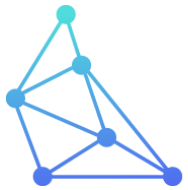
Searching for the **right** load flexibility

ESIG Load Forecasting Workshop | June 2023

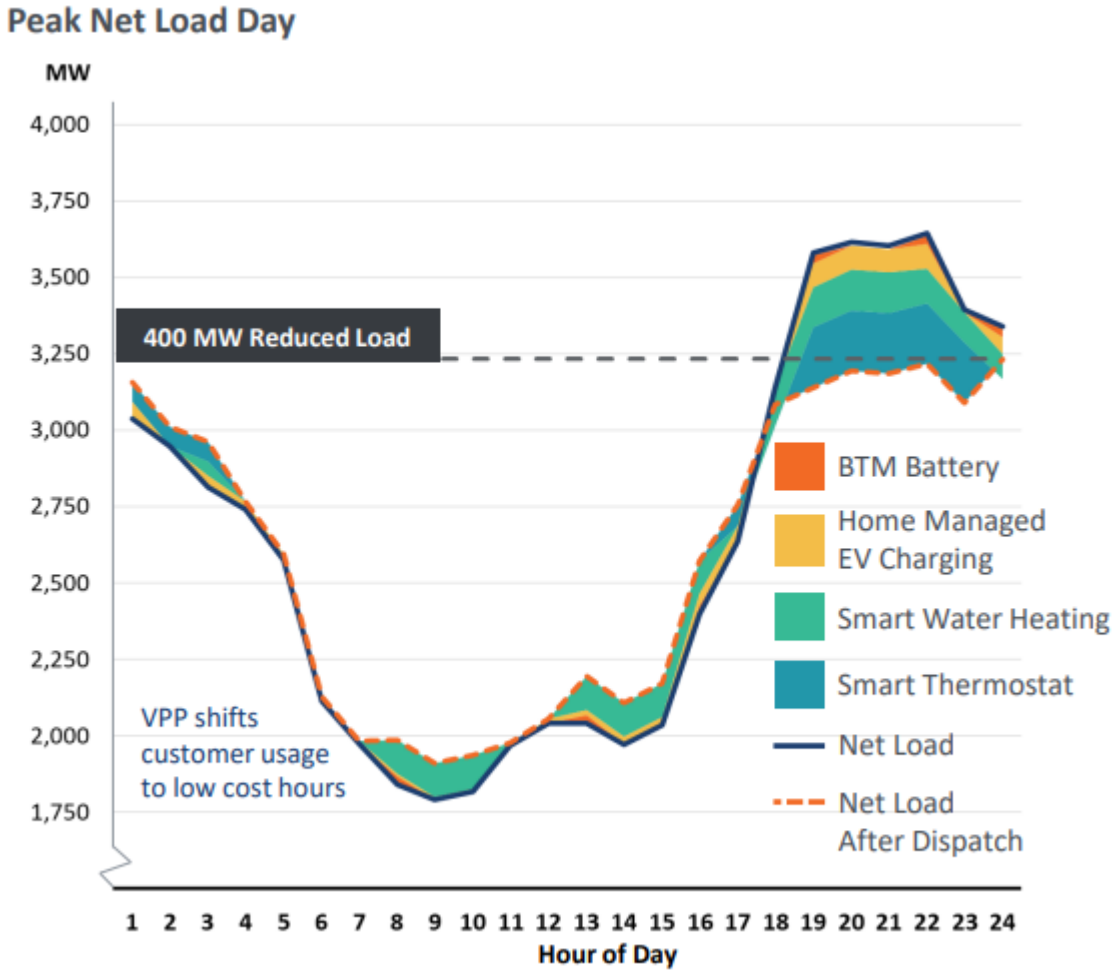


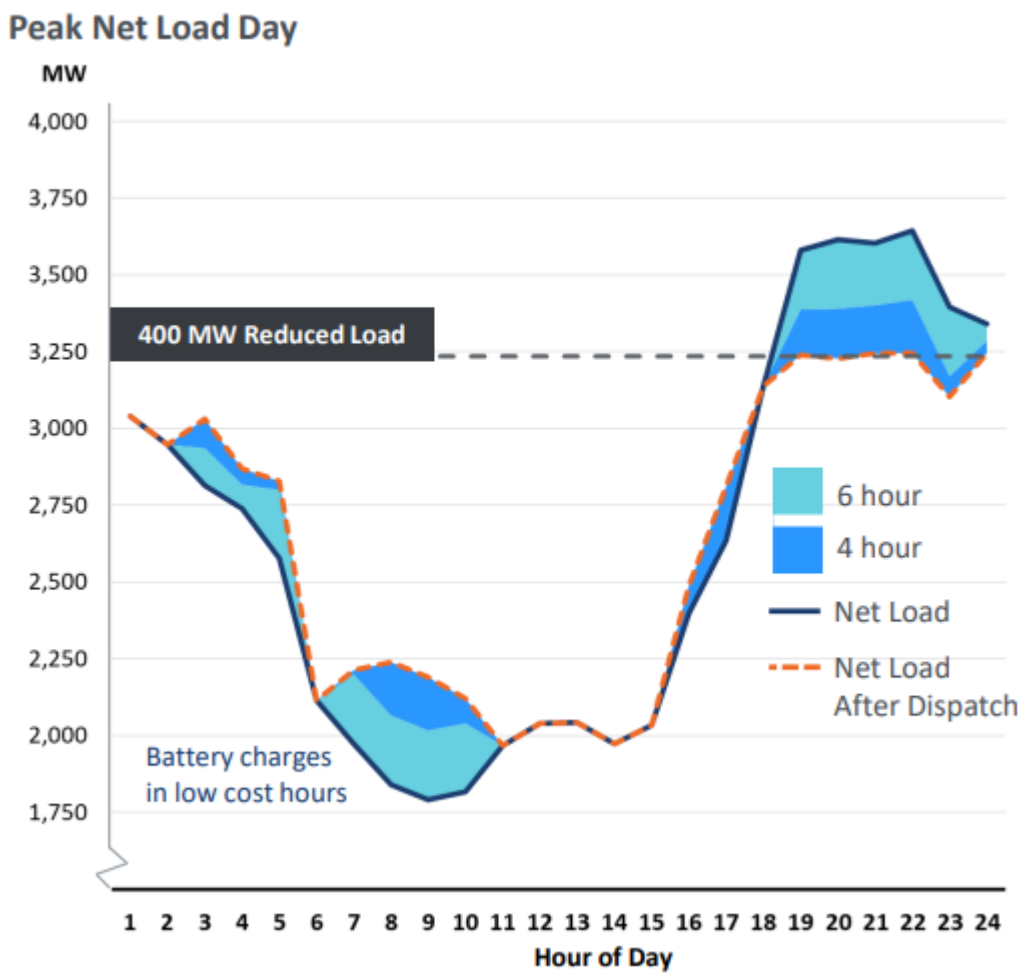
TELOS ENERGY

When we plan for load flexibility, are we looking into the future, or the rear-view mirror?

Batteries and Load Flexibility

"Energy Limited Resources" competing for similar use cases





Source: Brattle, The Value of Virtual Power, May 2023

Moonshot 100% Study

a New Mexico case study (PNM)

Source: Gridlab, The Moonshot 100% clean electricity study (forthcoming), Moment Energy Insights, Blue Marble Analytics, EFG, & Telos Energy

In a highly decarbonized system:

