Energy Transition – Enabling Technologies

IPS Connect 2022

Ben Loeffler, Alaska Center for Energy and Power at UAF
bhloeffler@alaska.edu

PMEC
Pacific Marine Energy Center

UNIVERSITY OF ALASKA FAIRBANKS

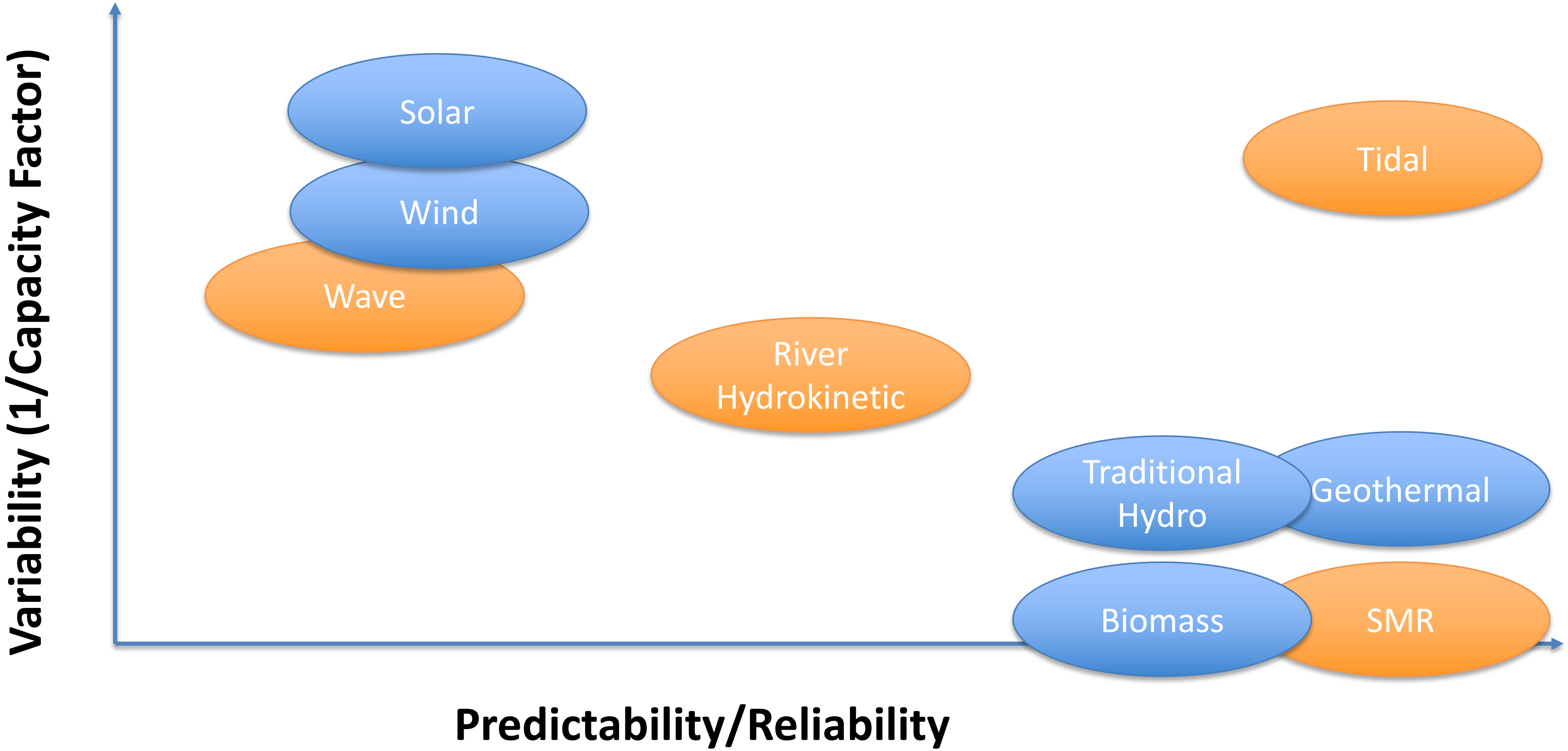
Oregon State University

Energy Transition - Enabling Technology

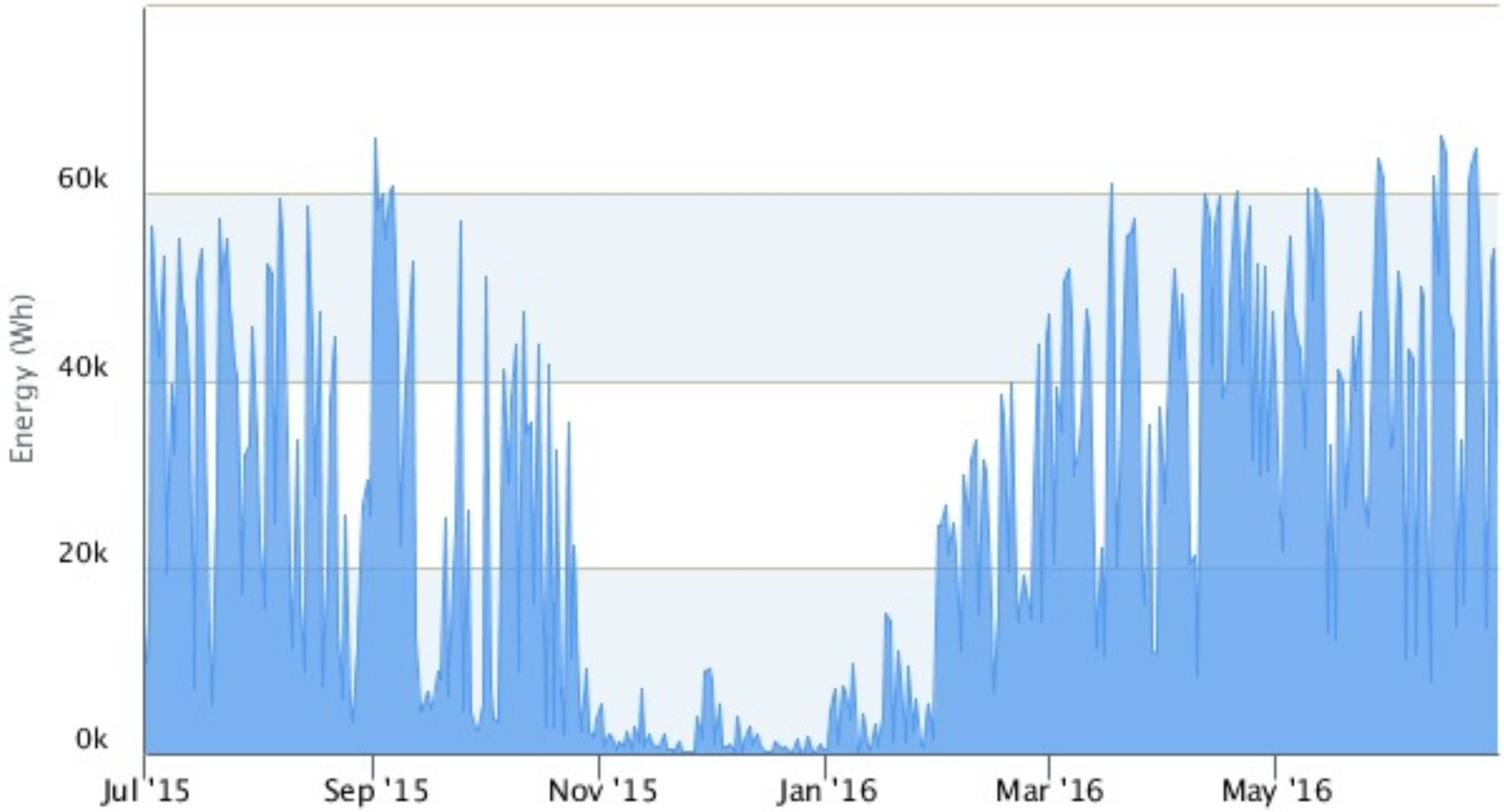
- Caveats
  - Not specifically my area of expertise
  - Graphs are qualitative
  - Opinions are my own
- Concepts that are key to this discussion:
  - Variability and Predictability
  - Energy Storage
    - Use energy in another time and place from where it is created
    - Examples
  - Scale

The "gold standard"

