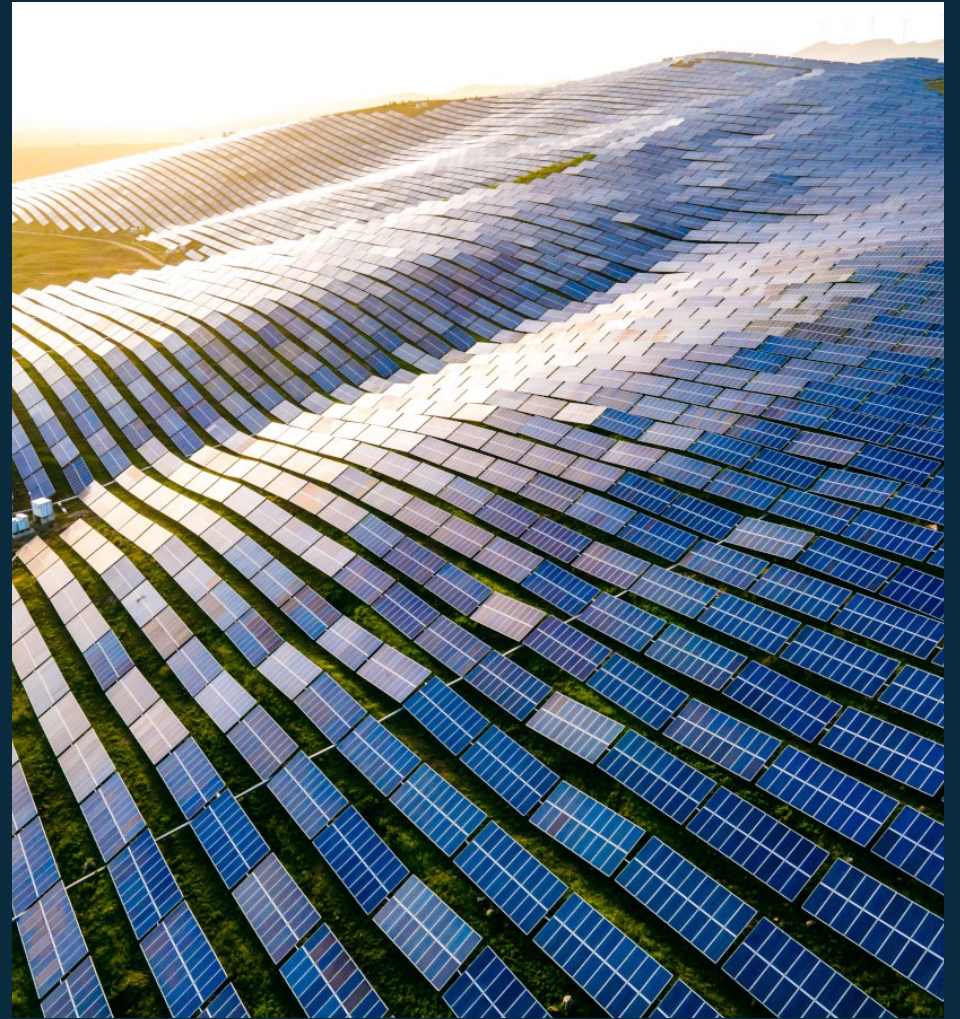
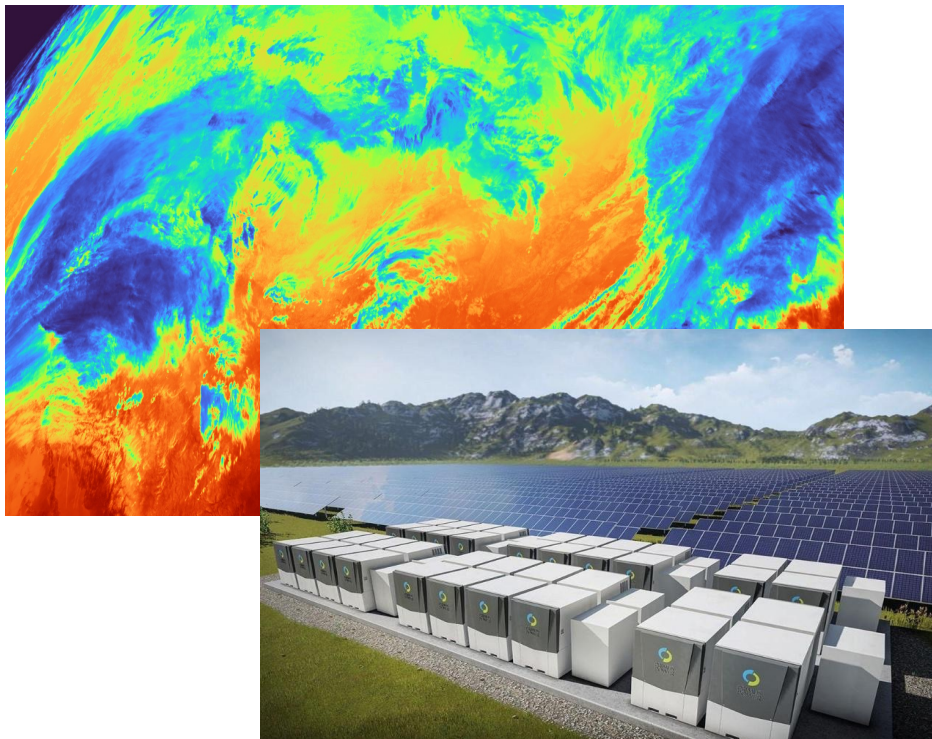


# Use of cloud "nowcasts" in short-term solar energy forecasting



# Driving the need for improved short-term forecasting



## WESTERN ENERGY IMBALANCE MARKET

About | Join WEIM | Governance | Initiatives | Resources | Search

The Western Energy Imbalance Market is a real-time wholesale energy trading market that enables participants anywhere in the West to buy and sell energy when needed.

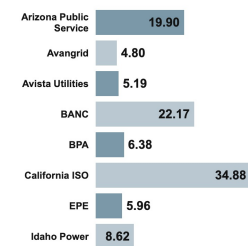
FERC accepts EDAM tariff  
[Read the news release](#)

\$462.05 million savings in Q3 2023  
[Read full report >>](#) [Read news release >>](#)  
(millions \$)

TOTAL \$4.66 billion  
gross benefits since Nov 2014

Quarterly benefits  
& Emissions Tracking  
Reports  
[Go to reports >>](#)

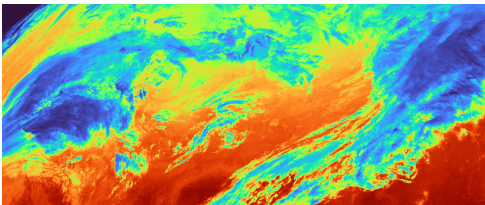
Join Western Energy  
Imbalance Market >>



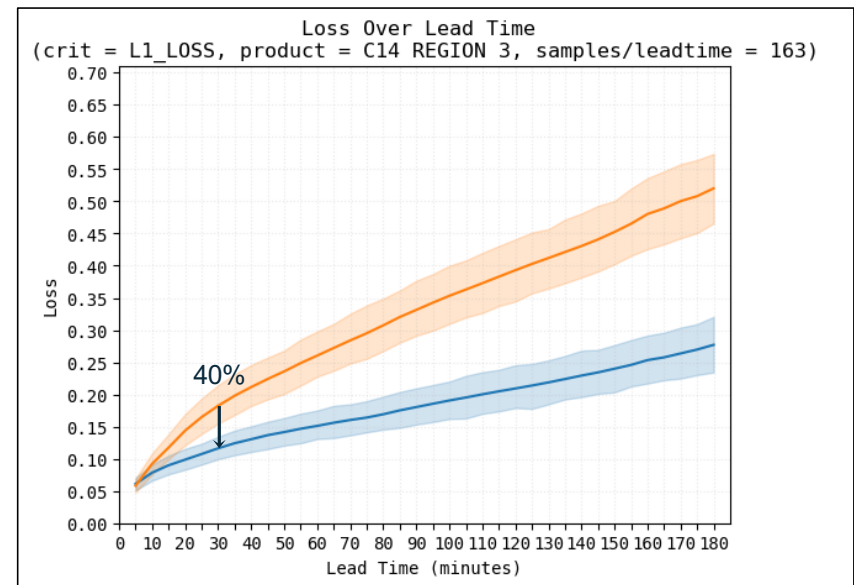
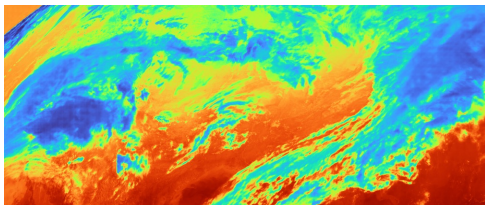
# Improved accuracy with cloud nowcasting

Yesterday, Eric Gruit went "Deep" into how our learning model predicts next 3 hours of GOES and MeteoSat satellite images for several products (visible, infrared, cloud mask).