- Investigated value of load flexibility for the High Electrification portfolio over 100 years
- Flexible load model and parameters based on NREL Electrification Futures Study[1]

Findings

- Flexible load reduced the need for battery storage by about 600 MW and 3,500 MWh
- **Flexible load did not reduce the need for firm resources, as these provide both capacity and energy to the system**

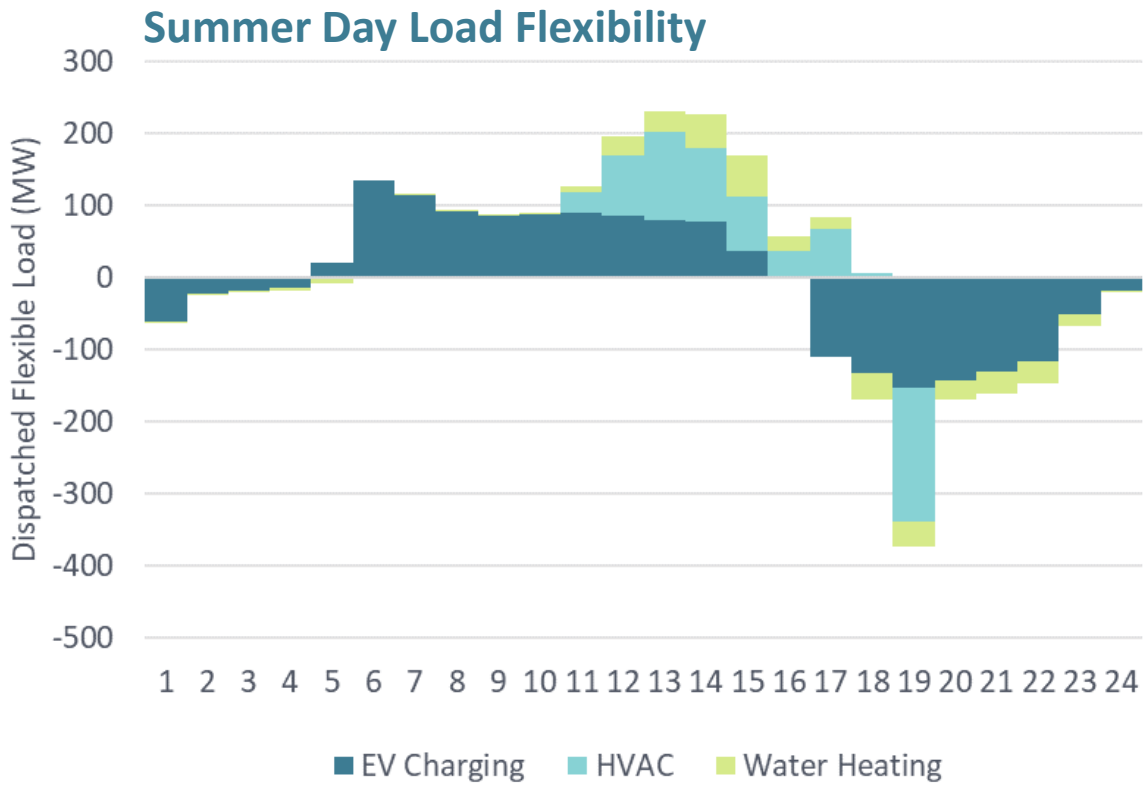
	% Flexible	Duration (hrs)	Hourly Losses[2]	Max Load (MW)
Res. HVAC	35%	1	20%	269
Res. Water Heating	35%	8	2.5%	78
Com. HVAC	34%	1	20%	80
Com. Water Heating	34%	4	2.5%	14
Light Duty Vehicles	38%	8	0%	169
		Maximum simultaneous flexible load (MW)		505