Carbon Free Energy Sources

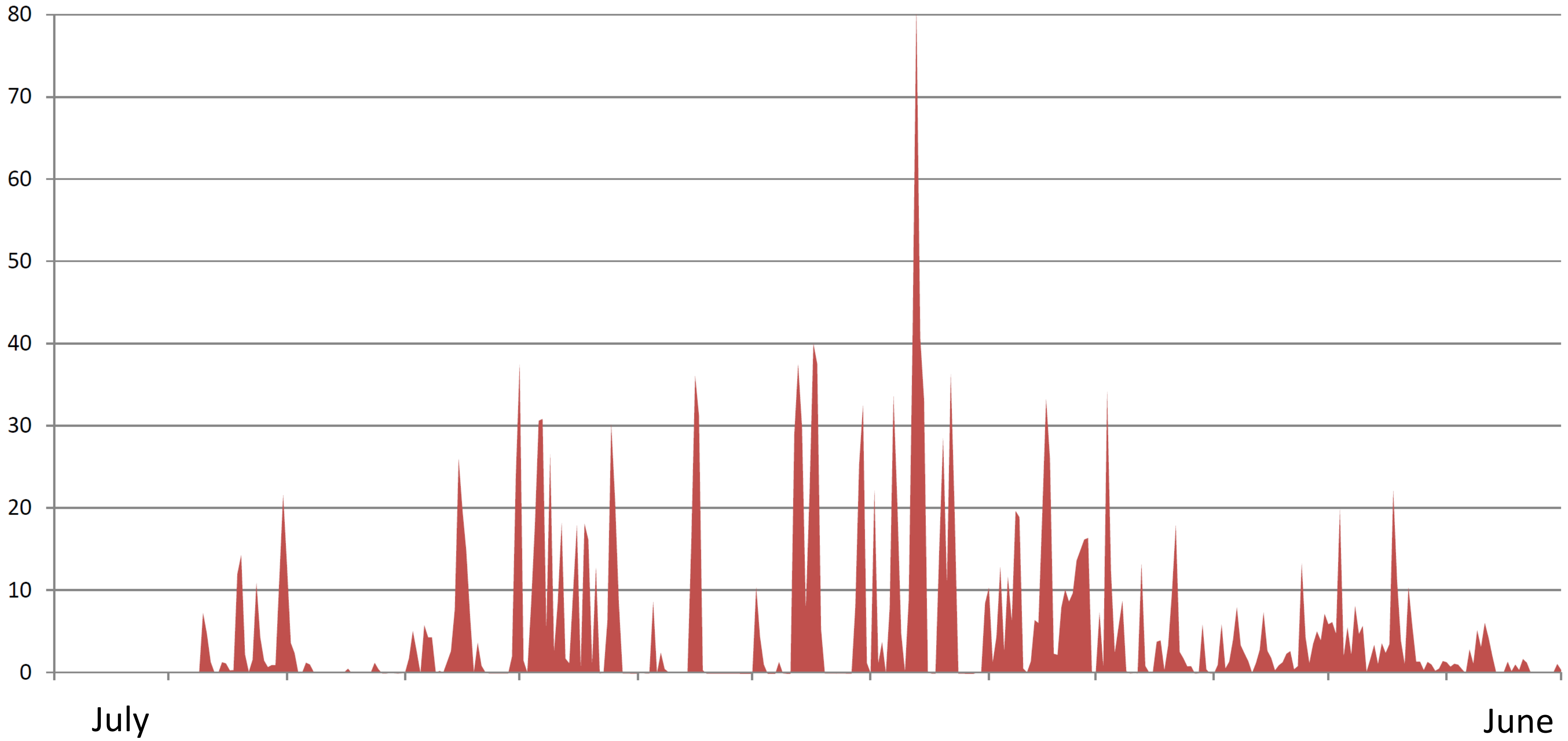


Renewable Energy Production - Solar



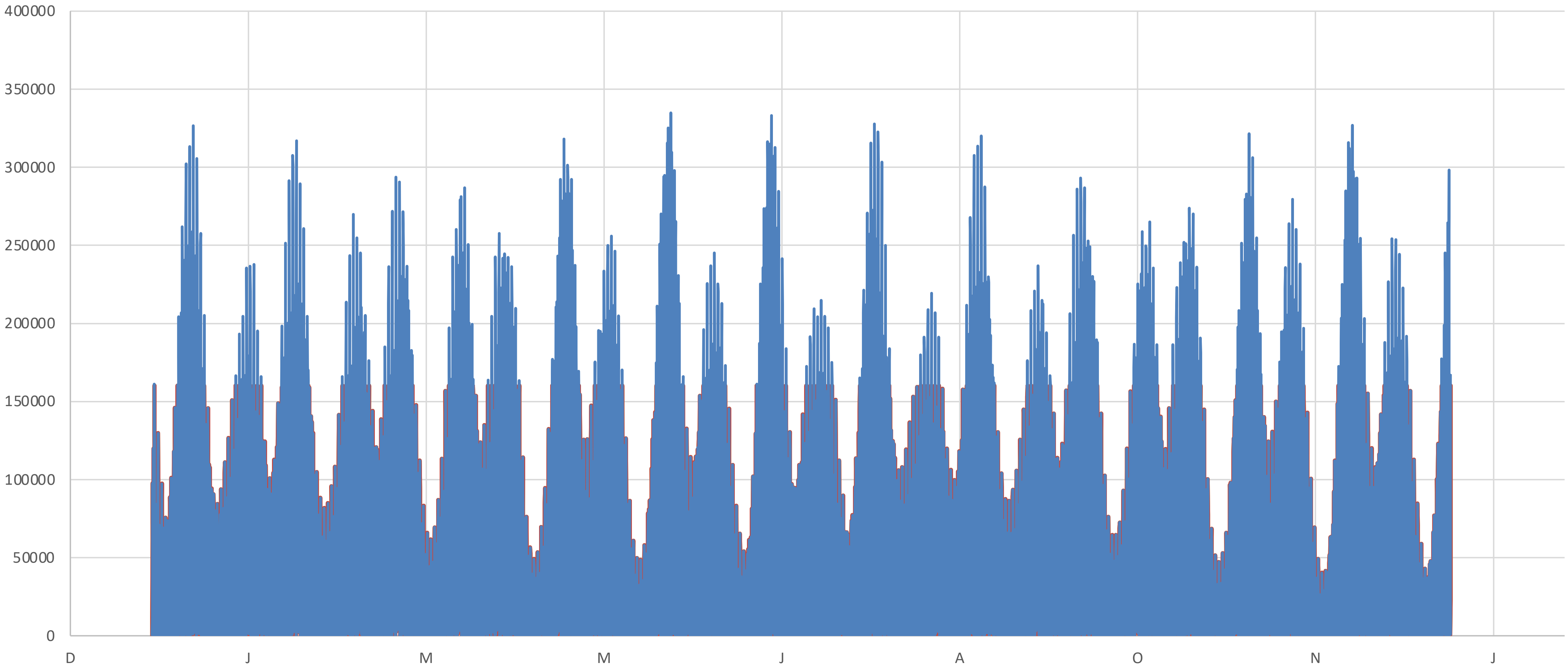
* Reliably Goes to 0 at night

