reserve

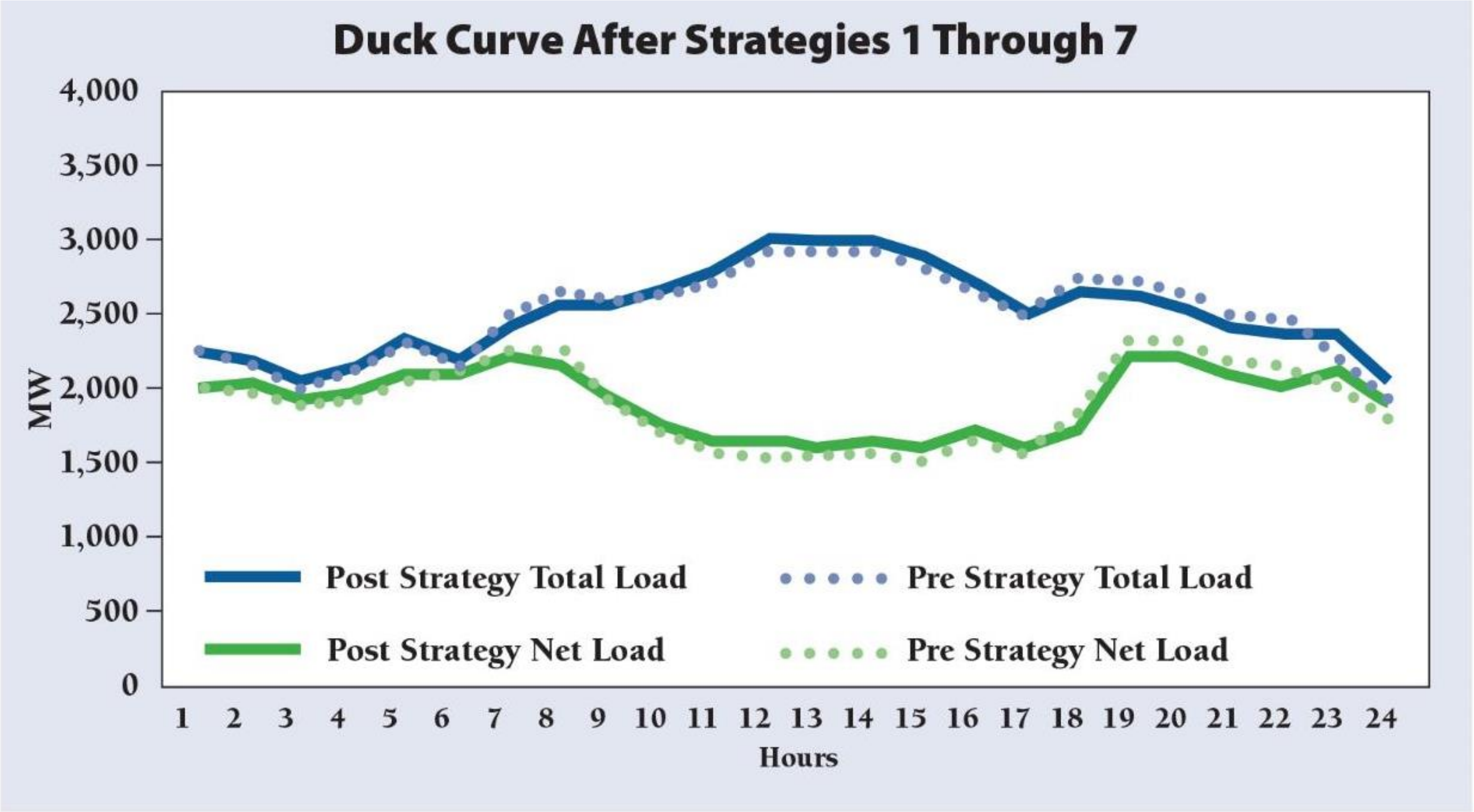
Batteries Need to Do Double Duty

Kauai Island Utility Coop: Solar Integration

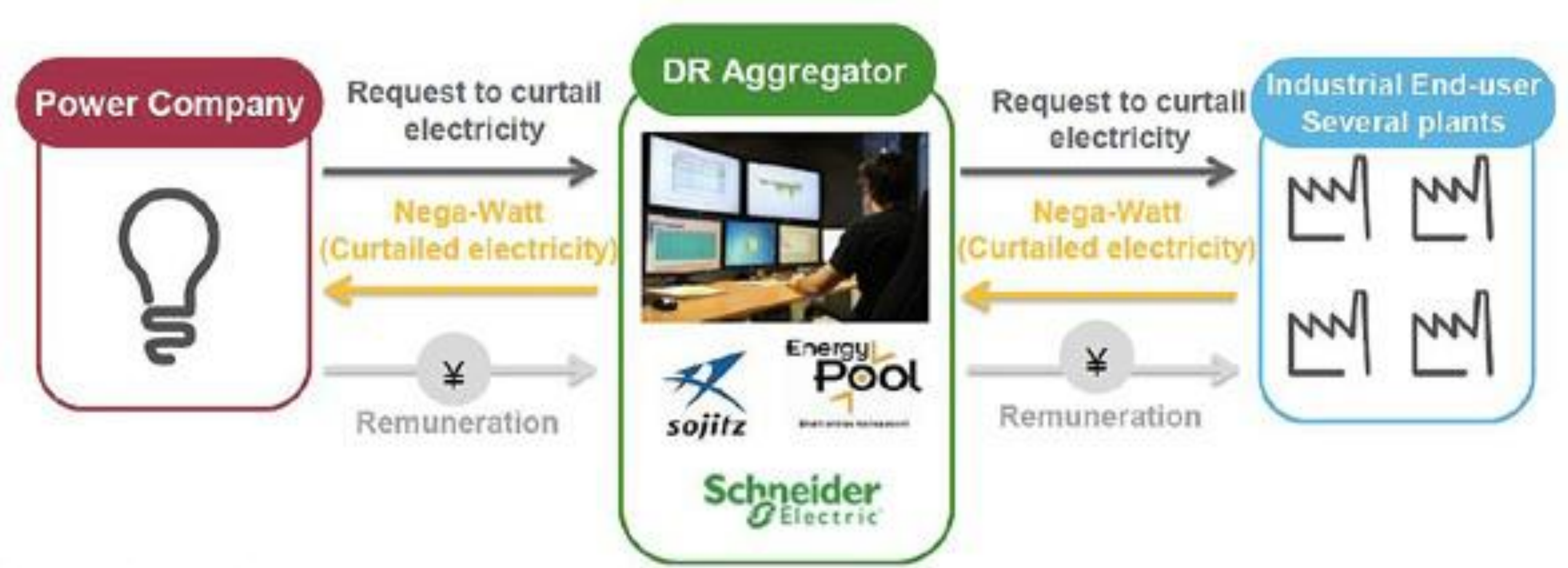


Source: Yamane, M. (2014). KIUC's Perspective.