Optical flow – strong baseline

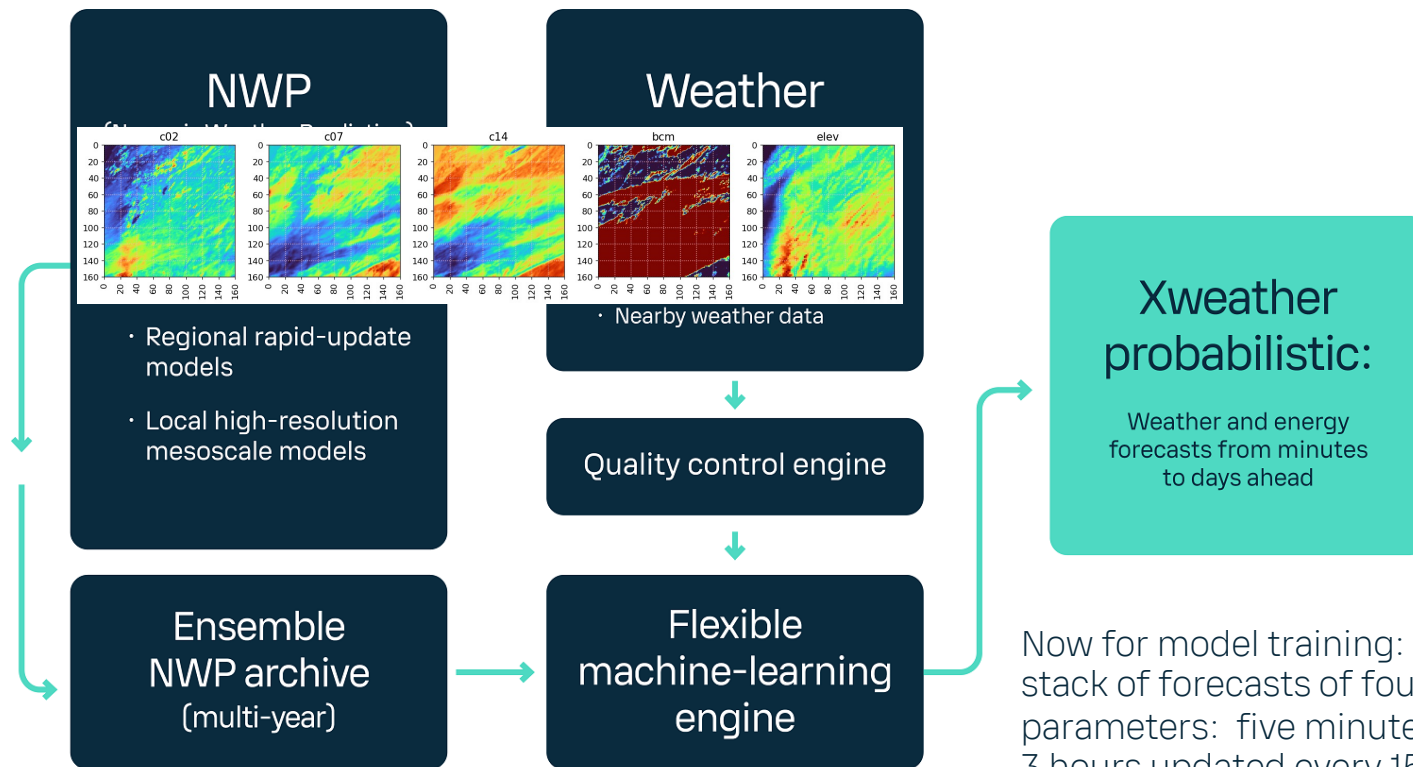


Deep neural network



40% improvement in MAE at 30-minute lead time compared with optical flow baseline.

# How we make RE forecasts



Now for model training: a one year stack of forecasts of four sat parameters: five minutely for next 3 hours updated every 15 minutes. In inference updated every 5 minutes.

# Let's define our references

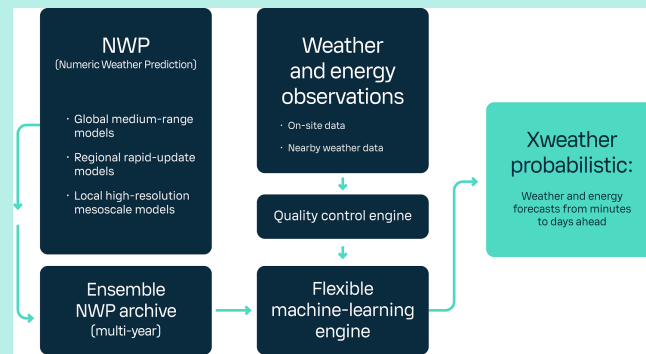
In order of increasing skill (we hope!)

So how good is that baseline compared to smart persistence?

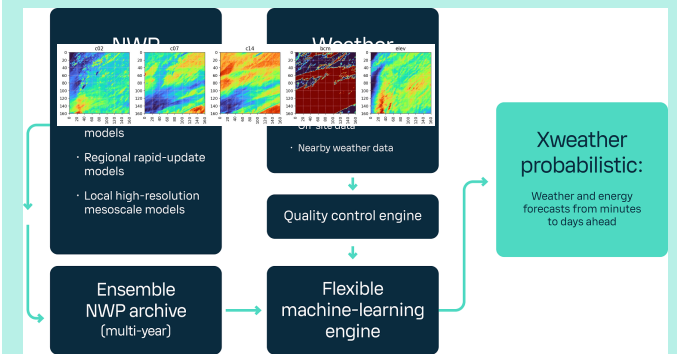
## Smart Persistence.

- Current cloudiness as obtained from on-site data
- Project metadata (panel/tracker/etc)
- Solar geometry

## Baseline (all inputs minus cloudcasts)



## Enhanced (now with cloudcasts)



# Results from a recent trial (9 providers)

Table 3. Weighted-average NMAE [%], where bolded values indicate the lowest (best) score per forecast schedule.

Forecaster	DA	HA4	HA2	HA1-15min	HA1-5min
Diamond	12.82	12.88	11.65	12.27	12.80
				15.52	16.05
				13.11	13.63
				11.51	12.20
				<b>10.89</b>	<b>11.54</b>
				12.97	14.66
				27.01	N/A
				11.85	12.61
				12.06	12.67
				12.26	13.25

1. **Top forecasters are similar:** Some of the teams consistently had lower average error



This suggests that the top commercial forecast providers can achieve similar—but not identical—forecast accuracy.

2. **Sub-hourly resolutions are more difficult to forecast accurately:** There is a larger



This suggests that sub-hourly time resolution forecasts are more challenging for commercial forecast providers.