Renewable Energy Production - Wind

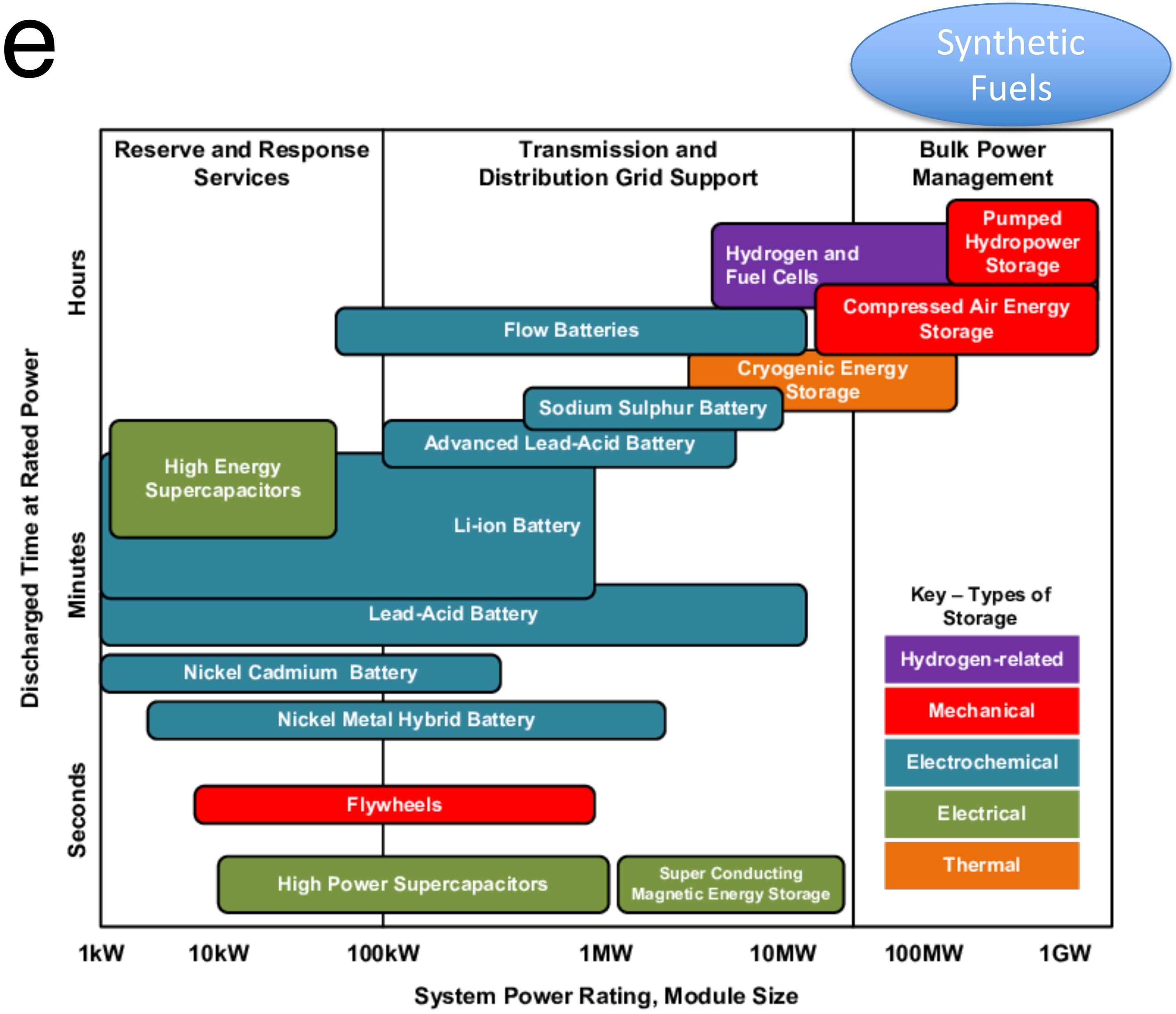


Renewable Energy Production - Hydrokinetic

Renewable Energy Production - Tidal

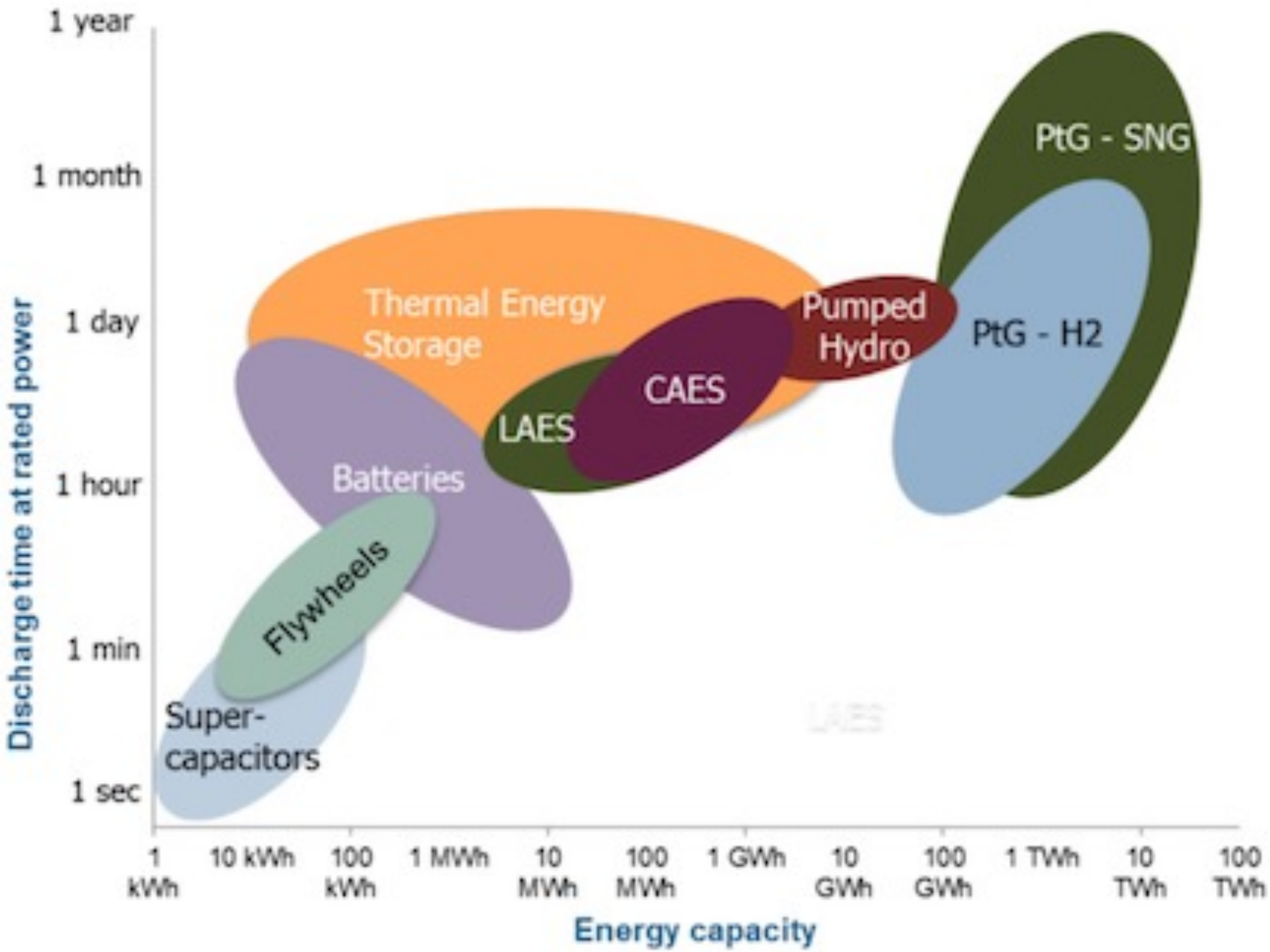


Storage



Sprake, David, et al. "Housing estate energy storage feasibility for a 2050 scenario." *2017 Internet Technologies and Applications (ITA)*. IEEE, 2017.