Load After Strategy 7

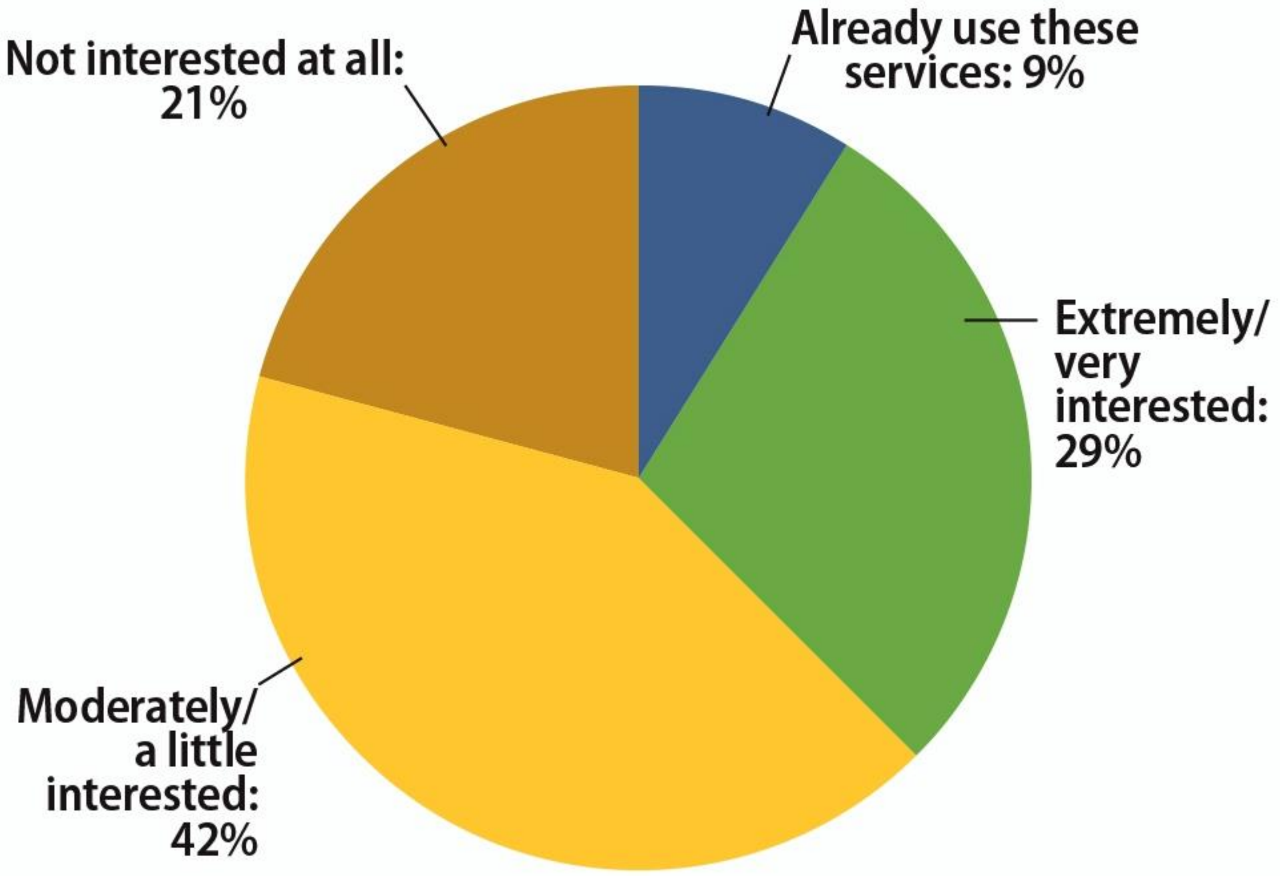


Strategy 8: Demand Response



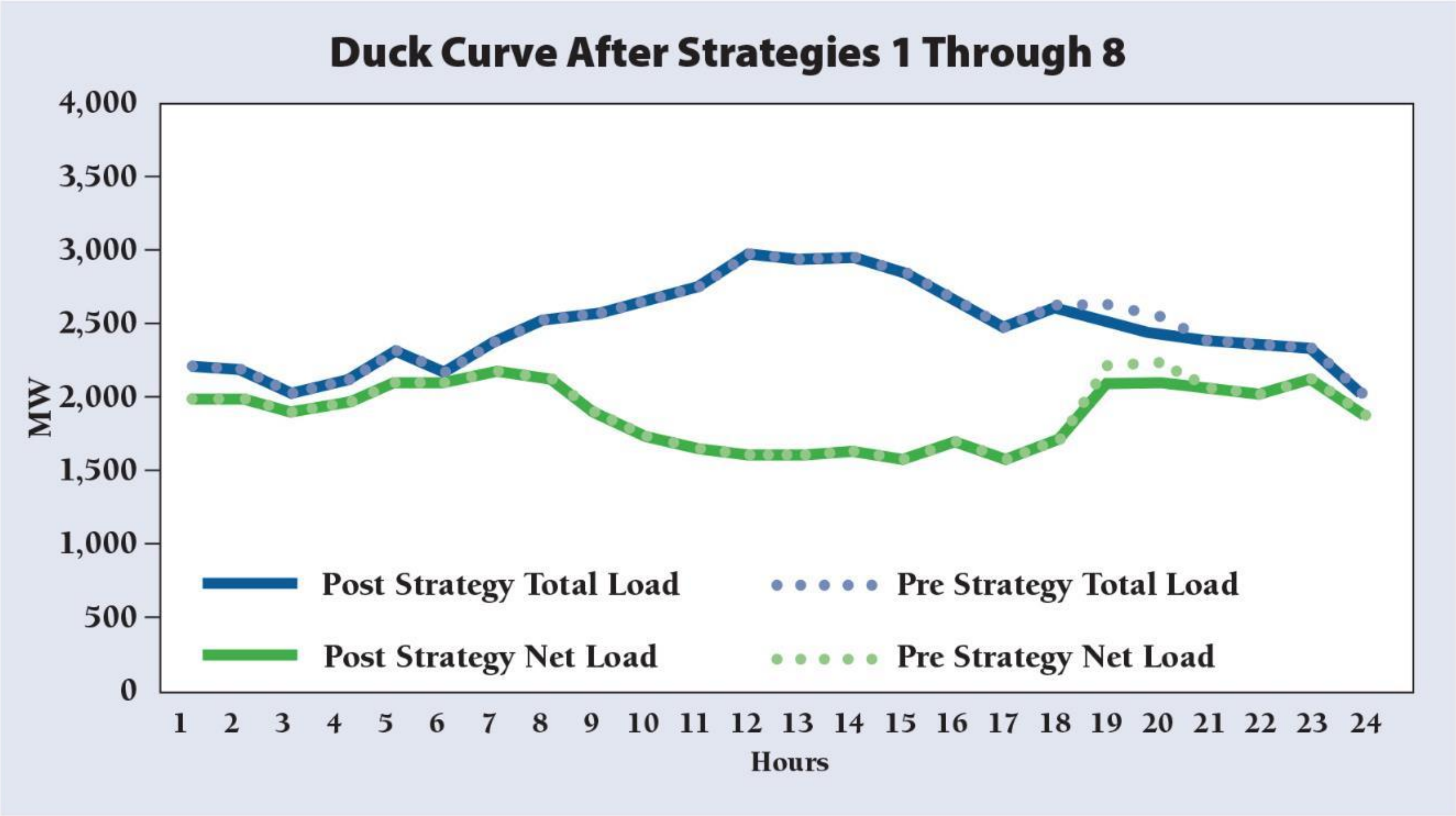