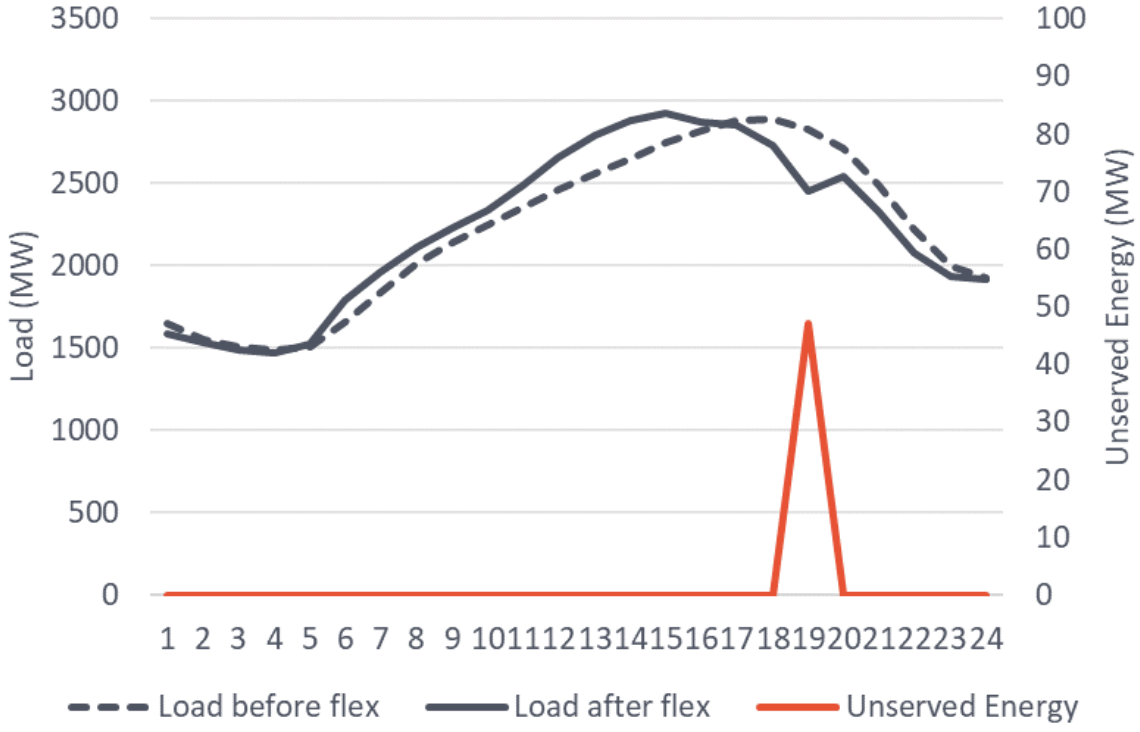
Draft Results

	Portfolio Without Flexible Load	Portfolio With Flexible Load
CT Capacity (MW)	950	950
Storage MW	**1,565**	**950**
Storage MWh (MW x duration)	**9,155**	**5,626**
LOLE (days/year)	0.07	0.10
EUE (MWh/year)	17.0	15.3

[1]https://www.nrel.gov/docs/fy20osti/73336.pdf and https://www.nrel.gov/docs/fy21osti/79094.pdf
[2]Hour-to-hour losses are estimated

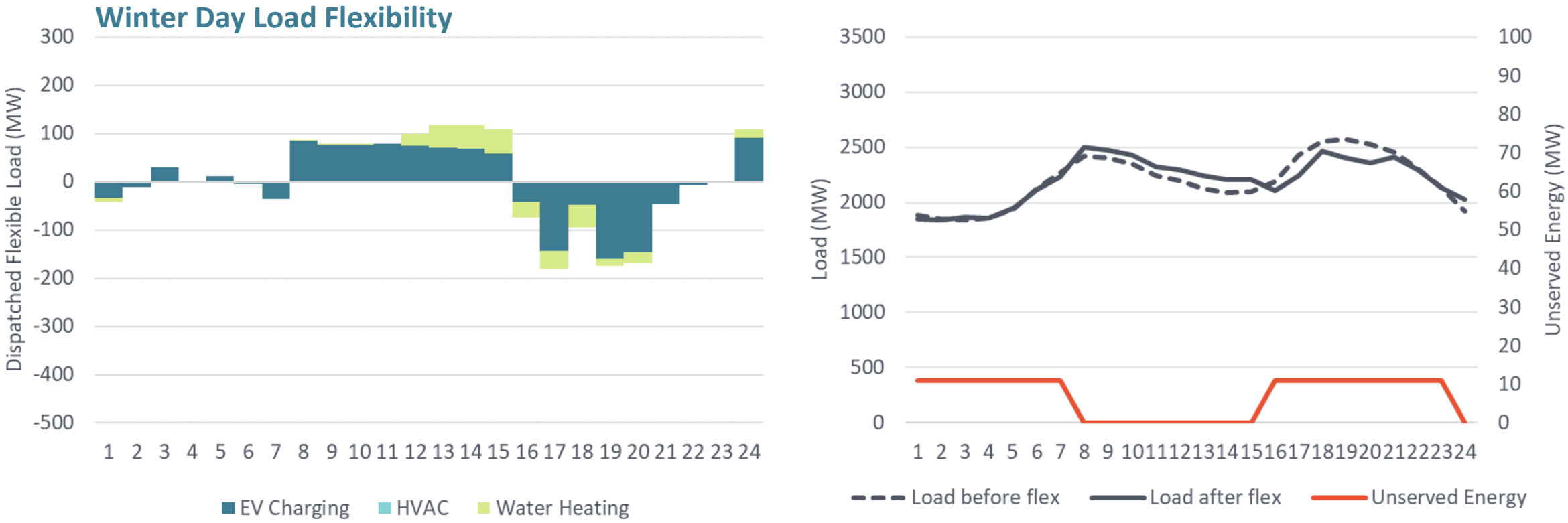
On summer days RA events, flexible loads offer a substitute for batteries by shifting demand away from brief periods of RA risk