Most about 5% improve

**13% improve**

**Smart Persist Ref**

Roughly 60 to 75 minute ahead

## How good was our baseline in that trial?

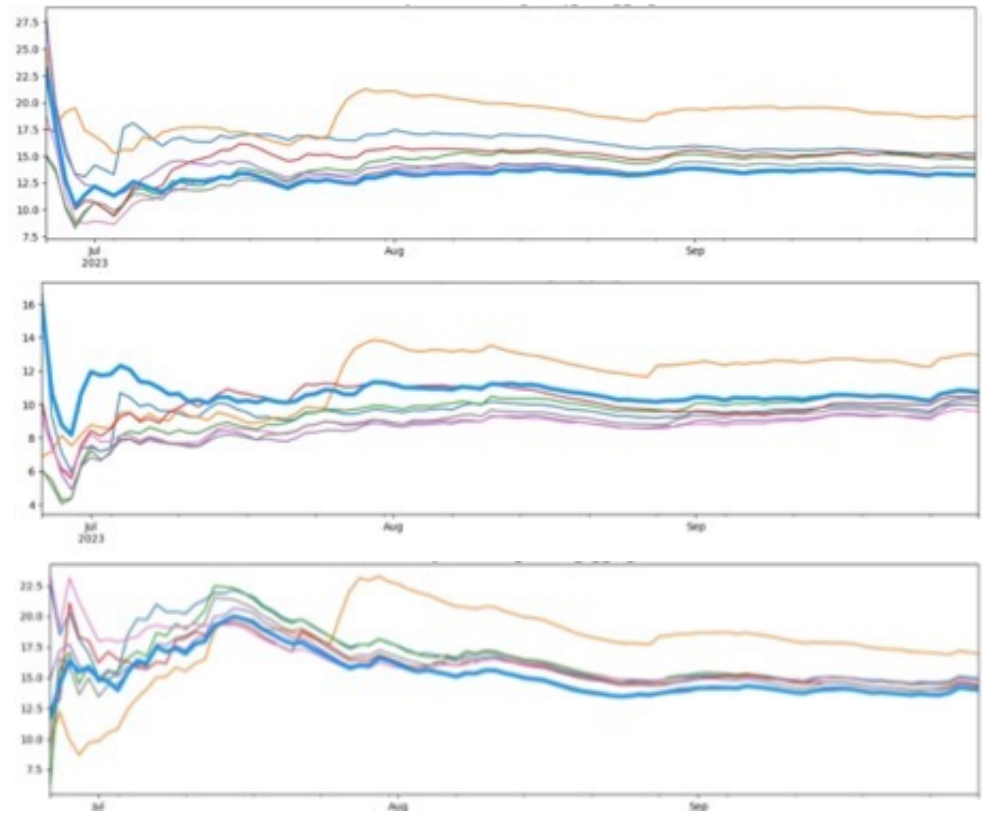
Skill of Baseline Forecasts using NWP and site observations: Hour Ahead (15 minute intervals) 3 sites.  
NO cloud nowcasting.

Lower Error is better.

Vaisala in heavy blue

We are in there with everyone else – win at some sites, lose at others.

From that trial: “Sub-hourly resolutions are more difficult to forecast accurately”

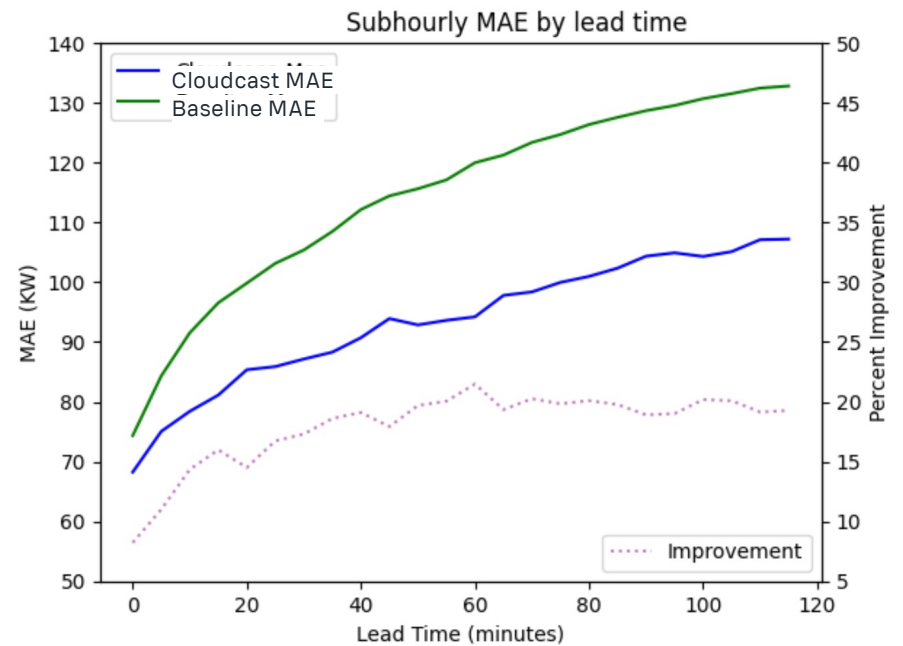


# Solar energy forecast improvement

**20% reduction in MAE** compared with a skillful baseline that uses ML models trained to site power observations and ECMWF and HRRR forecast models.

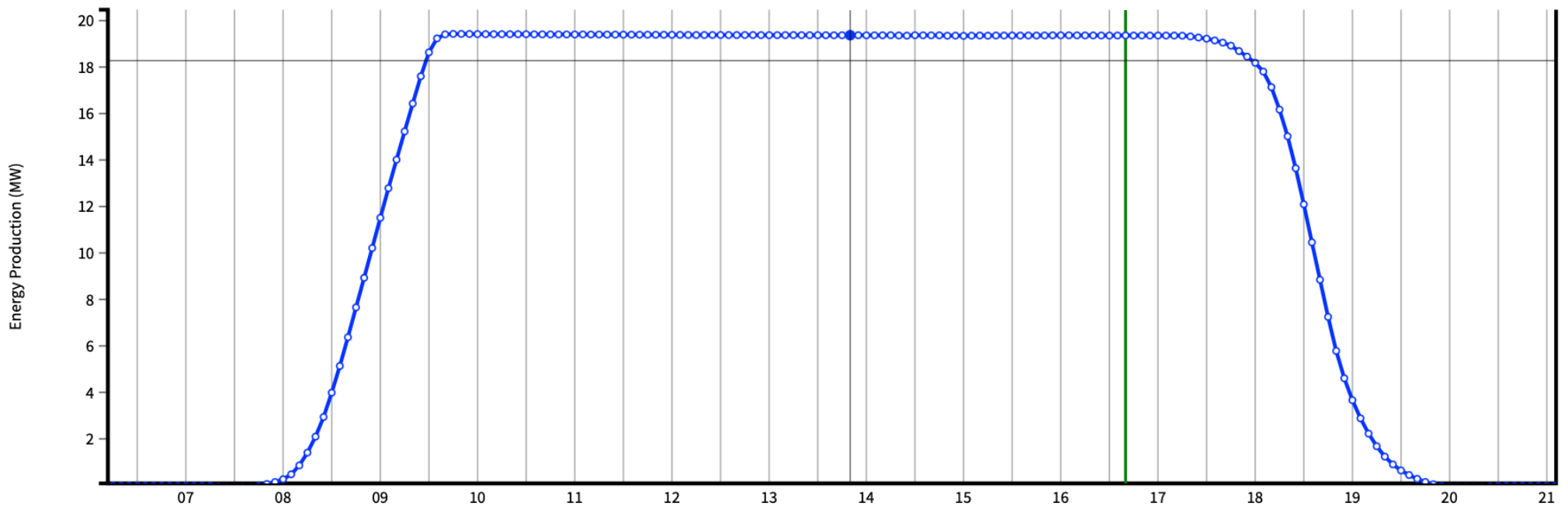
Remember that baseline could beat smart persistence by 5 to 13% (range of trial)

So looking for a 30% improvement at 60 minute lead for a five minute interval.