Source: Sojitz Corporation

Most Customers Will Consider DR



Source: Energy Research Council. (2013). Best Practices: Demand Response.

Load After Strategy 8



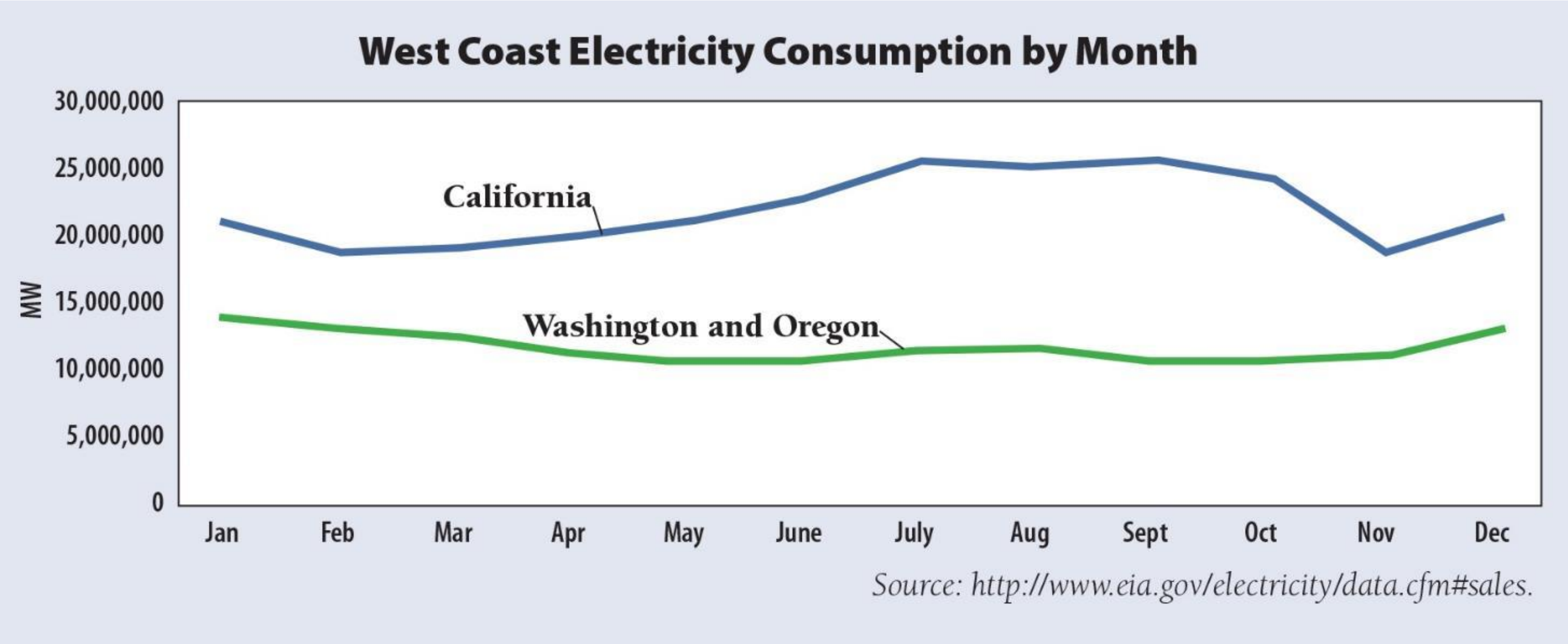
Strategy 9:
Inter-regional Power Exchange