Source: Gridlab, The Moonshot 100% clean electricity study (forthcoming), Moment Energy Insights, Blue Marble Analytics, Energy Futures Group & Telos Energy

But reliability risk is shifting to the winter…
"Winter is the new summer"



On winter days with energy shortages, daytime charging and water heating flexibility provide value, but HVAC flexibility is not utilized, likely due to losses

Source: GridLab, The Moonshot 100% clean electricity study (forthcoming), Moment Energy Insights, Blue Marble Analytics, Energy Futures Group & Telos Energy

The battery storage ship has sailed

My crystal ball …

Storage deployments will outpace load flexibility and saturate benefits from reduced peak demand and flexibility needs

Even if load flexibility is cheaper and makes more sense, battery storage won…

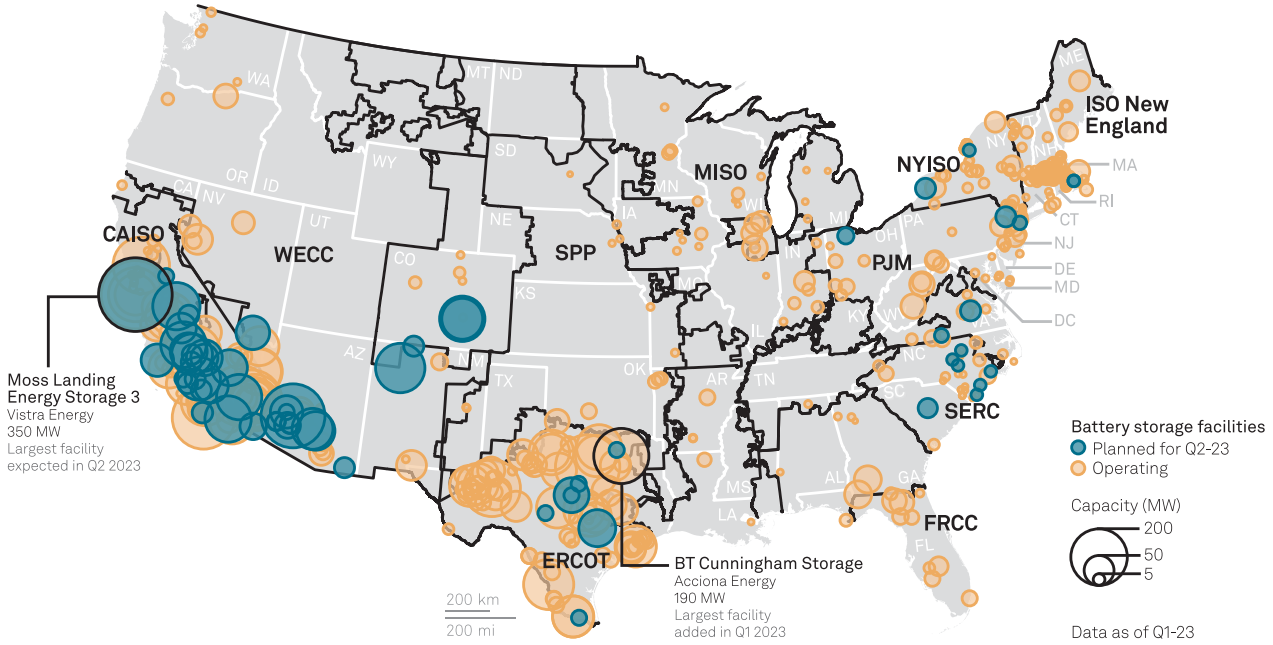
- ✓ Being built for multiple use cases (i.e. solar)
- ✓ Technological maturity
- ✓ Faster to deploy and interconnect at scale
- ✓ Easier to finance
- ✓ Transparent costs and performance

Storage deployments are growing rapidly with no end in sight

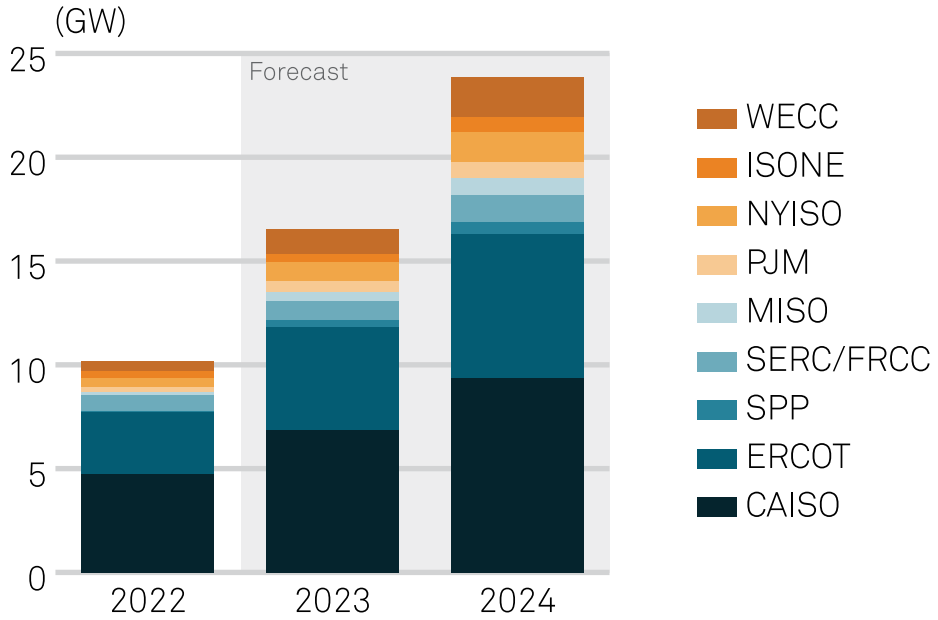
52% YoY growth, despite supply chain and without IRA