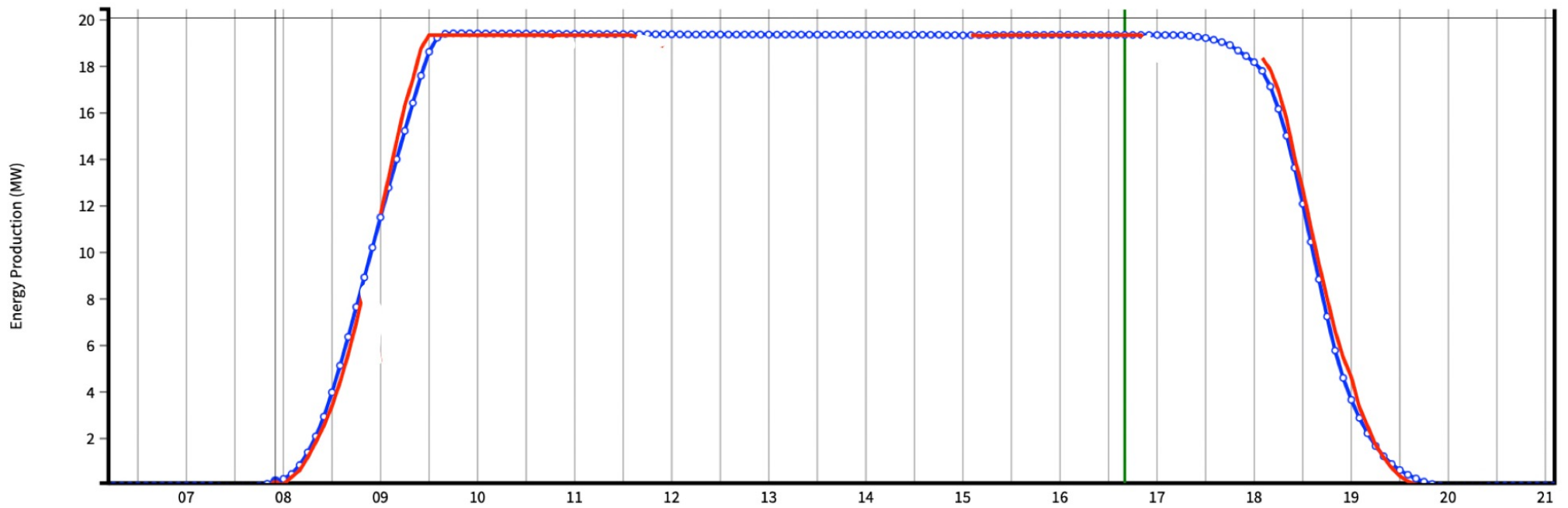
# Let's take a look at some forecasts (clear)

OBSERVED, BASELINE, CLOUDCAST



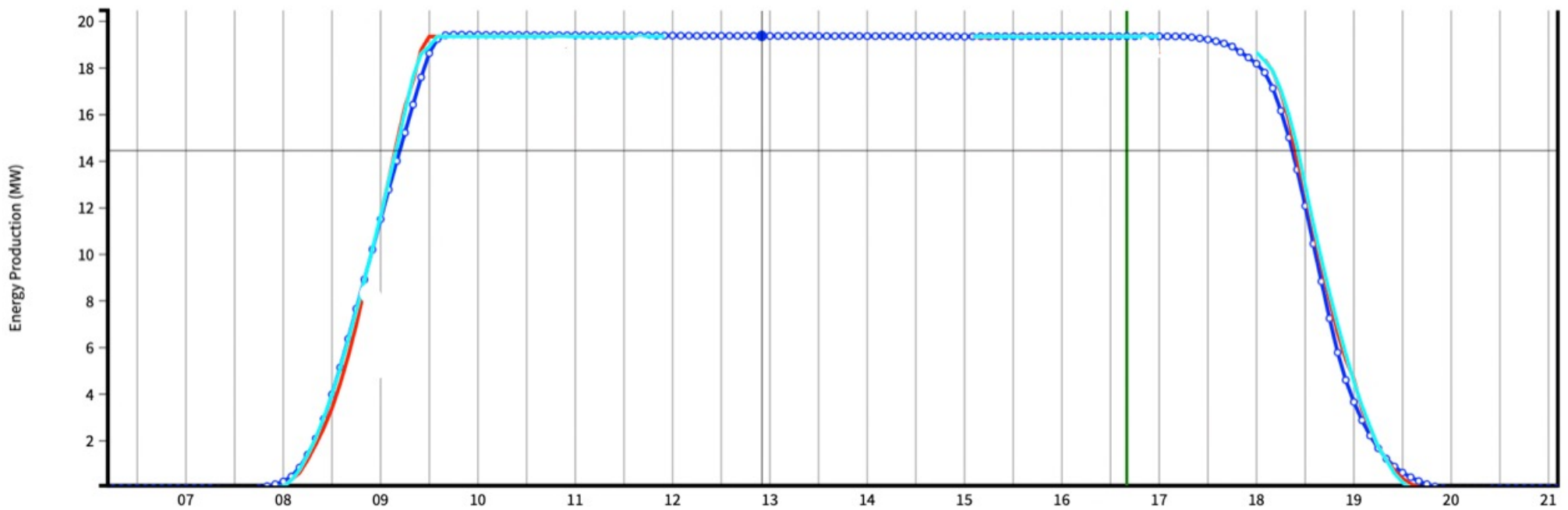
# Let's take a look at some forecasts (clear)

OBSERVED, BASELINE, CLOUDCAST



# Let's take a look at some forecasts (clear)

OBSERVED, BASELINE, CLOUDCAST

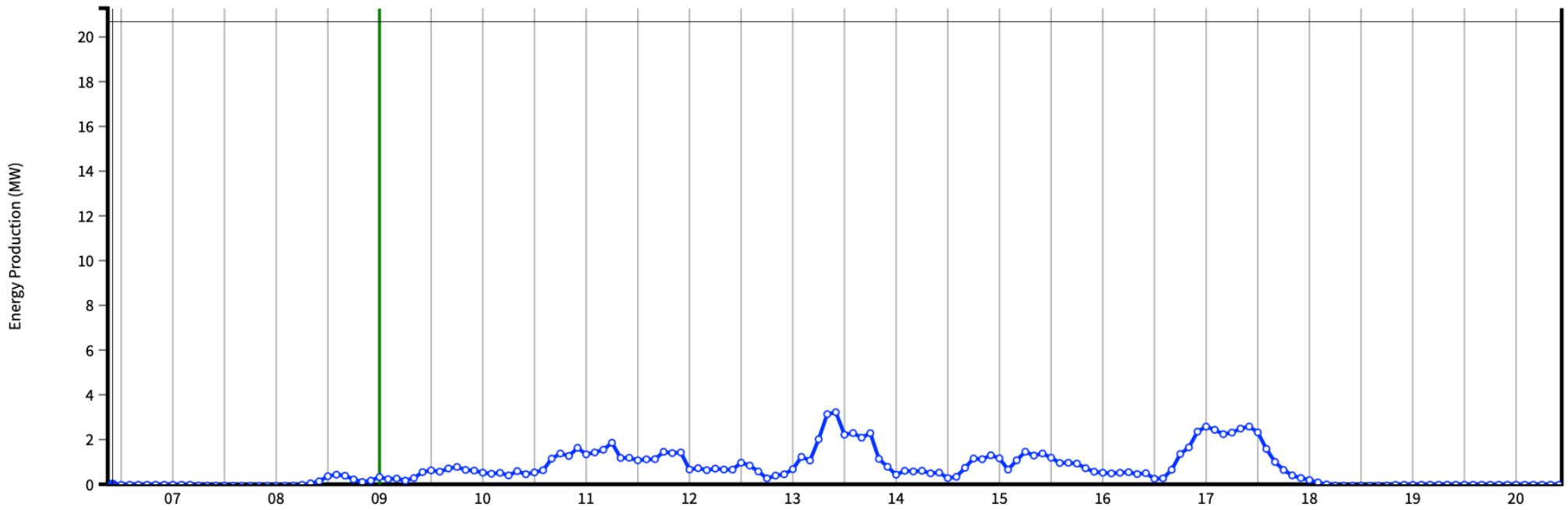


You'd be amazed at how much of "accuracy" is just getting the clear sky day shape "perfect".

