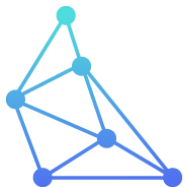


Searching for the **right** load flexibility

ESIG Load Forecasting Workshop | June 2023



T E L O S E N E R G Y

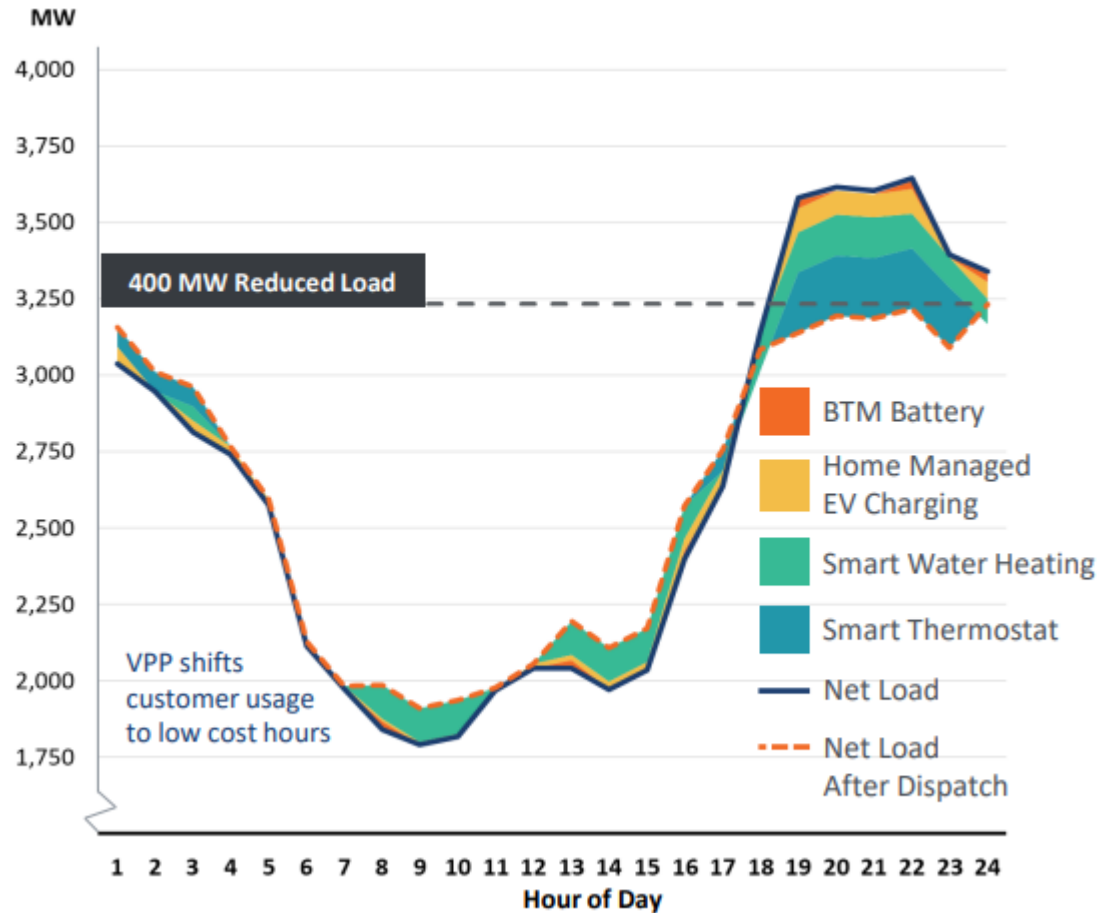
When we plan for load flexibility, are we looking into the future, or the rear-view mirror?