Top regional changes (% of total additions)

Q1-23 additions		Q2-23 planned additions	
ERCOT	WECC	CAISO	WECC
70.2%	16.2%	51.1%	37.8%

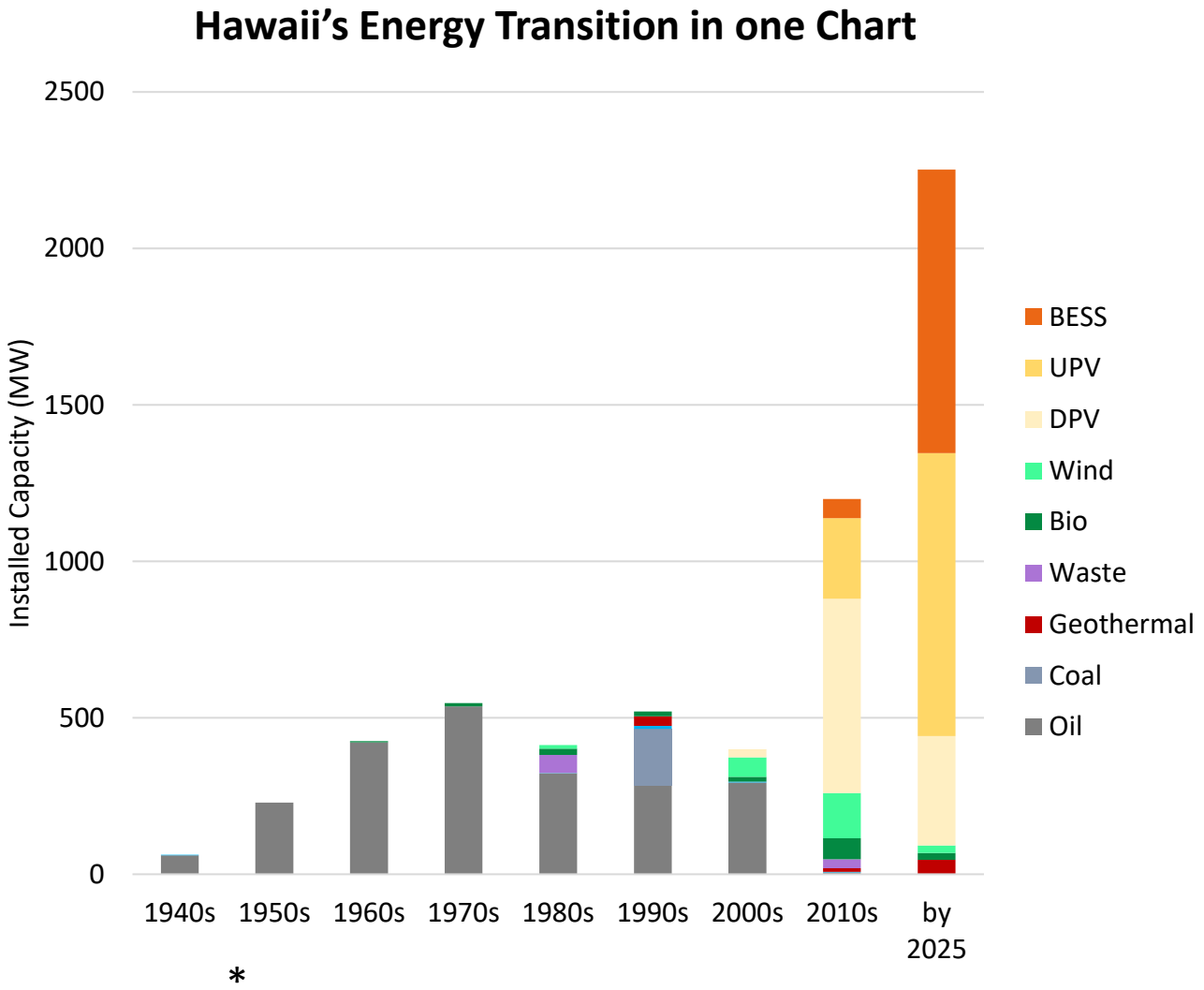


US annual battery storage capacity changes



Source: S&P Global Commodity Insights, Credit Kassia Micek

Hawaii as a Case Study



Oahu by the numbers

- 70% of Hawaii load
- ~1100 evening peak demand
- 600 MW of battery storage (soon*)
  *operating/under construction/awarded (totals subject to change due to project cancellations)
- Current procurement under way for an additional 400+ MW of solar+storage

New Time of Use Rate

- Planning for a default TOU rate
- 3:2:1 price ratio, Peak:Overnight:Mid-Day
  … 60cents, 40cents, 20cents
- Plus, a "battery bonus program" for BTM Storage

System becomes *energy constrained,*
and reliability risk is spread over an entire day

Last Year's Resource Adequacy Risk was in the afternoon hours

Percent of total loss of load hours

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	Total
1										1%			1%
2													
3													
4													
5													
6													
7										1%			1%
8													
9													
10								1%					1%
11						1%		1%	1%				2%
12								1%					1%
13													
14													
15													
16													
17										1%			1%
18									1%	2%	1%		3%
19	1%	1%	1%	1%	1%	1%			5%	6%	3%	1%	20%
20	1%	1%	1%	1%	2%	2%	2%	10%	7%	5%	2%	1%	33%
21		1%	1%	1%	1%	2%	2%	5%	5%	4%	1%		23%
22			1%	1%	1%	1%	1%	4%	2%	3%			12%
23					1%			1%	1%	1%			3%
24					1%				1%				1%
Total	1%	3%	2%	4%	5%	5%	5%	21%	23%	24%	6%	2%	100%