Obviously all our "cloud casts" are for naught on a clear day. IF the NWP has it.

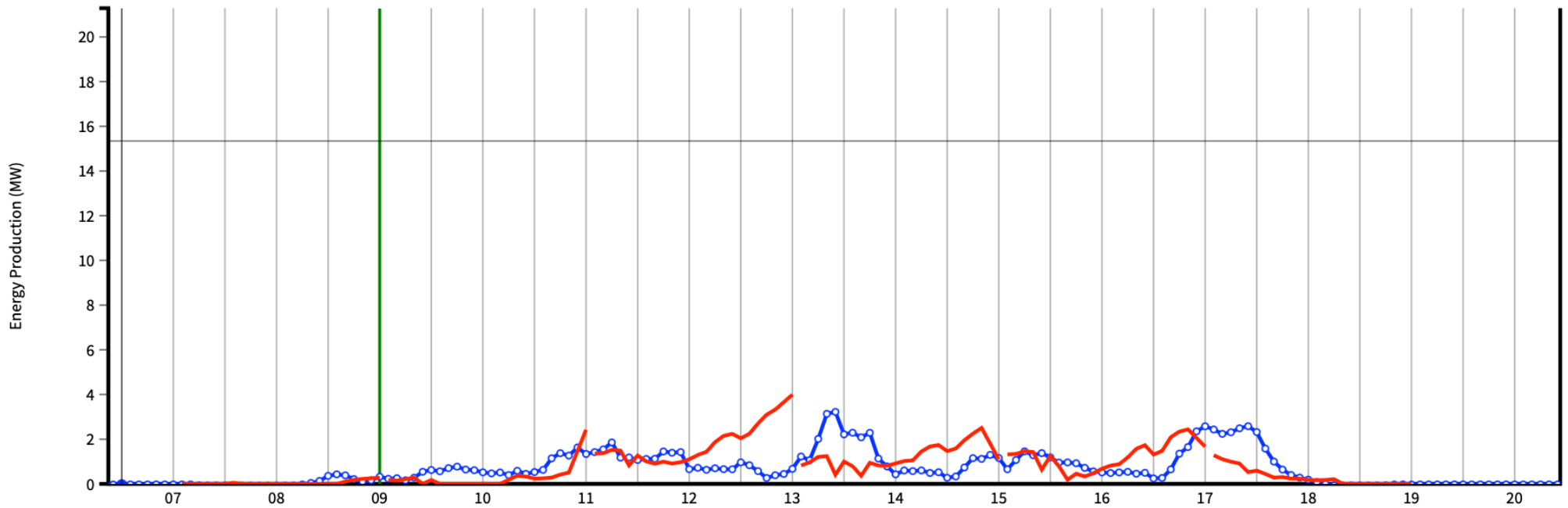
# Let's take a look at some forecasts (cloudy)

OBSERVED, BASELINE, CLOUDCAST



# Let's take a look at some forecasts (cloudy)

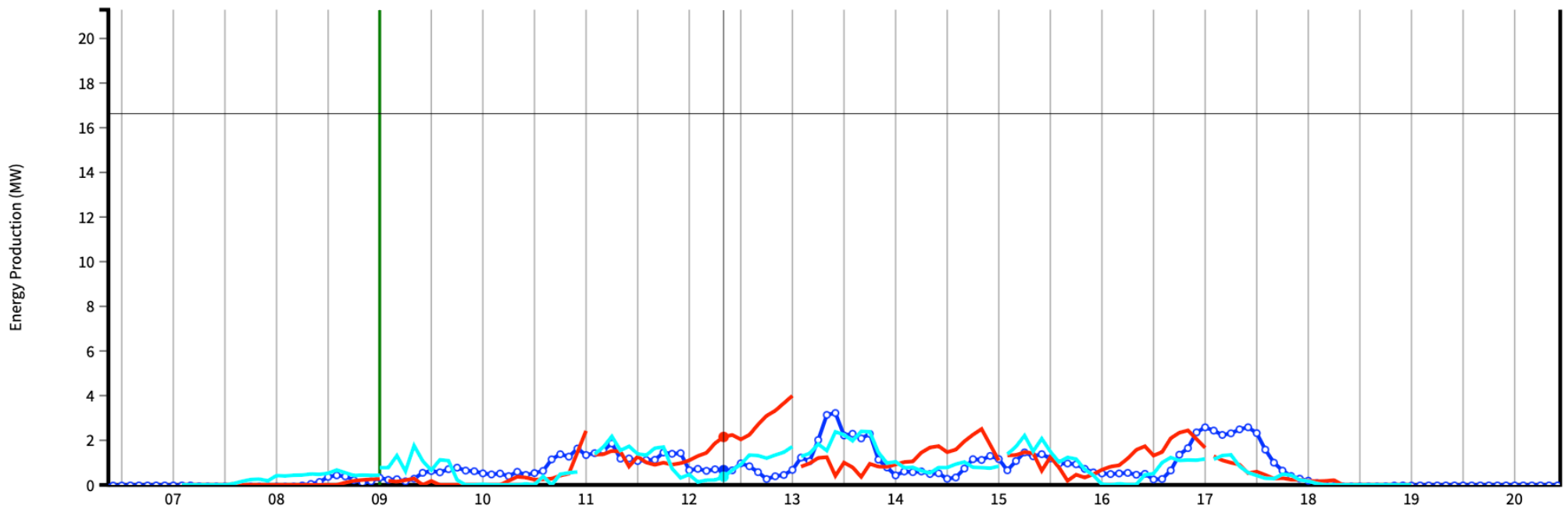
OBSERVED, BASELINE, CLOUDCAST



NOT BAD!!!

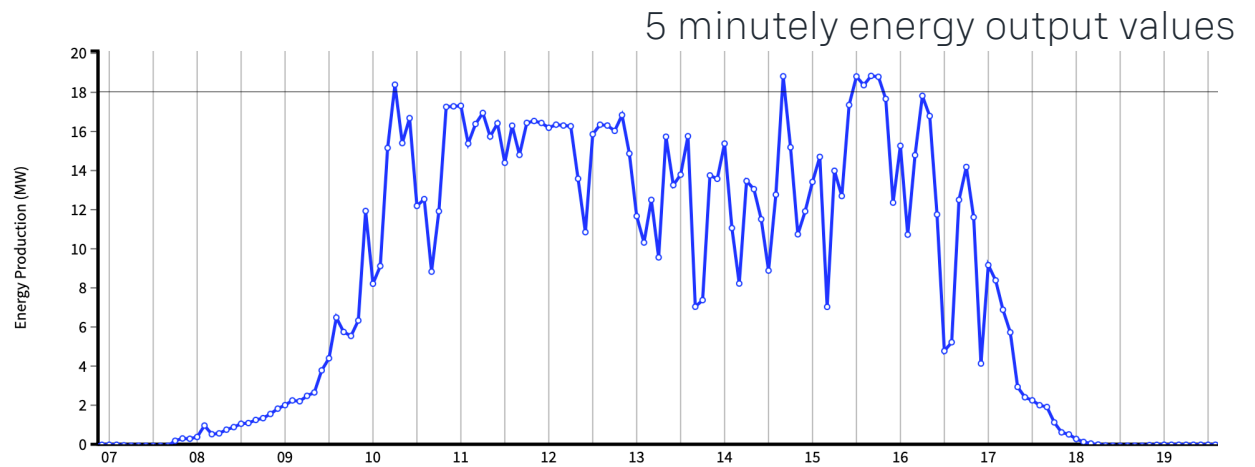
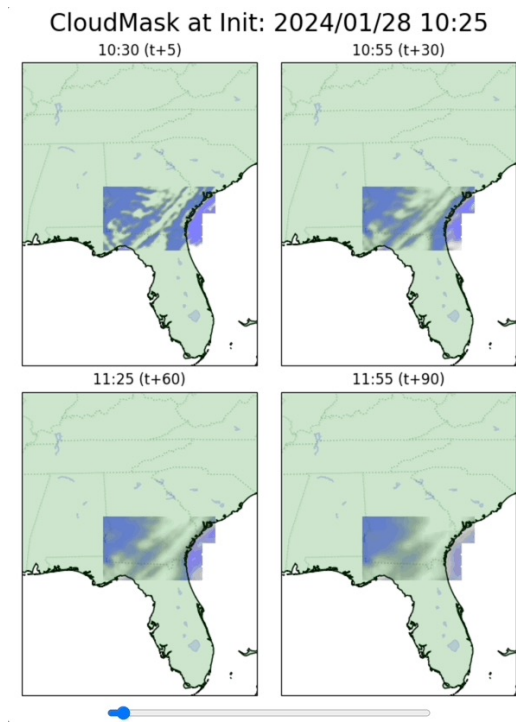
# Let's take a look at some forecasts (cloudy)

OBSERVED, BASELINE, CLOUDCAST



Better – held the clouds a bit longer in the middle of the day, NWP tended toward a break.