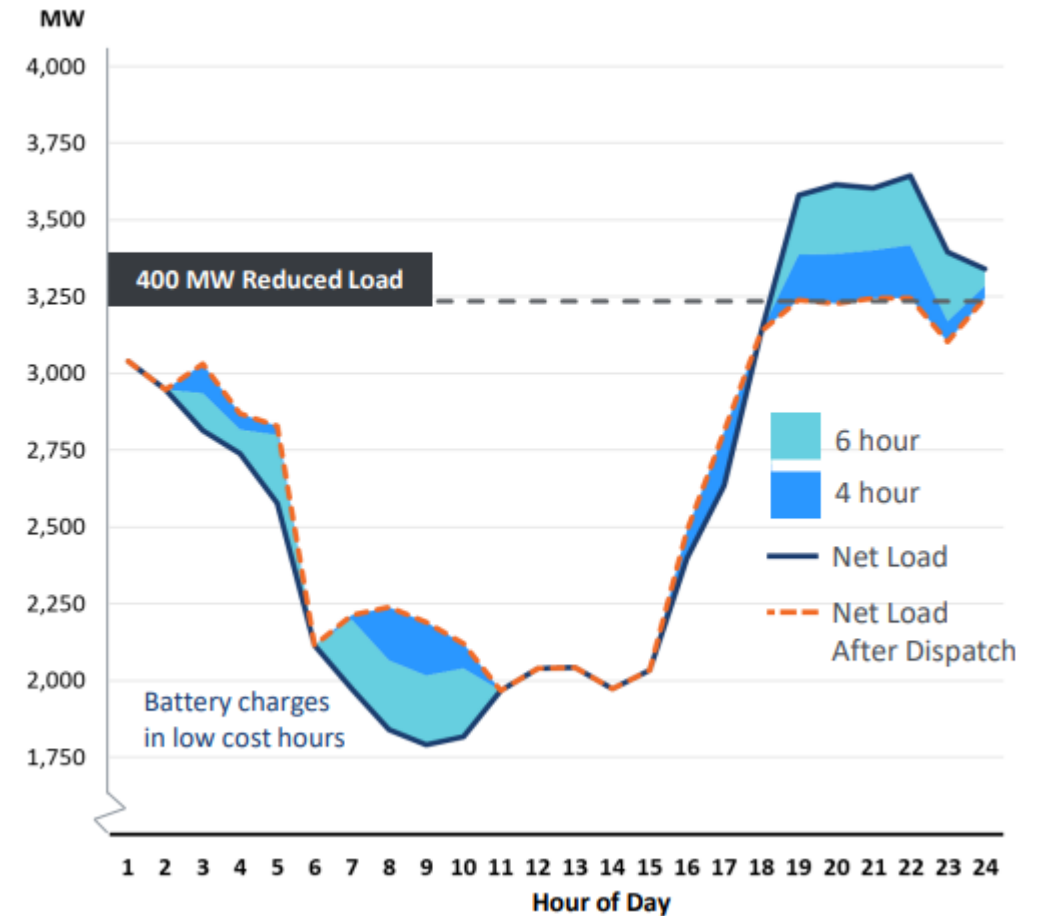
Batteries and Load Flexibility

“Energy Limited Resources” competing for similar use cases

Peak Net Load Day



Peak Net Load Day



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 Study¹

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