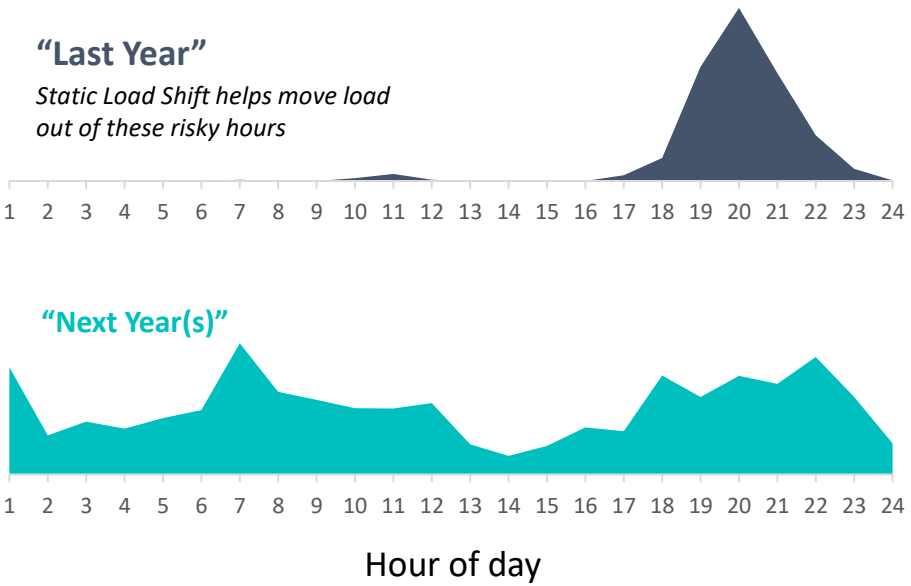
Static Load Shift helps move load out of these risky hours

Next Year's Resource Adequacy risk is diversified across all hours (days)

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	Total
1		1%			1%			0%	2%	2%	1%	0%	9%
2		0%			1%			0%	1%	2%	0%		5%
3		0%			1%				1%	1%	0%		4%
4		0%			1%				1%	1%	0%		4%
5		0%			1%			0%	1%	2%	0%		5%
6					1%				2%	2%	1%		5%
7		0%			1%			0%	3%	2%	1%	0%	9%
8		0%			0%			1%	1%	0%	1%	1%	5%
9		0%			0%			0%	1%		1%	1%	4%
10		0%						0%	1%		1%	0%	3%
11		1%						0%	1%		0%	0%	3%
12								0%	1%	0%	0%	1%	3%
13									0%		0%	0%	1%
14									0%		1%		1%
15					0%				0%		1%		2%
16		0%			0%			1%	1%		1%		4%
17					1%			0%	0%	0%	1%	0%	3%
18					1%			1%	2%	0%	1%	0%	6%
19		1%			0%			1%	0%	1%	1%	0%	5%
20		0%						1%	2%	0%	0%		4%
21		1%			1%			1%	0%	1%	1%	0%	5%
22		1%							2%		1%	0%	4%
23					1%			0%	1%	2%	1%	0%	5%
24									1%			1%	2%
Total		9%			13%			9%	27%	17%	17%	8%	100%

→ **peak load reduction is less effective**

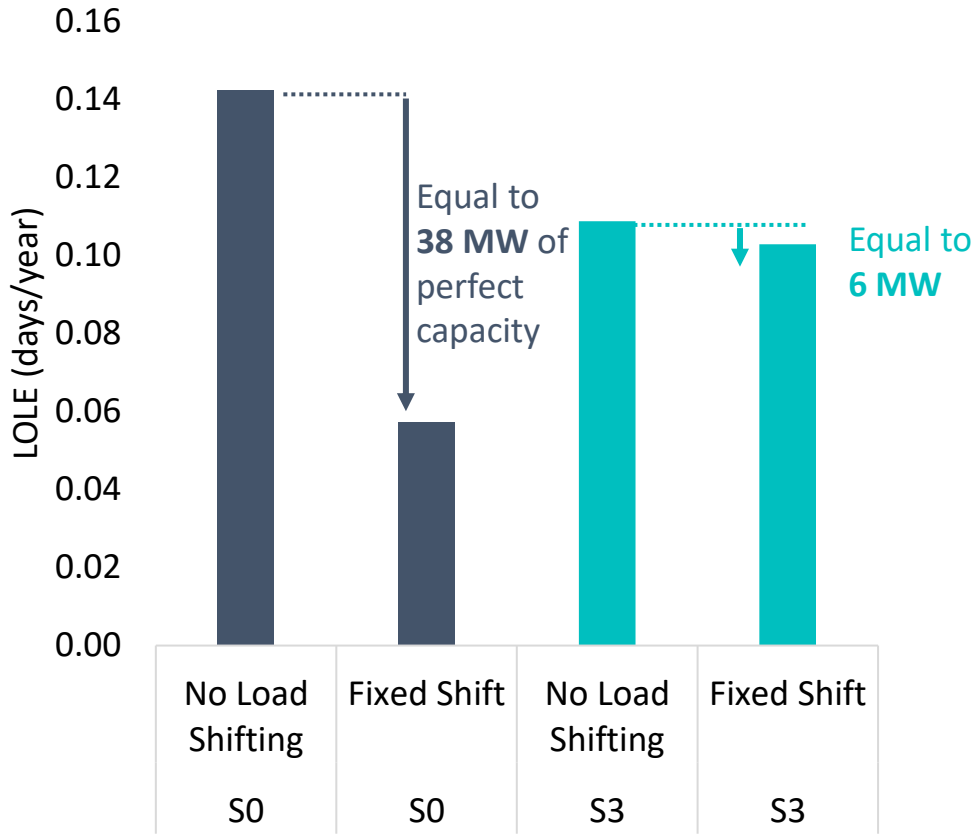
Average unserved energy by hour of day



Source: Hawaii Natural Energy Institute, Telos Energy, Hawaii Benefits of Load Flexibility & Time of Use Rates (forthcoming)