Transmission lines mostly used for baseload connections and economy energy.

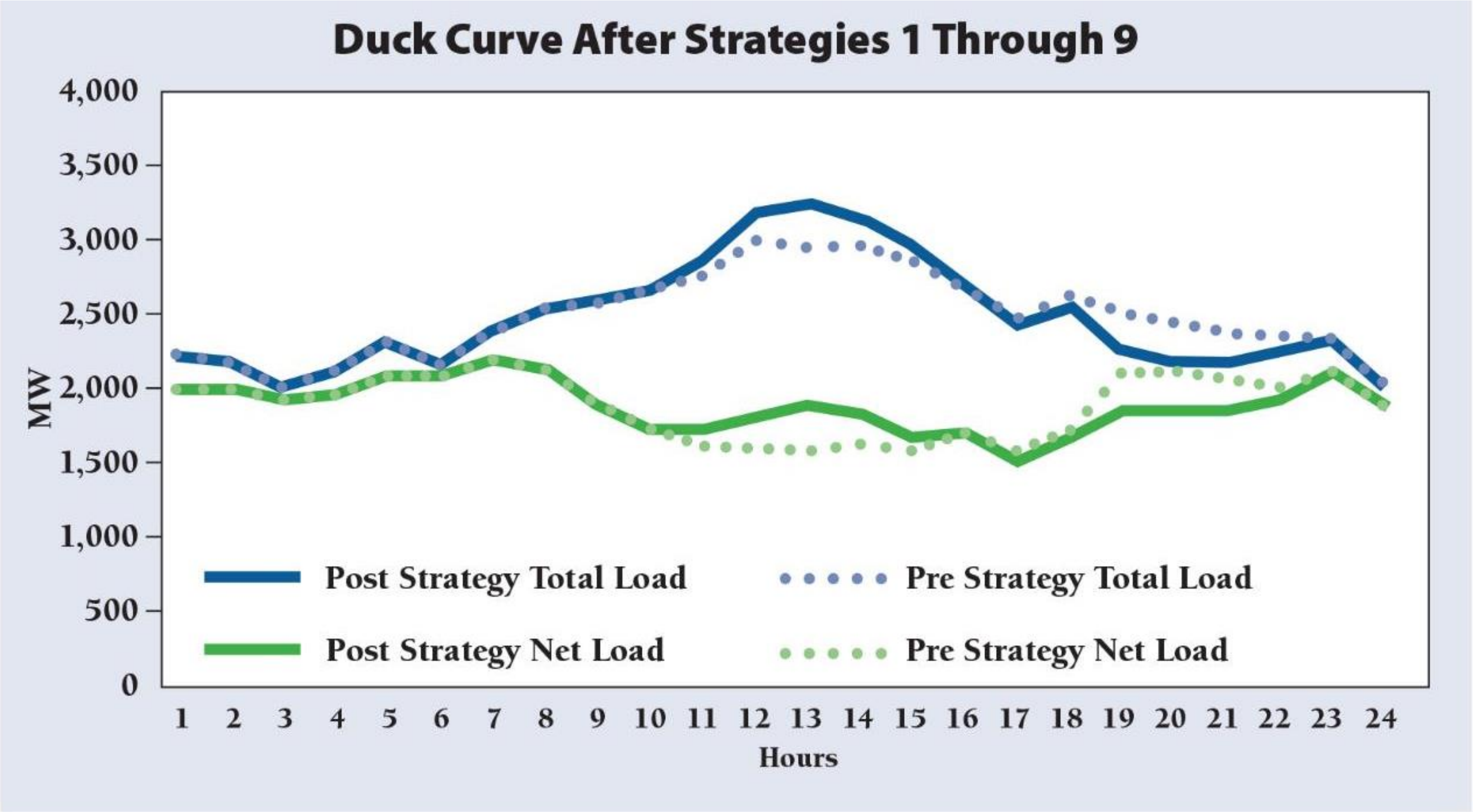
Also useful for peak diversity exchanges