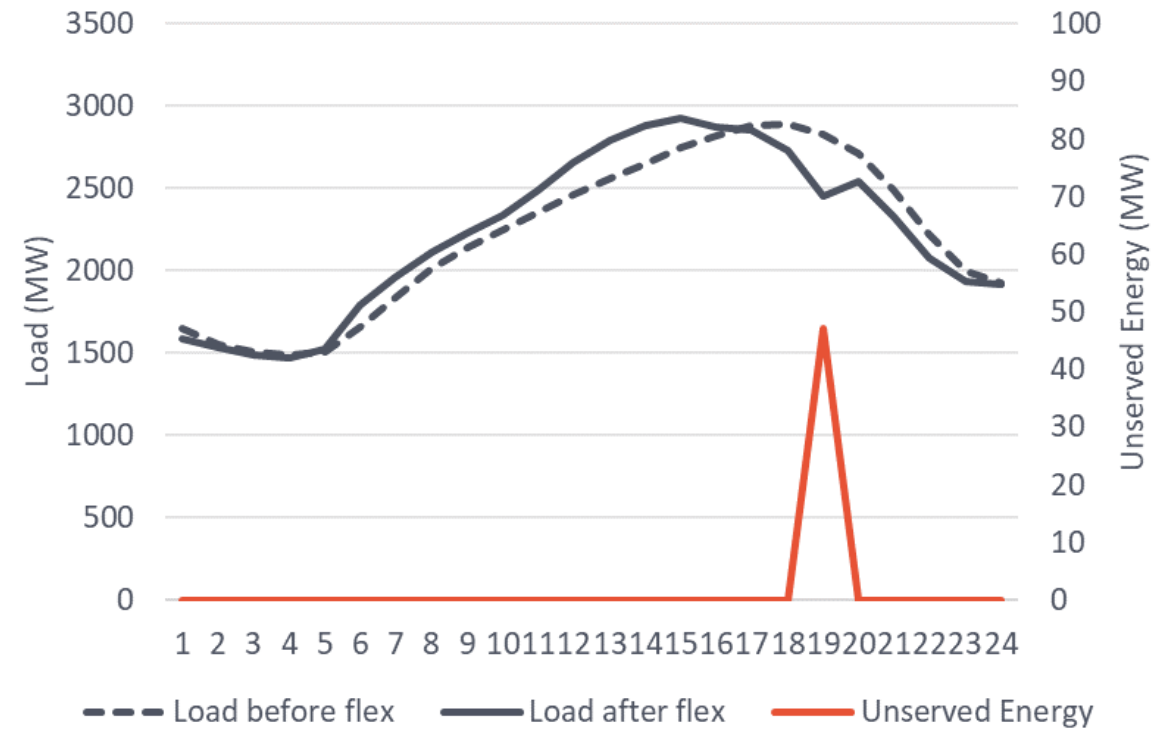
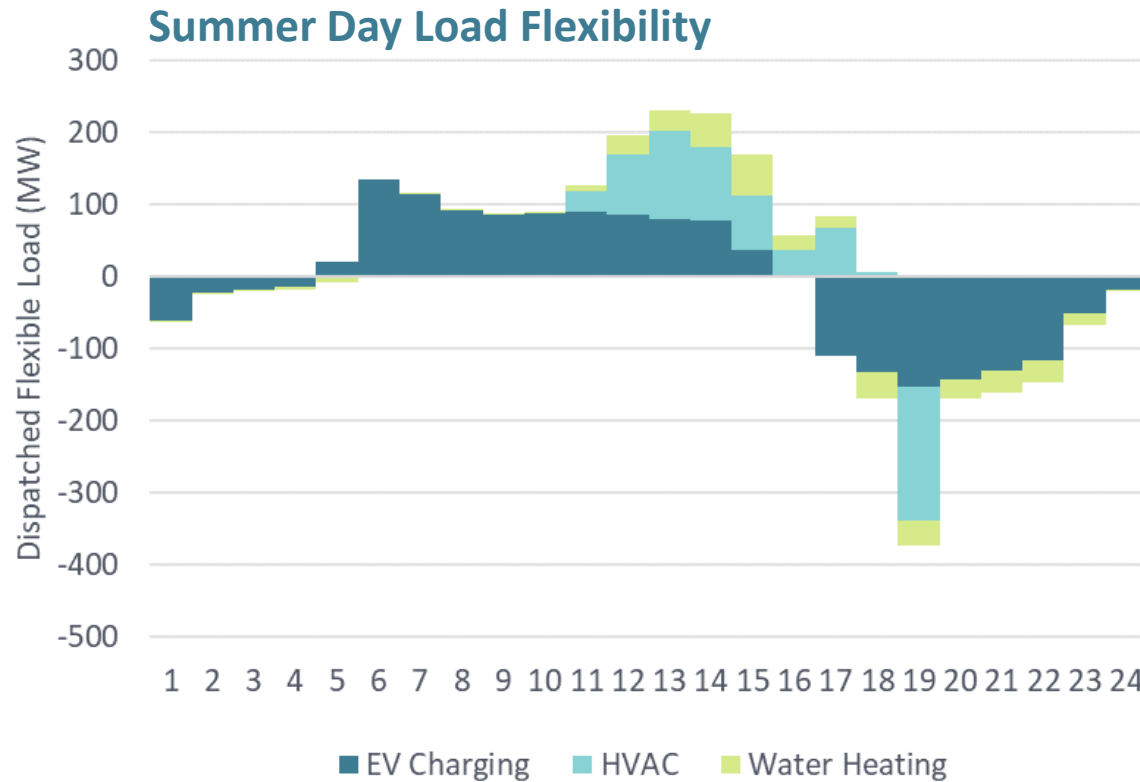
	Portfolio Without Flexible Load	Portfolio With Flexible Load
CT Capacity (MW)	950	950
Storage MW	1,565	950
Storage MWh (MW x duration)	9,155	5,626
LOLE (days/year)	0.07	0.10
EUE (MWh/year)	17.0	15.3