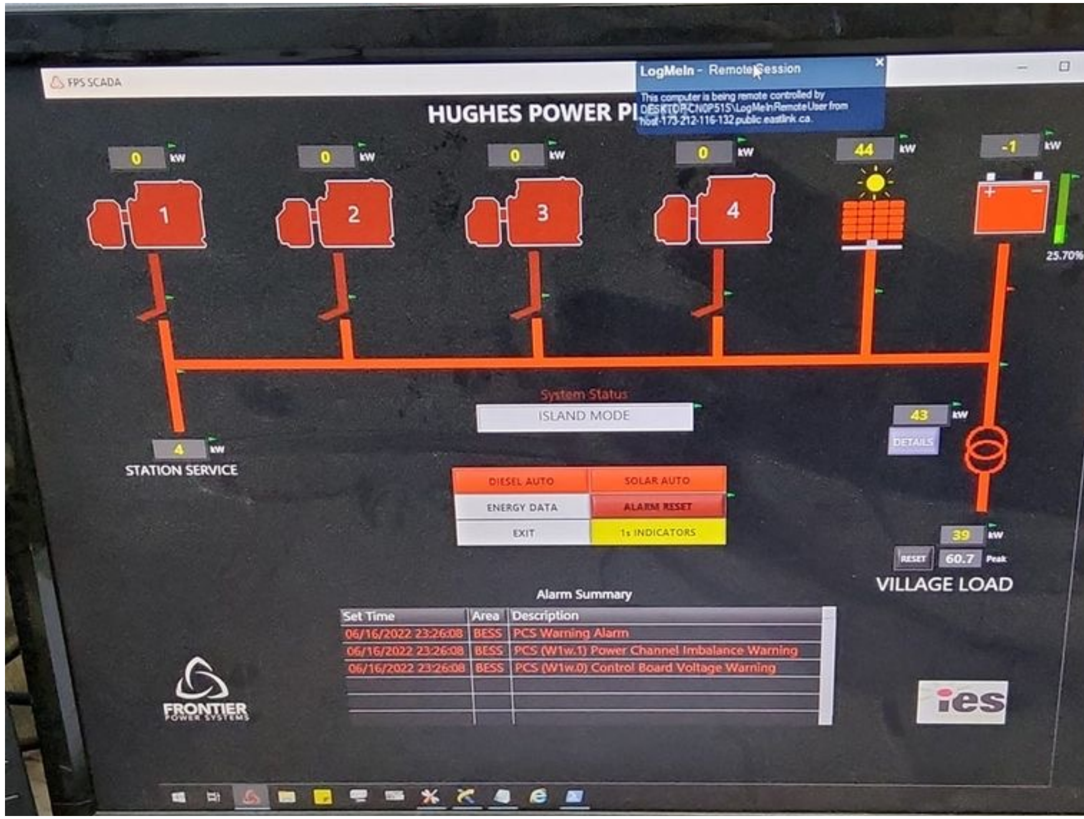
Storage



https://electrificationstrategy.eu/faq/costs-benefits-and-distributional-impacts/hydrogen-is-the-better-technology-for-energy-storage

Recent Example – Hughes, Alaska

- Hughes Village Council (DOE grant)
- Solar + Battery (ABB, now Hitachi)
- Battery provides spinning reserve to enable diesels-off
- 21% diesel offset in May 2022
- https://www.energy.gov/indianenergy/articles/can-solar-work-alaska-hughes-village-says-yes



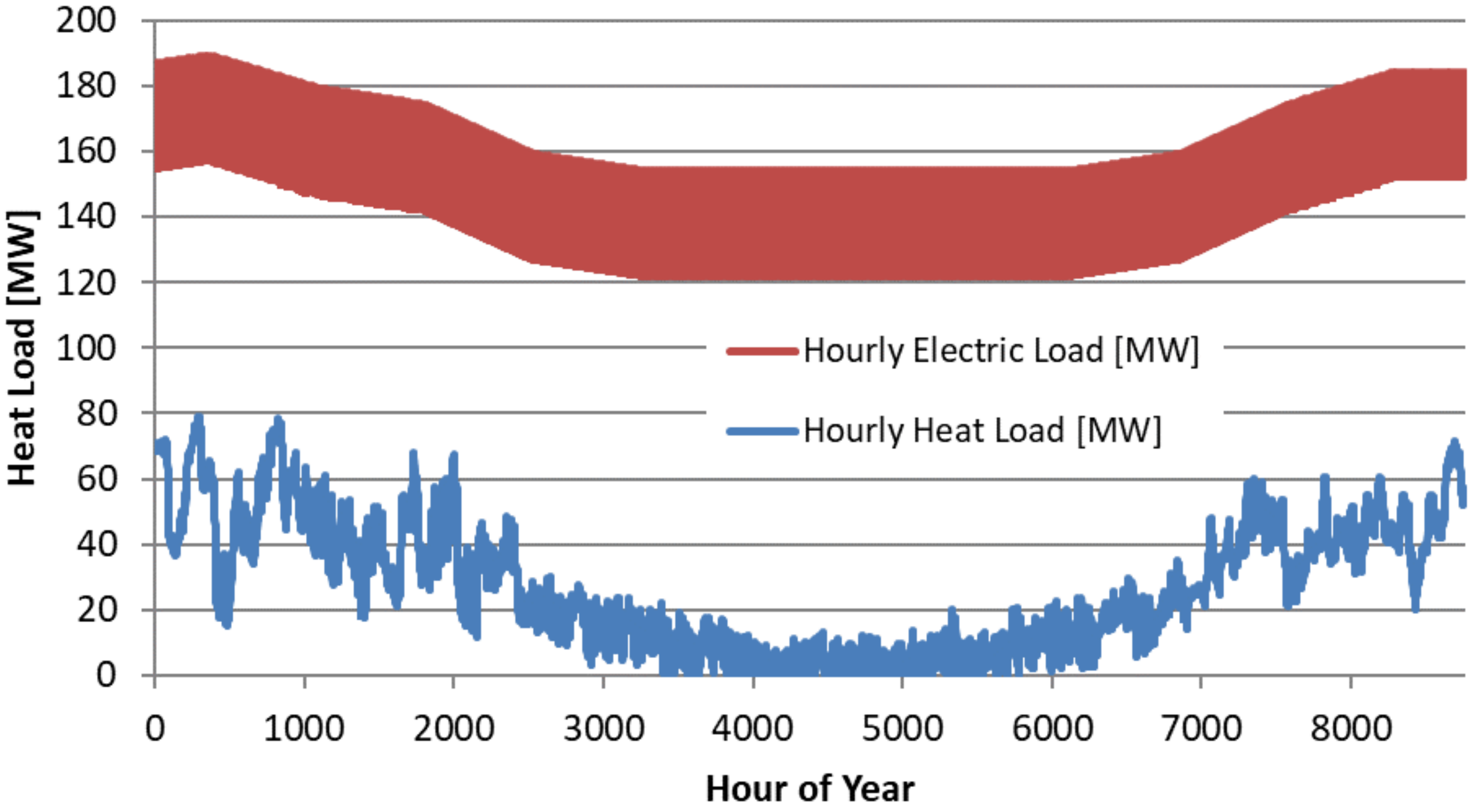
Photos by Dave Messier, Tanana Chiefs Conference