Source: Los Angeles Department of Water and Power

Diversity Between Regional Peaks



Load After Strategy 9

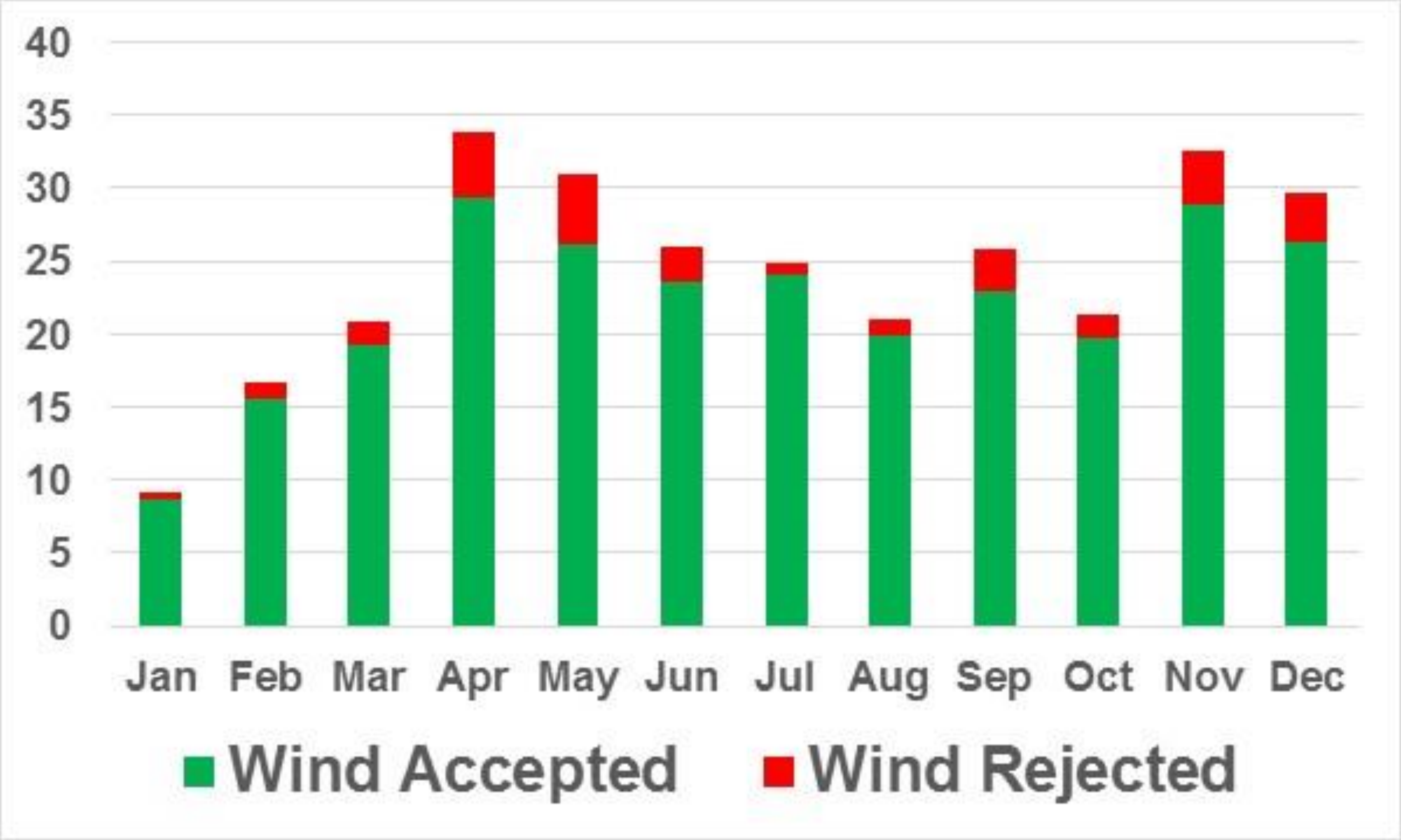


Strategy 10:
Retire Inflexible Older Generation

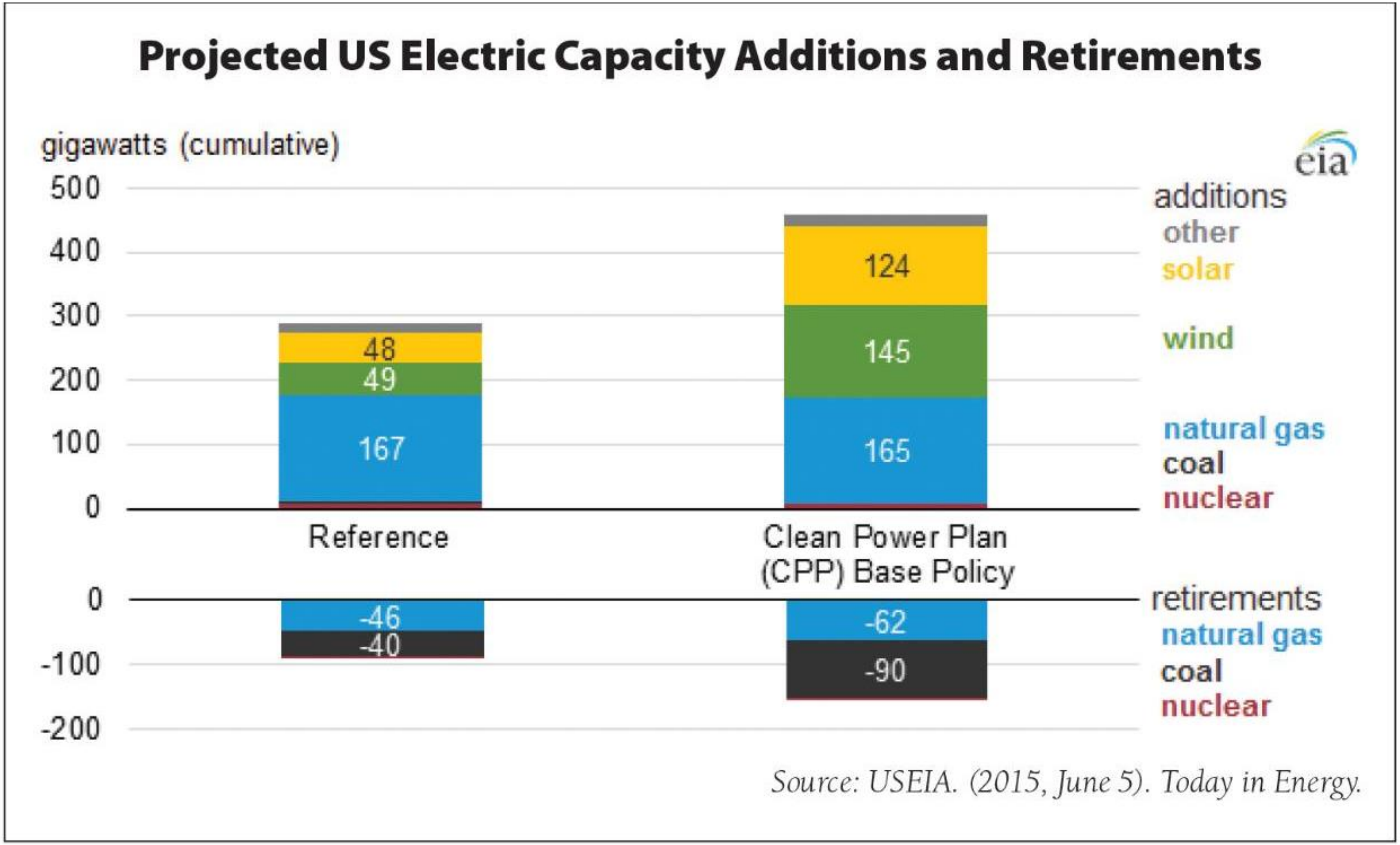
Minimum load restrictions on older power plants force utilities to run them at hours when the generation is not needed.