Measuring resource adequacy benefits of load shifting & time of use Rates

- Sequential, 8760-hourly resource adequacy analysis used to quantify loss of load probability
- Each scenario was brought to the reliability criteria (0.1 days/year) through retirements *before* adding load shifting so we can appropriately measure capacity benefits
- A 20% TOU Load Shift = 94 MW of contribution to the peak hours,
- Based on aggregating thousands of AMI customer loads

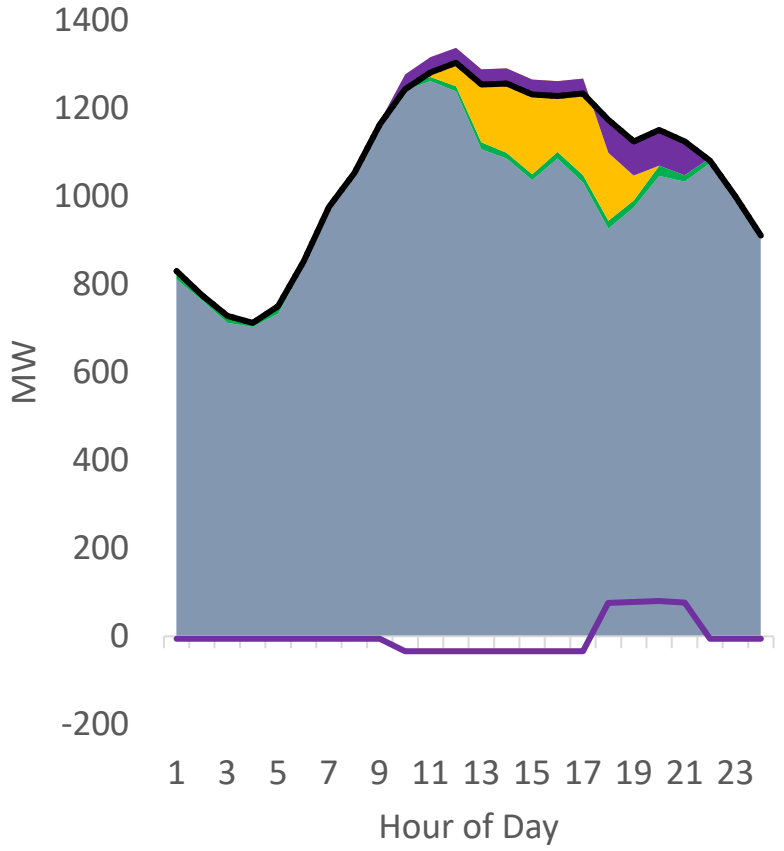


Source: Hawaii Natural Energy Institute, Telos Energy, Hawaii Benefits of Load Flexibility & Time of Use Rates (forthcoming)

Why does load shifting become less effective?

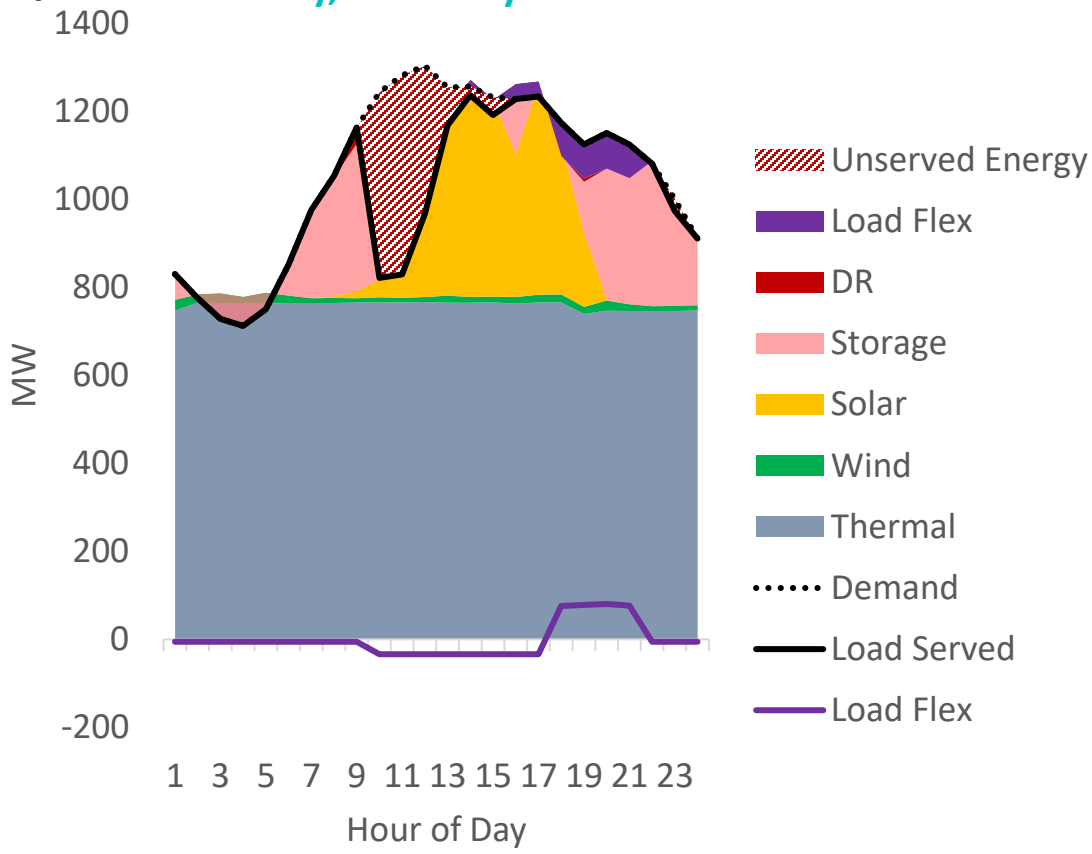
Last Year's Low Solar Days

Still available thermal capacity to cover low solar events with increased load mid-day