Recent Example – Shungnak, Alaska

- AVEC Utility
- Solar + Battery (Blue Planet Energy)
- Video - https://www.youtube.com/watch?v=_Q-VXsIwYhk

Photos by Dave Messier, Daylight Energy Services

Scale – Case Study – 100% Solar Fairbanks

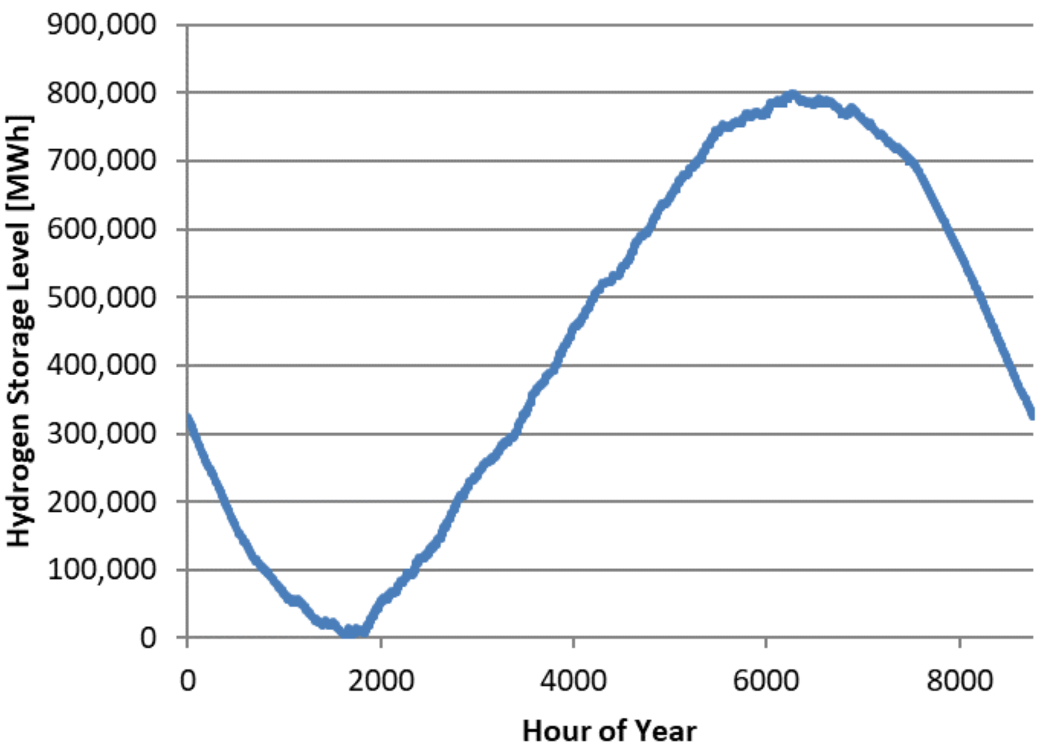


Scale – Case Study – 100% Solar Fairbanks

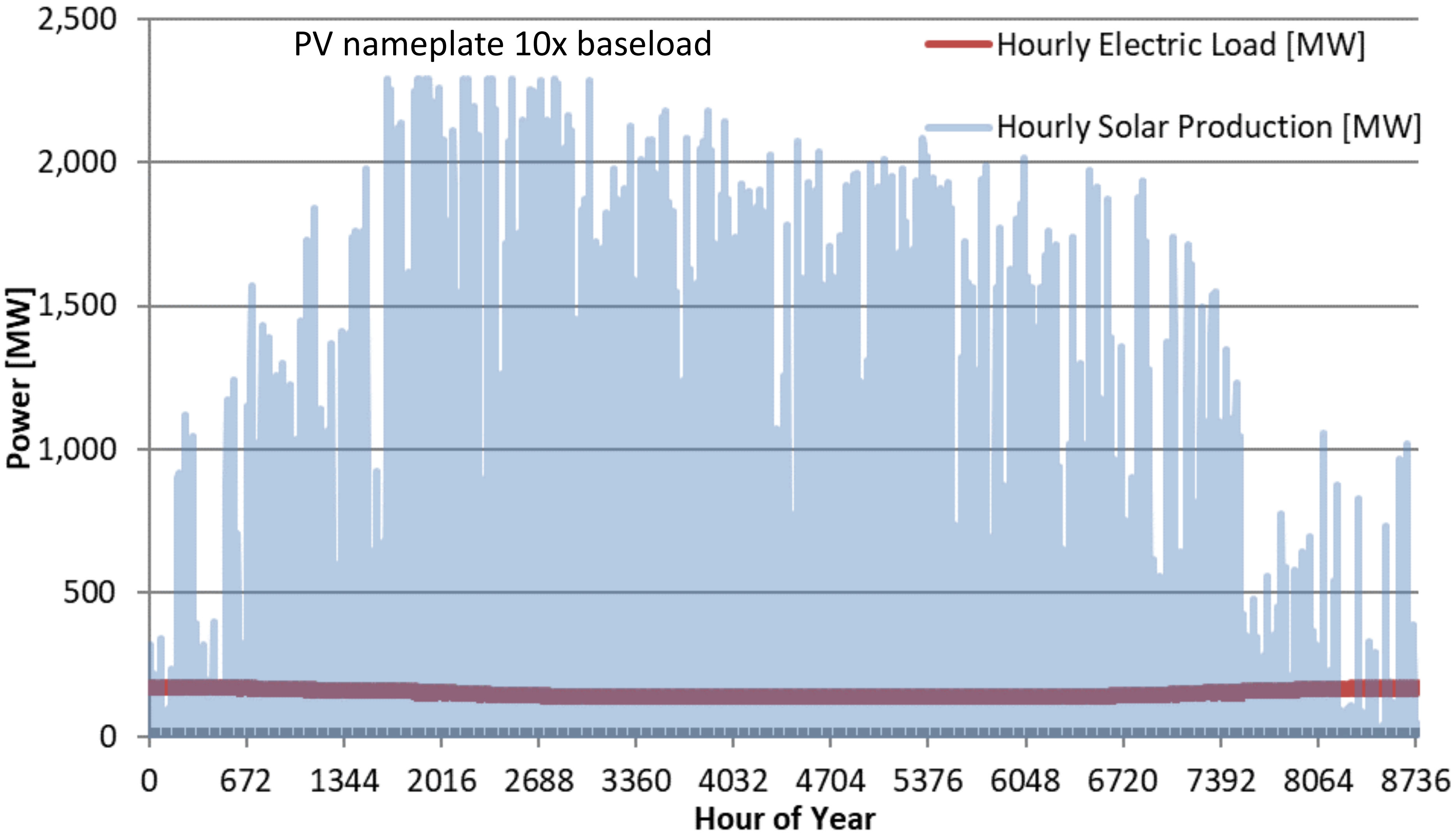
η=62%

η=55%

Hour of Year	Day of Year	Hour of Day	Air Temperature [F]	Heating Degree Hour	Hourly Heat Load [MW]	Hourly Electric Load [MW]	Hourly Solar Production [MW]	Net Generation [MW]	H2 Energy From Storage [MWh]	H2 Energy to Storage [MWh]	H2 Storage Balance [MWh]
0	1	0	-35.0	100	69	164	0	-164	366	0	325,000
1	1	1	-36.0	101	69	160	0	-160	361	0	324,639
2	1	2	-36.0	101	69	[illegible]	0	-157	356	0	324,284
3	1	3	-36.0	101	69	[illegible]	[illegible]	-156	353	0	323,931
4	1	4	-36.9	102	70	155	0	[illegible]	351	0	323,580
5	1	5	-36.9	102	70	155	0	-155	352	0	323,228
6	1	6	-38.0	103	71	159	0	-159	360	0	322,868
7	1	7	-38.0	103	71	166	0	-166	373	0	322,495
8	1	8	-36.9	102	70	173	0	-173	385	0	322,109
9	1	9	-36.9	102	70	180	0	-180	397	0	321,712