¹<https://www.nrel.gov/docs/fy20osti/73336.pdf> and <https://www.nrel.gov/docs/fy21osti/79094.pdf>

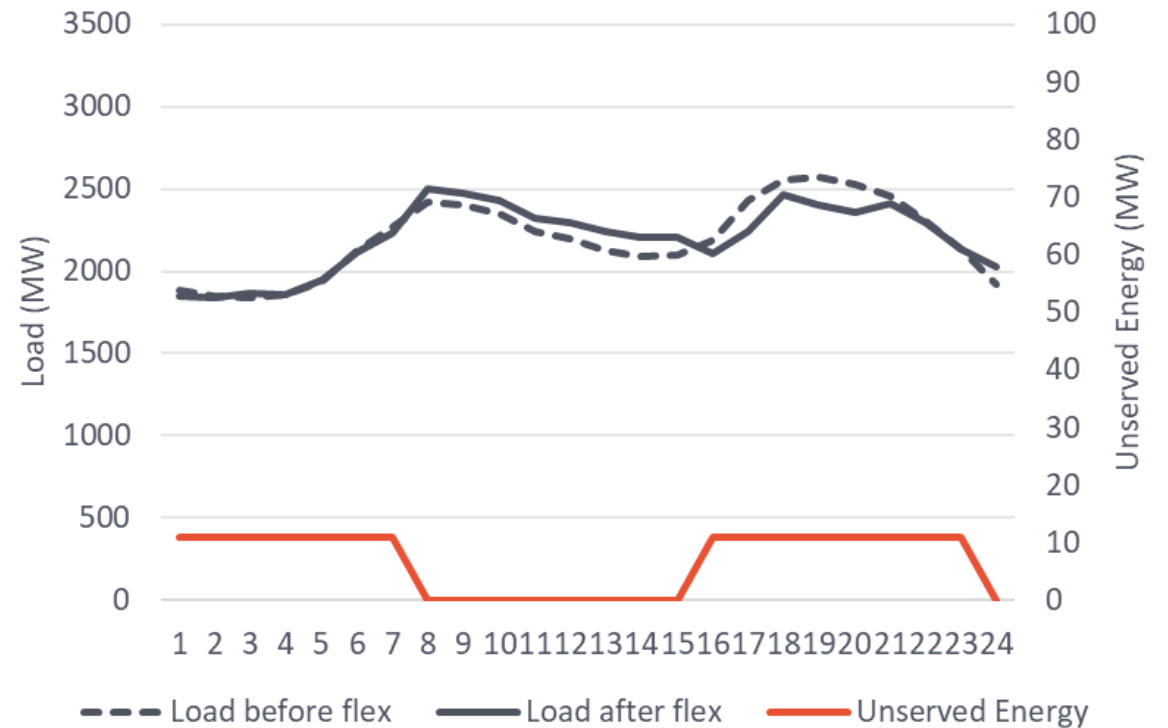
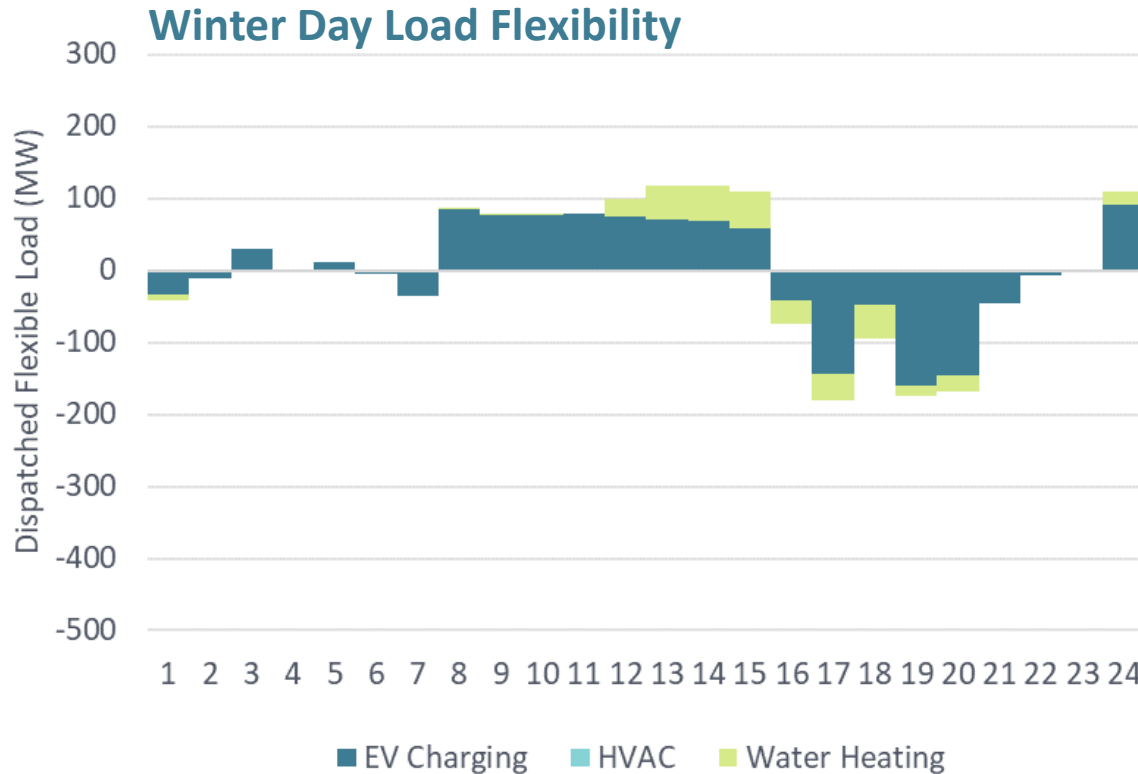
²Hour-to-hour losses are estimated



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



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



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...

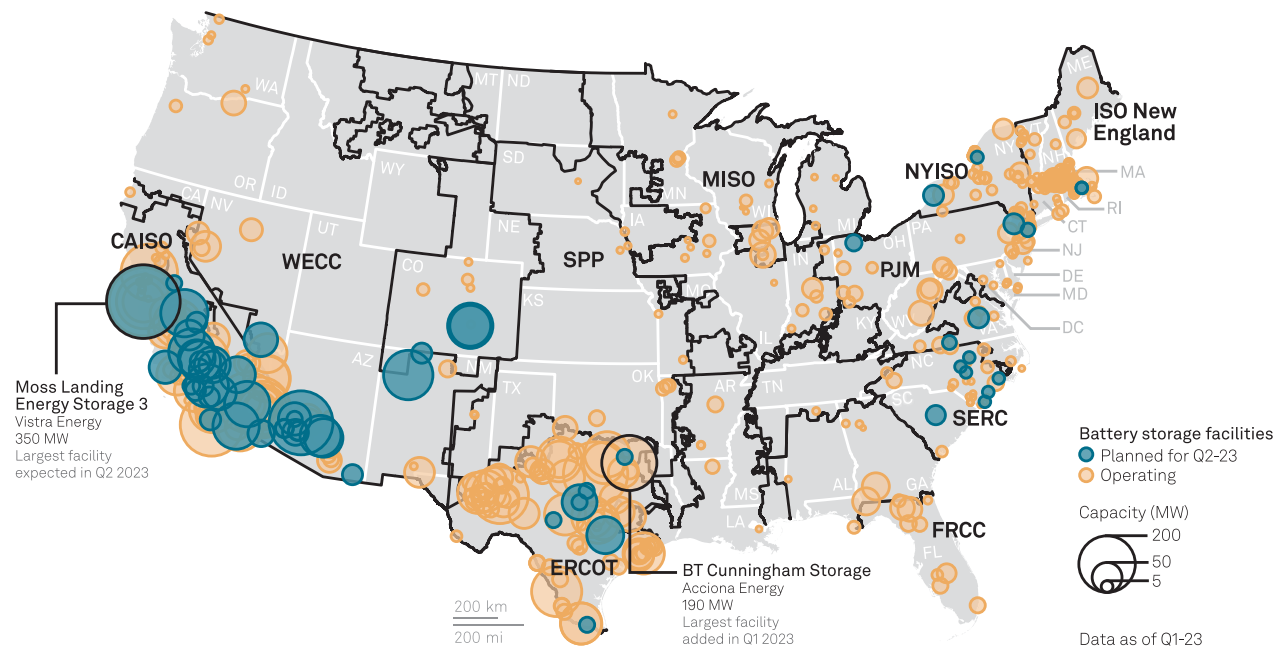
- ✓ Being built for multiple use cases (i.e. solar)
- ✓ Technological maturity
- ✓ Faster to deploy and interconnect at scale
- ✓ Easier to finance
- ✓ Transparent costs and performance