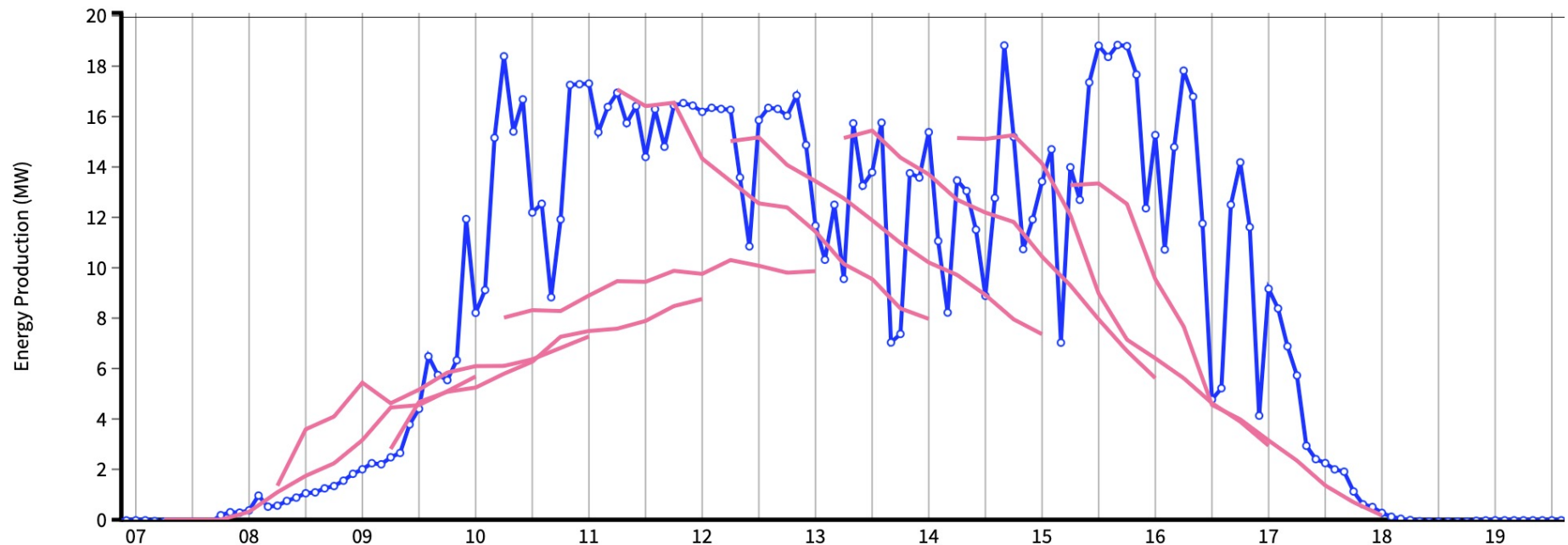
# A PARTLY CLOUDY day in the life of solar farm



← 5 minutely satellite images and forecasts for next 2 hours, updated every five minutes

# A partly cloudy day with the baseline forecasts

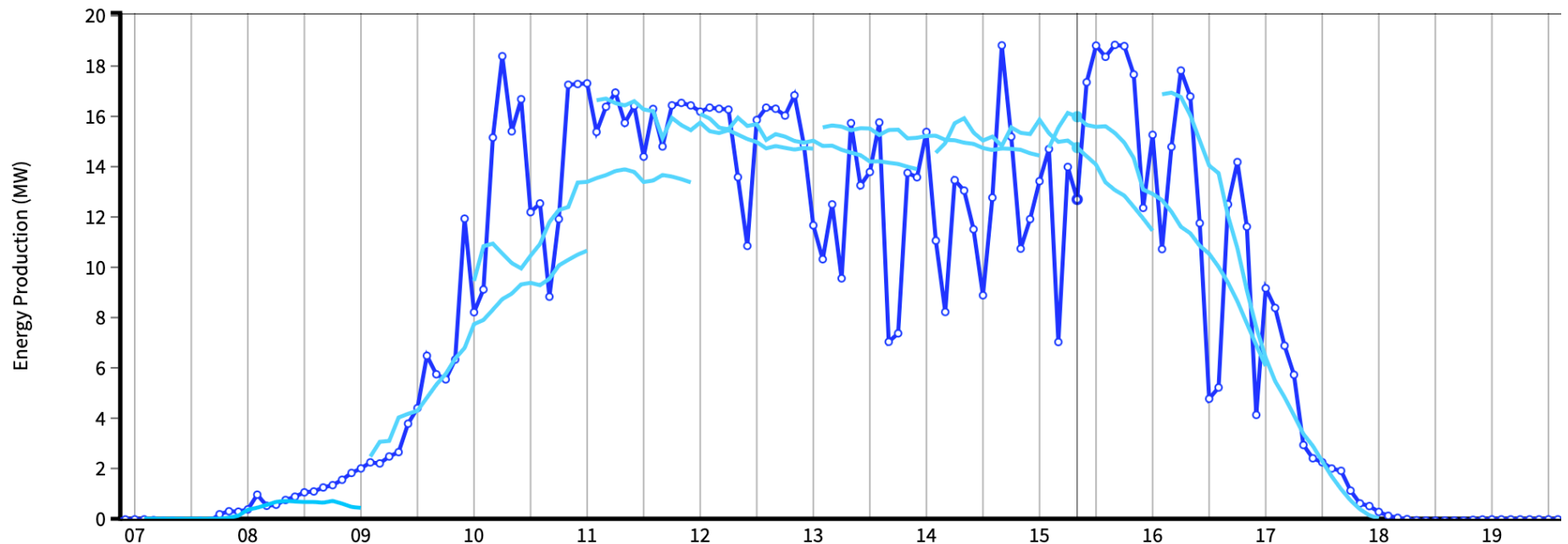
OBSERVED, BASELINE, CLOUDCAST



**Baseline:** A forecast that considers local observations and NWP only is not very skillful - despite the statistics in the trial