In some places, this forces prices to zero or negative; in others it forces curtailment of renewables.

Wind Curtailment on Maui



Many Retirements are Planned



End Result

Load Factor and Maximum Hourly Ramping Requirements Before and After the Ten Strategies				
	Total Load Without Renewables or Strategies	Net Load With Renewables and Without Strategies	New Load With Renewables and First Edition Strategies	Net Load with Renewables and Second Edition Strategies
Load Factor	73.6%	63.6%	83.3%	86.5%
Maximum Hourly Ramp	500 MW	550 MW	350 MW	198 MW
Total Difference Beween Highest and Lowest Hour	1,800 MW	2,000 MW	950 MW	660 MW

Teaching the Duck to Fly

Requesting Permission for Take-Off

Questions?

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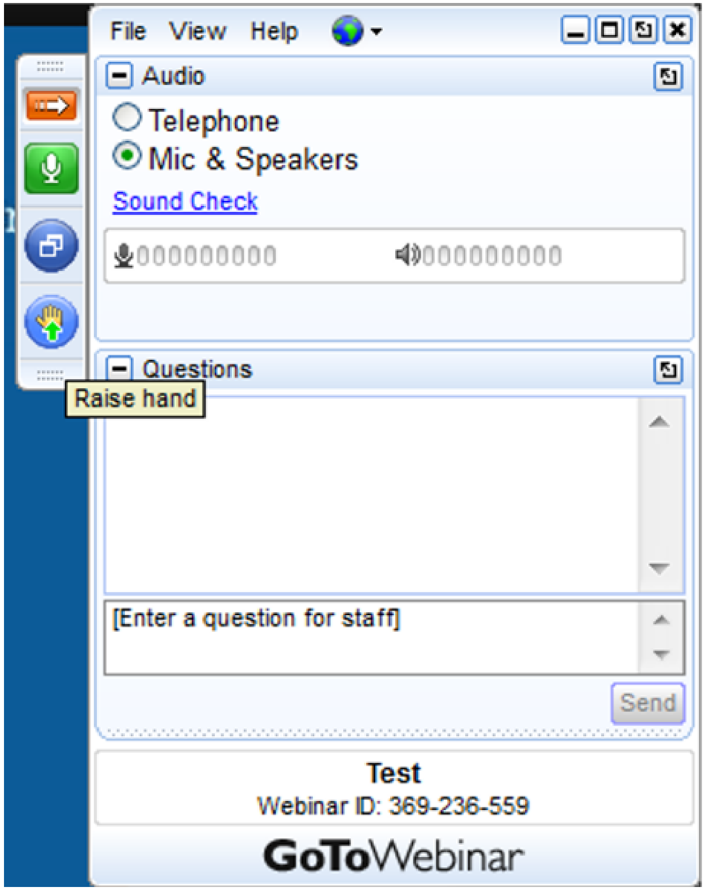

About RAP

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 sector. 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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