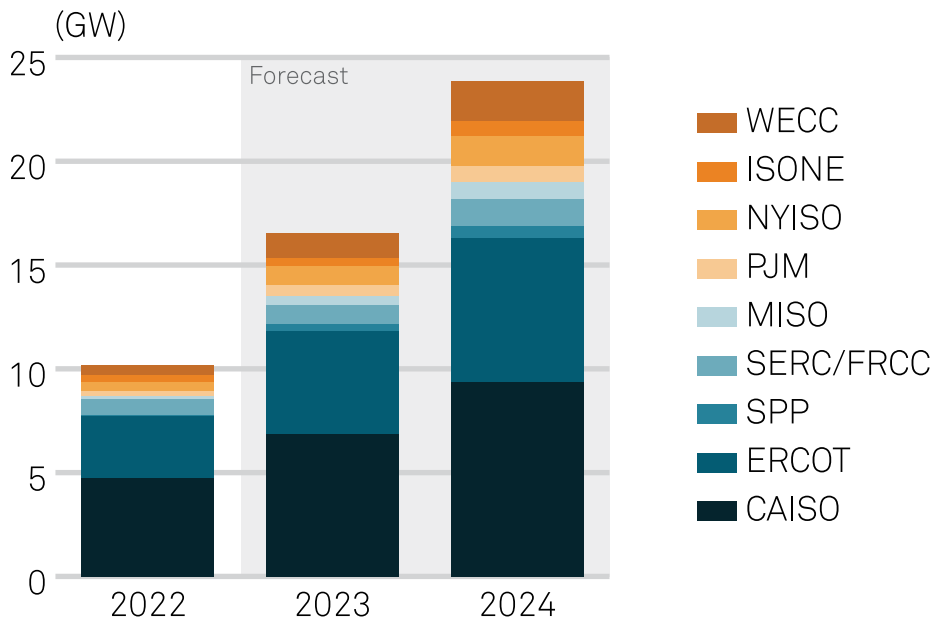
Storage deployments are growing rapidly with no end in sight