# Short-term energy forecasts and cloud now-casting

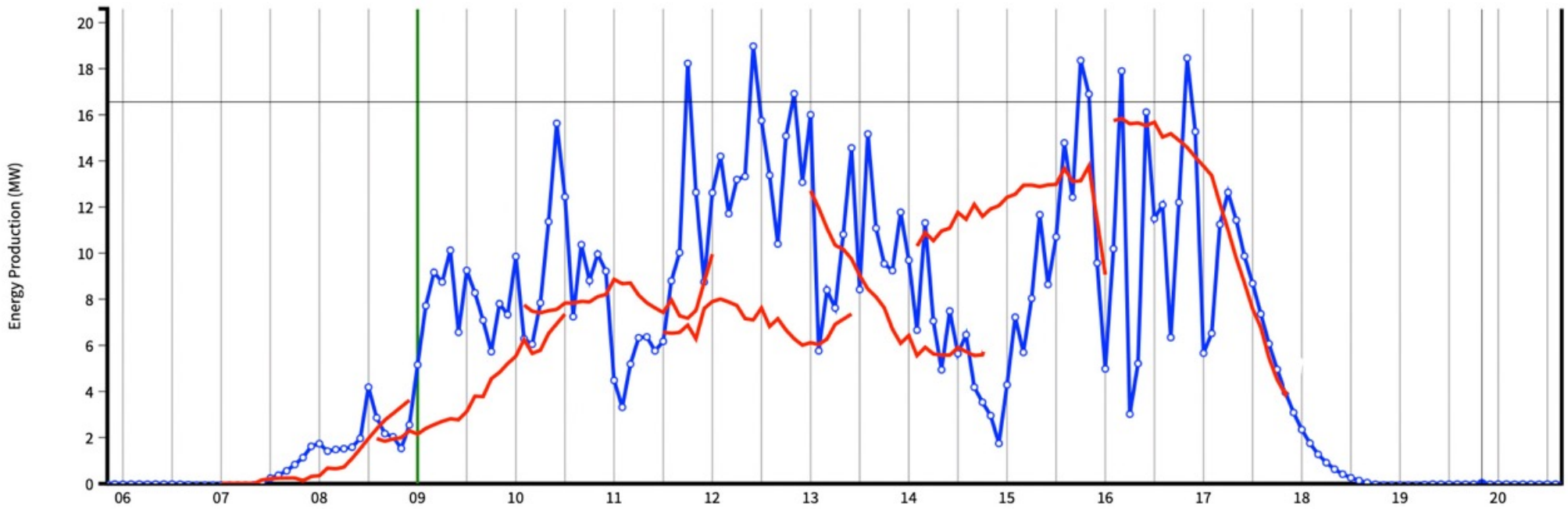
OBSERVED, BASELINE, CLOUDCAST



Now that's a better forecast that considers local observations, NWP, and cloud motion.

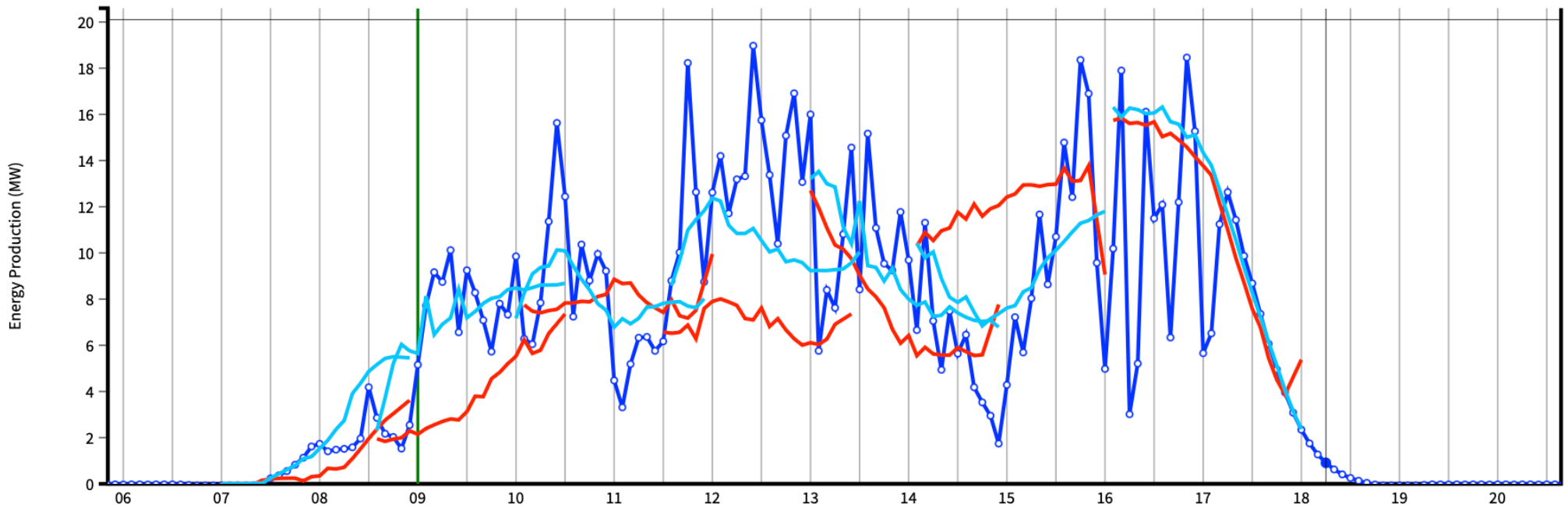
# Another Partly Cloudy Day.

OBSERVED, BASELINE, CLOUDCAST



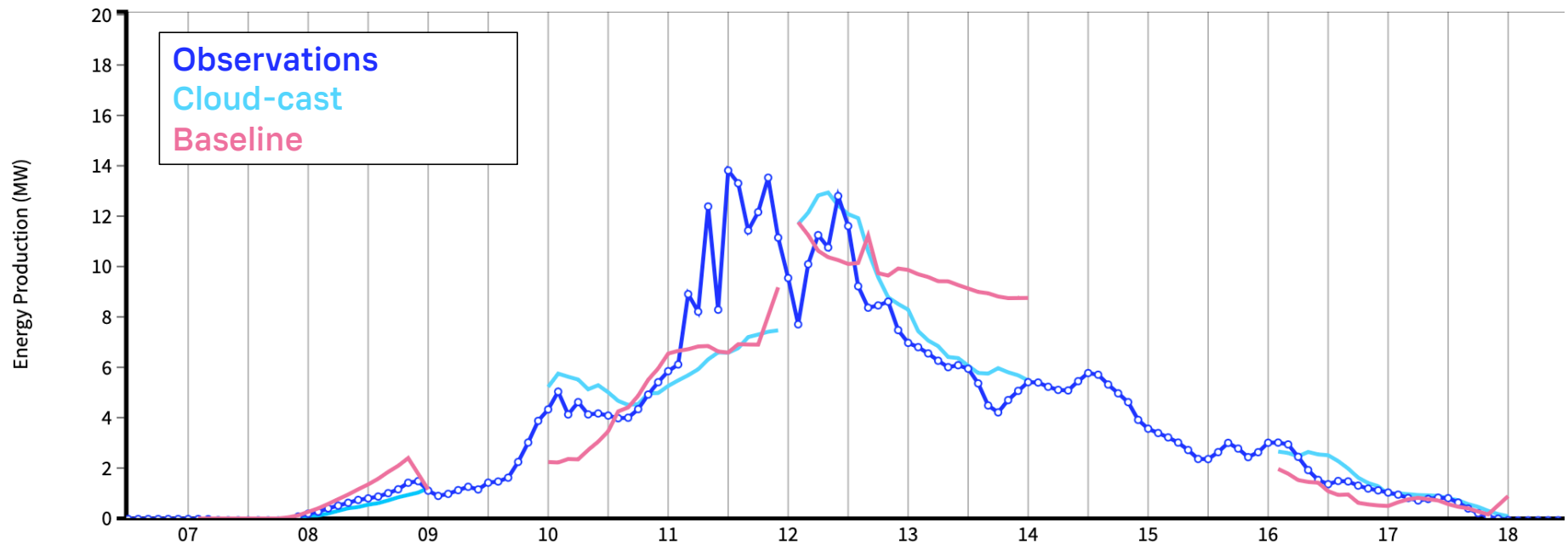
# Another Partly Cloudy Day.

OBSERVED, BASELINE, CLOUDCAST



Now that's better – but still ...