Nex Year's – Low Solar Days

Load Shift doesn't help overall
This day, it actively hurts at 11am



In high solar+storage scenario:

1. Battery storage already saturated evening peak reduction
2. Risk shifts to low solar periods, when adding load mid-day could actually hurt

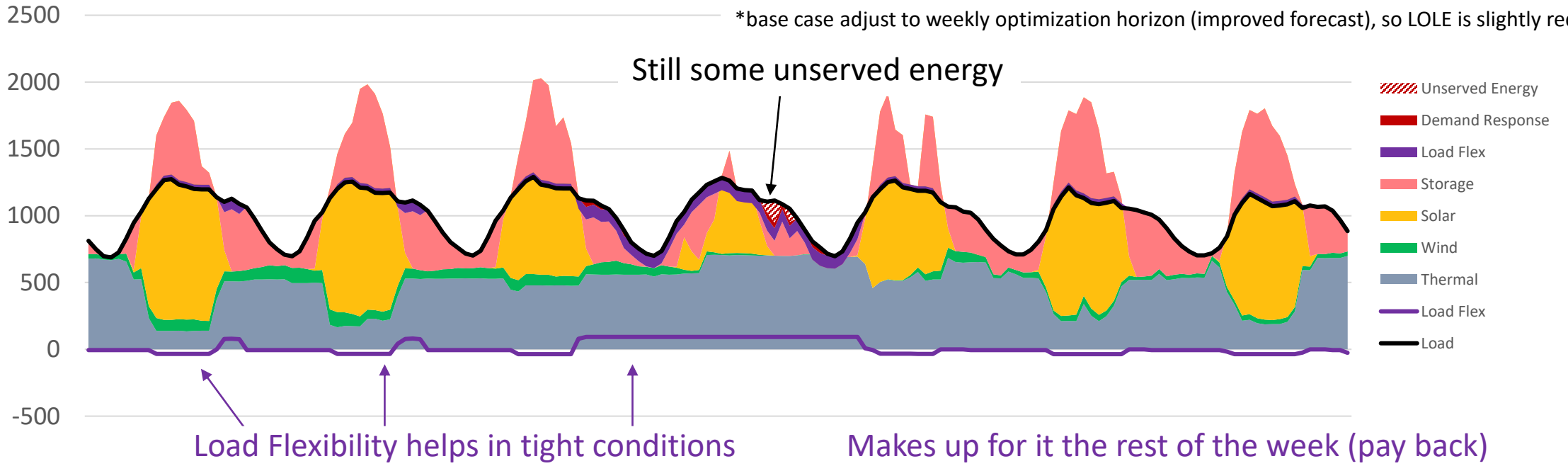
Source: Hawaii Natural Energy Institute, Telos Energy, Hawaii Benefits of Load Flexibility & Time of Use Rates (forthcoming)

Opportunities for multi-day load flexibility?

If we're able to **flexibly shift load across the week**, we see significantly improved reliability around low solar days.

Case	LOLE (days/year)	EUE (MWh/year)
Base Case (no load flex)*	0.08	42
Static Daily Load Shifting	0.06 (-30%)	34 (-19%)
Weekly Load Flexibility	0.004 (-95%)	2.3 (-95%)

*base case adjust to weekly optimization horizon (improved forecast), so LOLE is slightly reduced

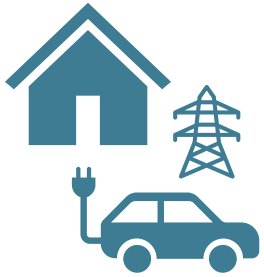


Source: Hawaii Natural Energy Institute, Telos Energy, Hawaii Benefits of Load Flexibility & Time of Use Rates (forthcoming)

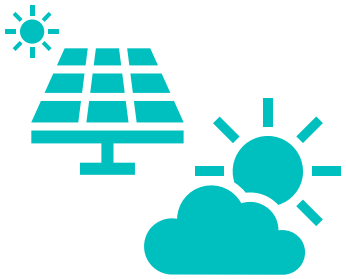
Searching for the right load flexibility

If we no longer need peak shaving or real-time flexibility (ancillary services & ramping) what should we be planning for in the future?

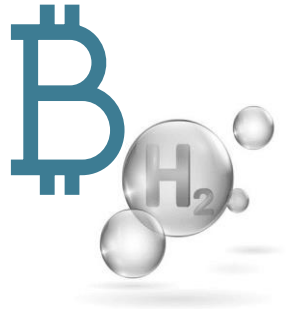
Don't forget about energy efficiency



Load flexibility can defer circuit-level and distribution constraints



Multi-day load shift to reduce loads on cloudy days
TOU/RTP → Cloudy day rates



Large flexible Loads change the game…
Reduce load during low wind/solar events and build out grid remainder of year

Thank You!

Questions?

Derek Stenclik
derek.stenclik@telos.energy
Telos Energy

TELOS ENERGY