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

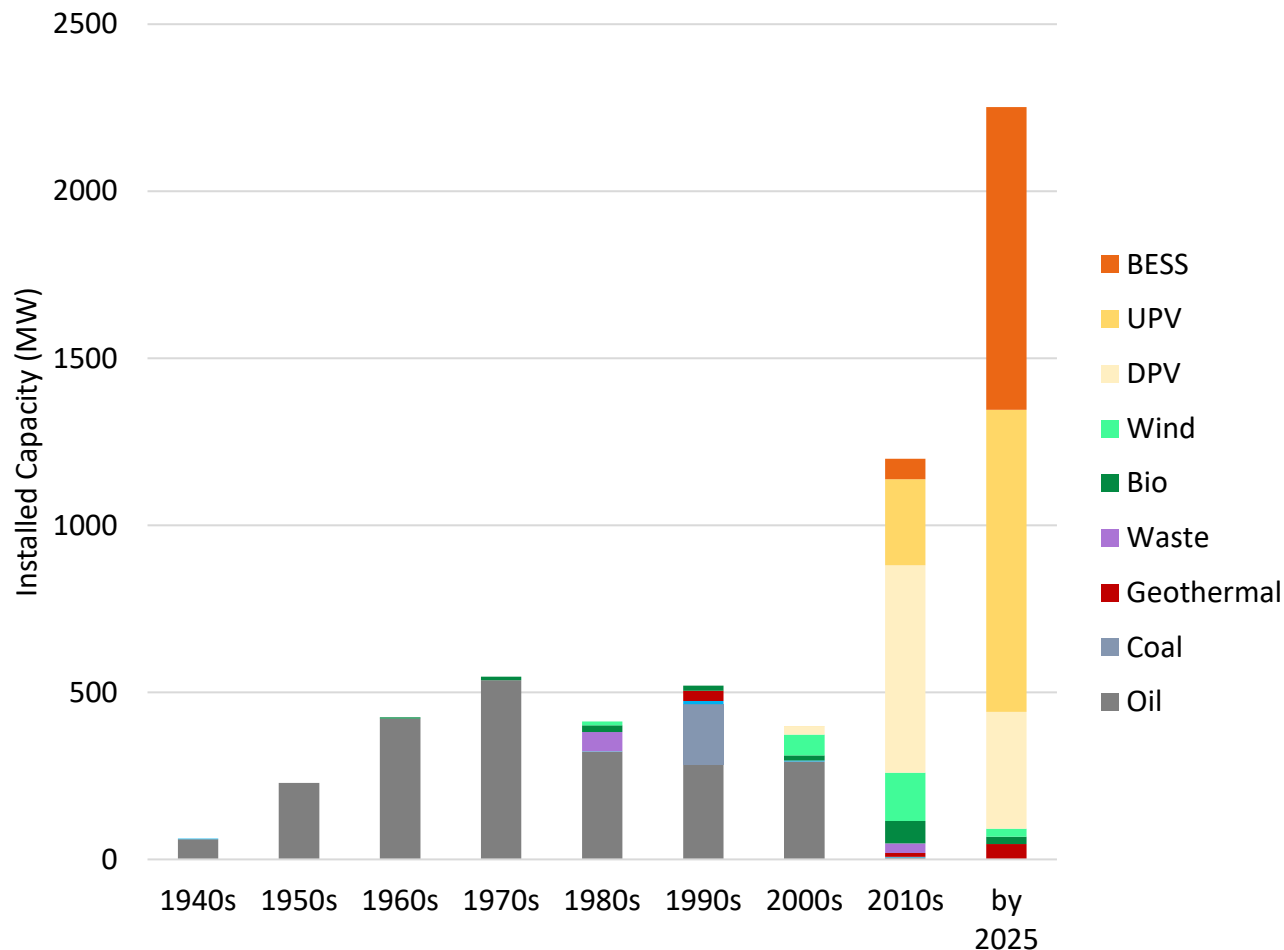


Source: [S&P Global Commodity Insights](#), Credit Kassia Micek



Hawaii as a Case Study

Hawaii's Energy Transition in one Chart



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)

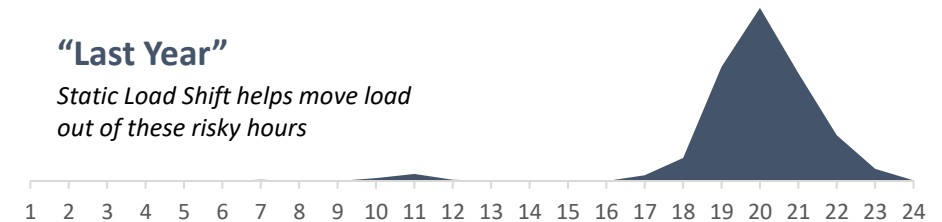
	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	Total
1		1%			1%			0%	2%	2%	1%	0%	9%
2		0%			1%			0%	1%	2%	0%		5%
3		0%			1%				1%	1%	0%		4%
4		0%			1%				1%	1%	0%		4%
5		0%			1%			0%	1%	2%	0%		5%
6					1%				2%	2%	1%		5%
7		0%			1%			0%	3%	2%	1%	0%	9%
8		0%			0%			1%	1%	0%	1%	1%	5%
9		0%			0%			0%	1%		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

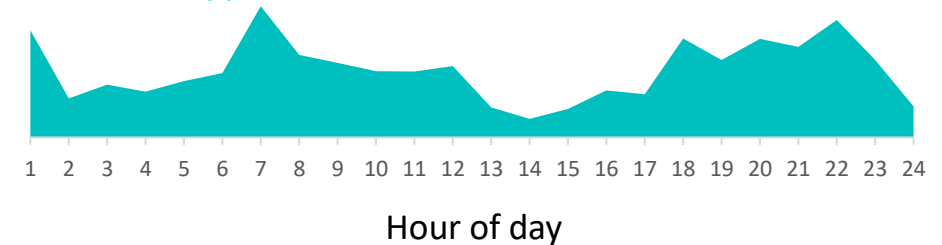
Average unserved energy by hour of day

"Last Year"

Static Load Shift helps move load
out of these risky hours



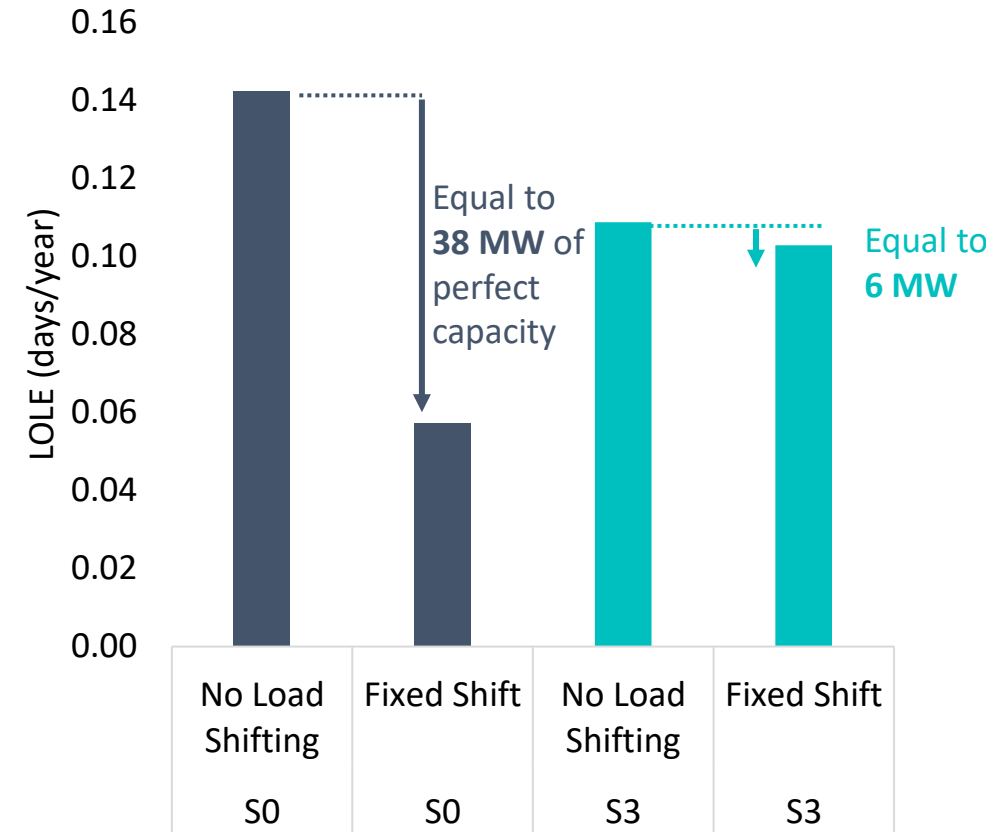
"Next Year(s)"