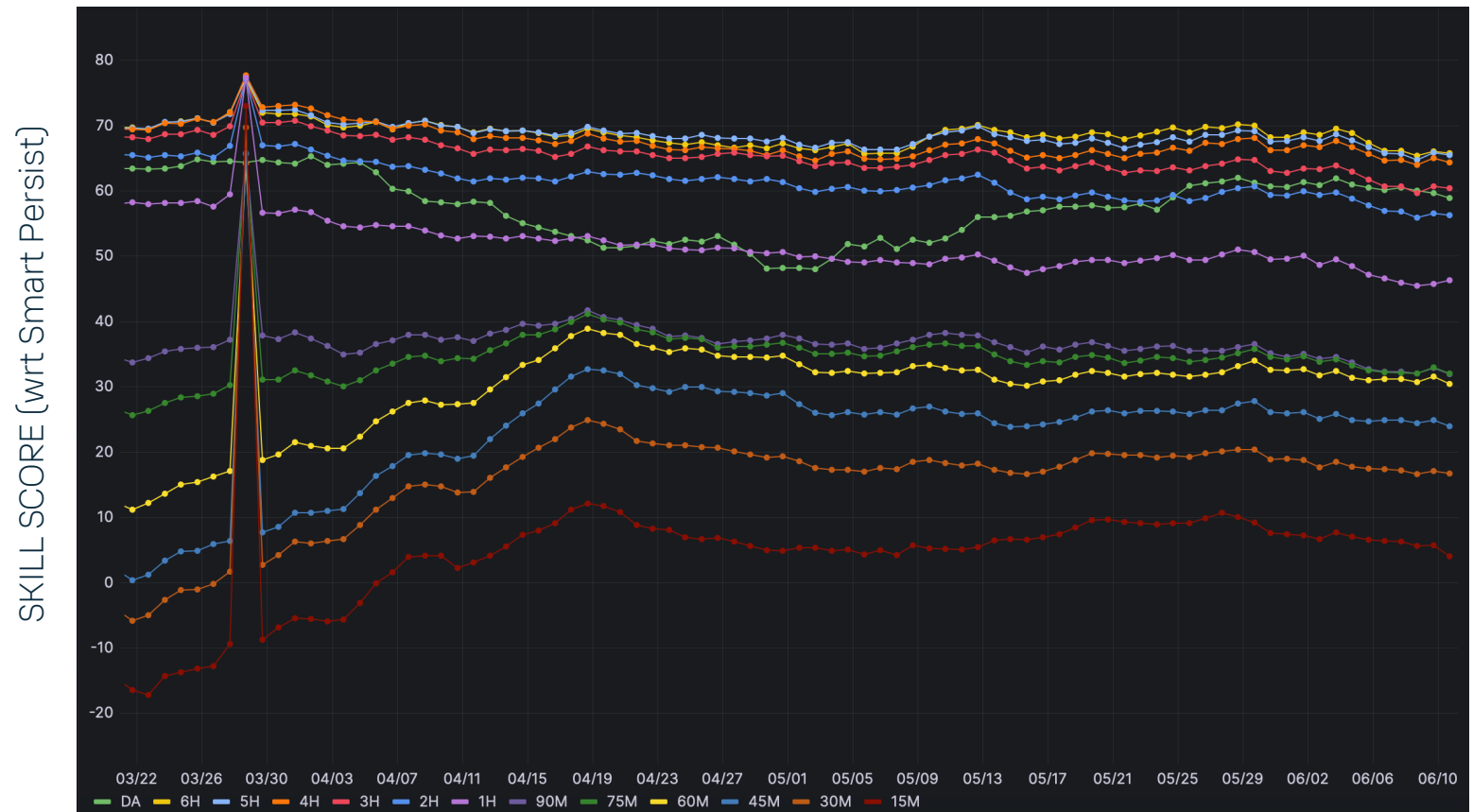
# A different day in the life . . .



That occasional flash of brilliance . . . we've only just begun!

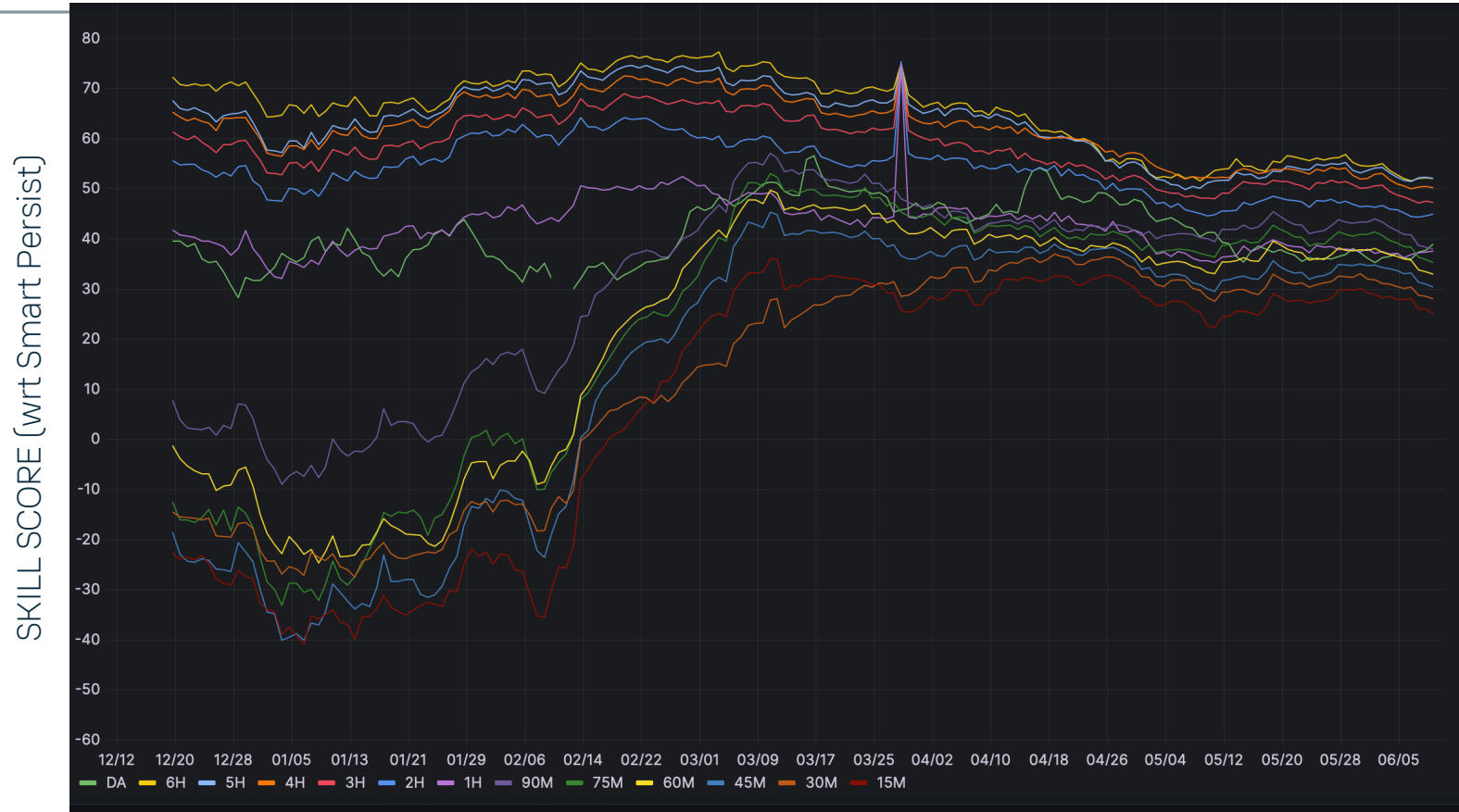
# FEAST YOUR EYES

- Cloudcast enhanced energy forecasts put into production on March 22.
- 60-75 min horizon skill score improved from (10 to 20%) to 35%
- 30 minute ahead skill score improved from 0 to ~20%



# FEAST YOUR EYES

- Cloudcast enhanced energy forecasts put into production in January.
- 60-75 min horizon skill score improved from 0 to 30 to 40%%
- 30 minute ahead skill score improved from dreadful to ~25%
- 15 minute ahead skill score increased from awful to over 20%



# Short-term solar forecasts are like children!?

---

1. They are ours, so of course we think they are above average. (Outperform the benchmarks)
2. Occasional flashes of brilliance (Nail those ramps, sometimes!)
3. Still room for improvement! (We/They are just starting to learn).

What if we could do this for wind?