10	1	10	-36.9	102	70	184	0	-184	404	0	321,308
11	1	11	-36.9	102	70	186	238	52	70	49	321,287
12	1	12	-36.0	101	69	186	265	79	69	74	321,292
13	1	13	-36.0	101	69	187	205	18	69	17	321,239
14	1	14	-36.0	101	69	187	96	-91	234	0	321,005
15	1	15	-36.0	101	69	186	0	-186	408	0	320,596



100% Solar Fairbanks



100% Solar Fairbanks

System	Nameplate Capacity	Nameplate Cost	Capital Cost
PV Array	2,288 MW	2,000 $/kW	$4.6B
Electrolyzer	1,645 MW	800 $/kW	$1.3B
Hydrogen Storage	800,800 MWh	15 $/kWh	$12B
Fuel Cell	189 MW	7,197 $/kW	$1.4B
Total:			**$19.2B**

- O&M projected at $200M per year
- LCOE projected at $1.20/kWh over 30 years (current fuel rate $0.14/kWh)
- Optimum sizing is much smaller, getting to 100% is expensive

Summary

- Different carbon-free sources pose different integration problems
- Storage is required on multiple timescales
- Scale is an immense challenge (oil and gas are better at this than any other industry)
- Getting to 100% on annual basis is expensive

Questions?

Ben Loeffler
Alaska Center for Energy and Power
at UAF
bhloeffler@alaska.edu