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



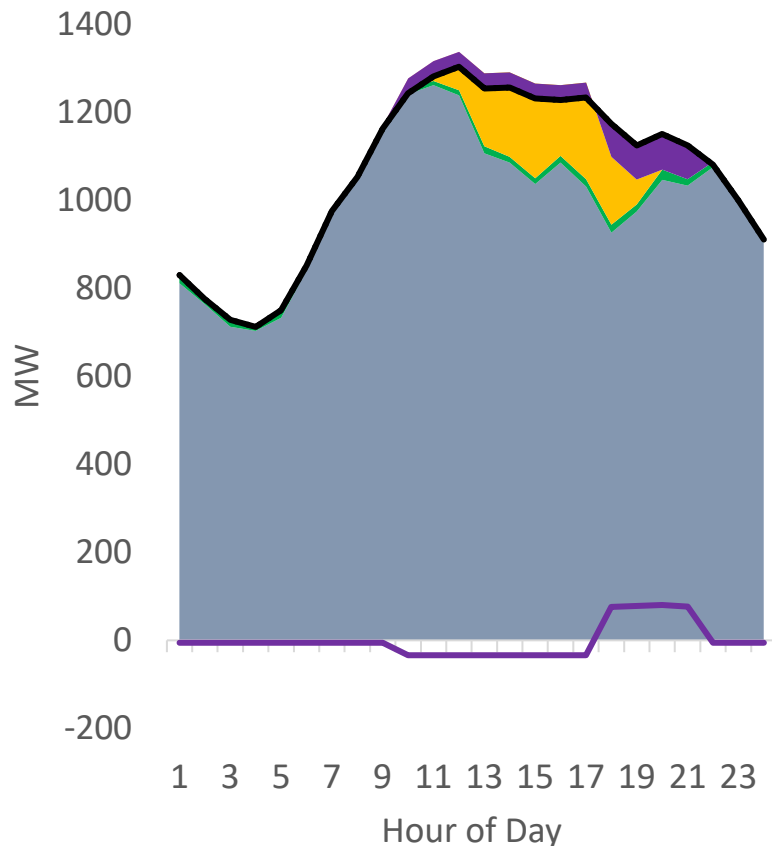
Source: Hawaii Natural Energy Institute, Telos Energy, Hawaii Benefits of Load Flexibility & Time of Use Rates (forthcoming)



Why does load shifting become less effective?

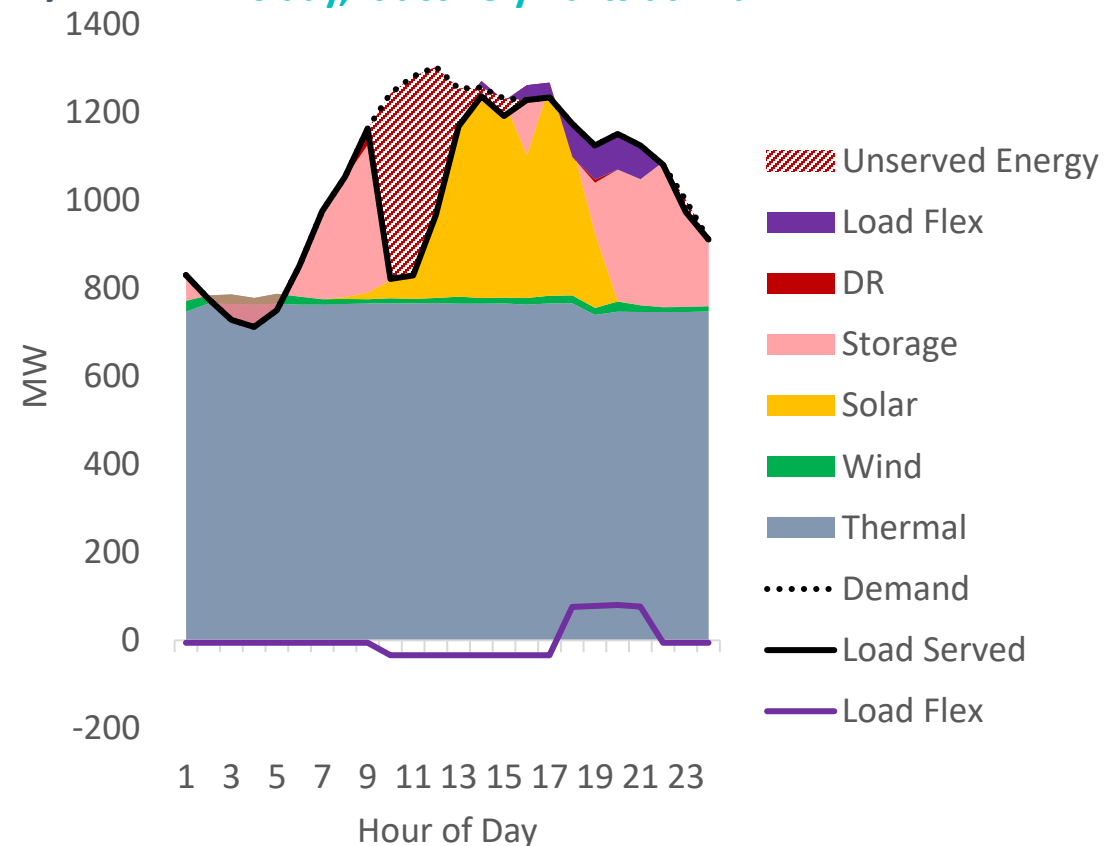
Last Year's Low Solar Days

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)

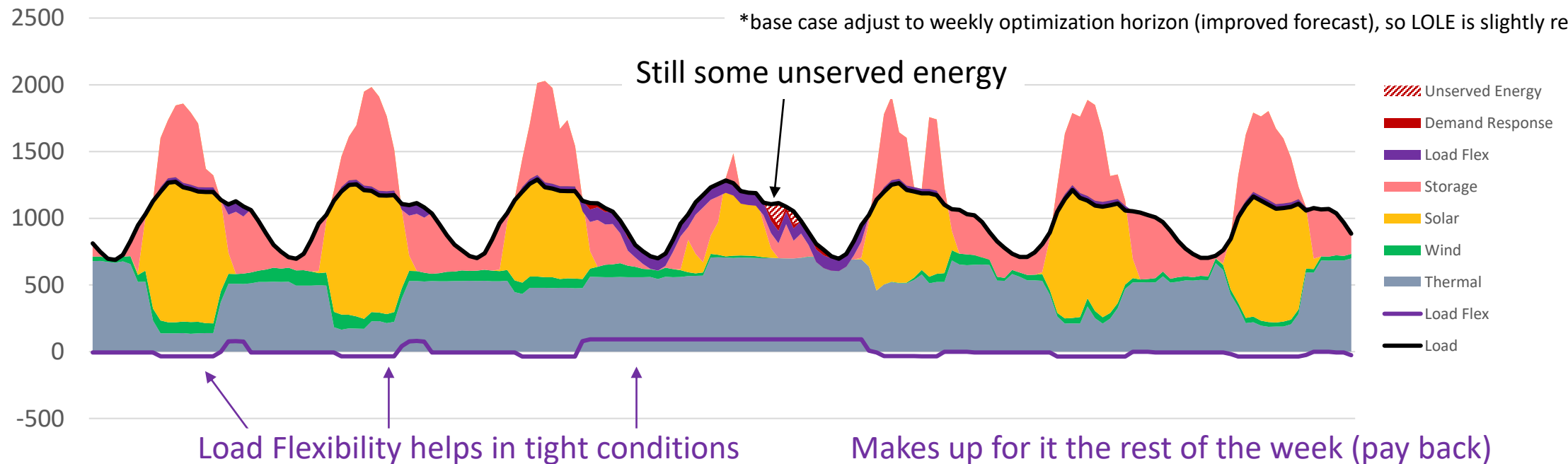


Opportunities for multi-day load flexibility?

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

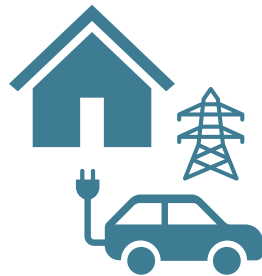


Searching for the right load flexibility

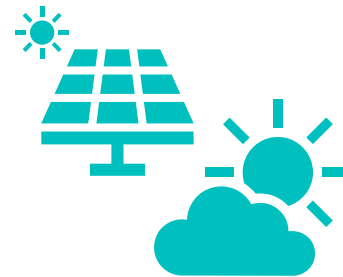
If we no longer need peak shaving or real-time flexibility (ancillary services & ramping)
what should we be planning for in the future?



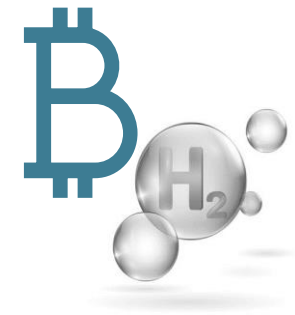
Don't forget
about
**energy
efficiency**



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?



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Telos Energy



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