



Considerations for Long-Term Load Forecasting in Morocco

Jennie Jorgenson

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Webinar with ONEE

Long-Term Load Forecasting

Long-term load forecasting is *important*:

- Power system investments are capital-intensive and take time;
- Unrealistic forecasts could lead to too much investment or too little; and
- Meeting long-term goals (such as renewable energy targets) could be dependent on future load.

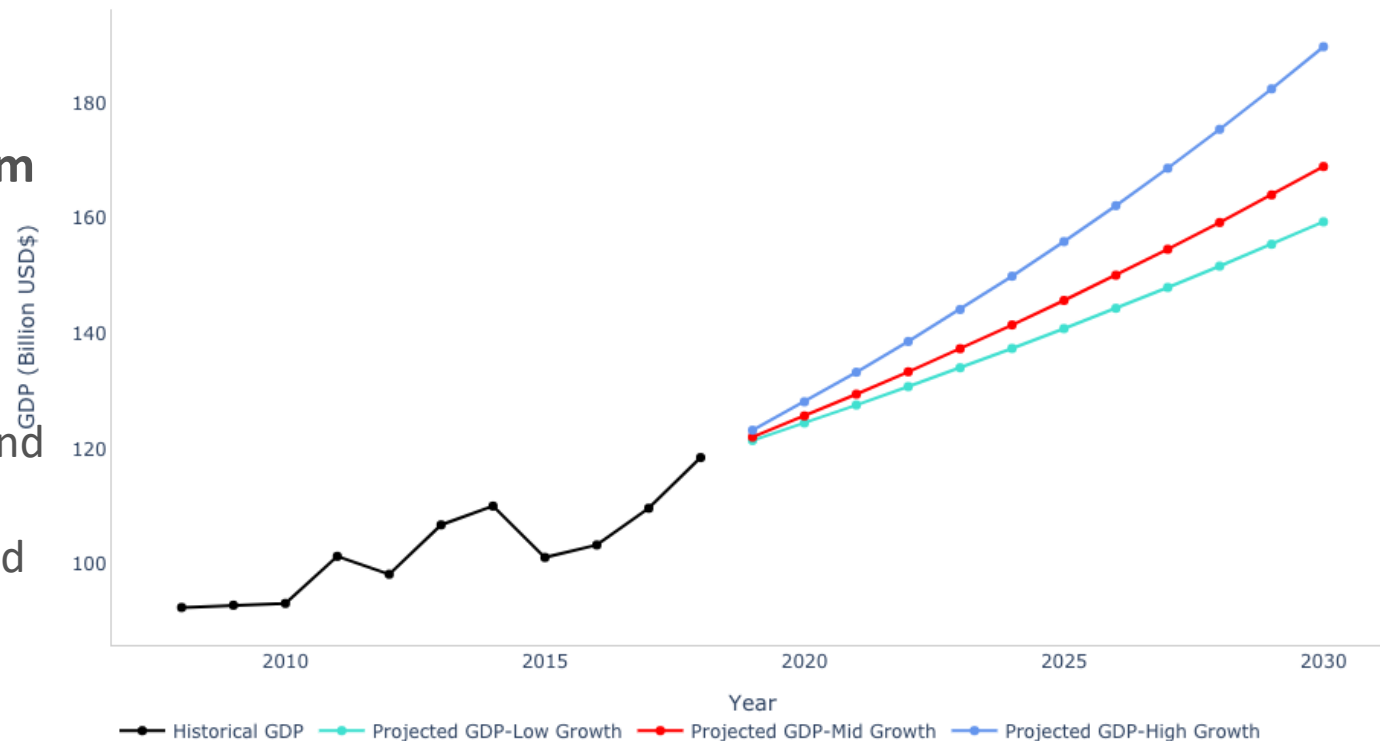
Long-term load forecasting is *challenging*:

- Many factors influence electricity demand (gross domestic product [GDP], population size, degree of electrification); and
- Some factors may involve consumer behavior (customer adoption of technologies or distributed generation).

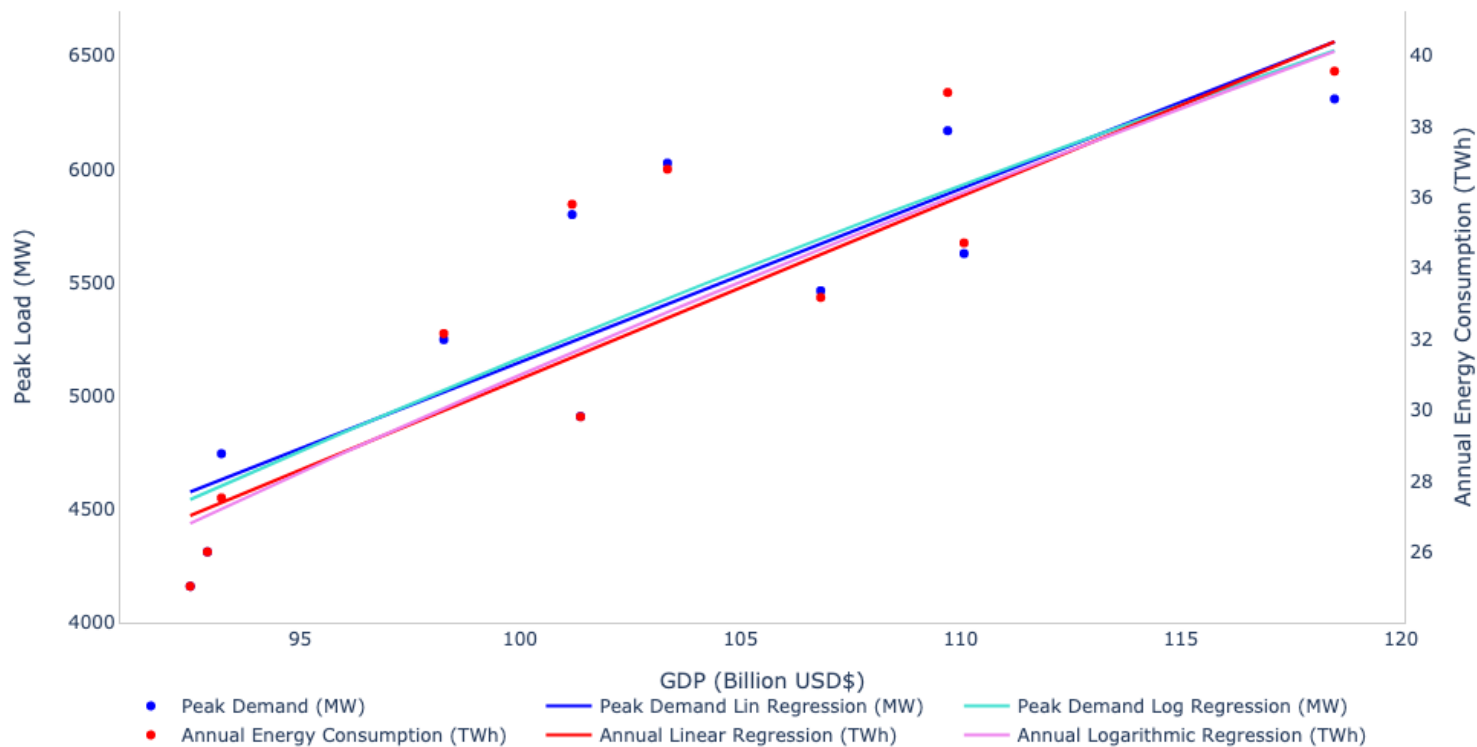
GDP and Demand Growth

Predicting GDP growth is often the first step in long-term load forecasting:

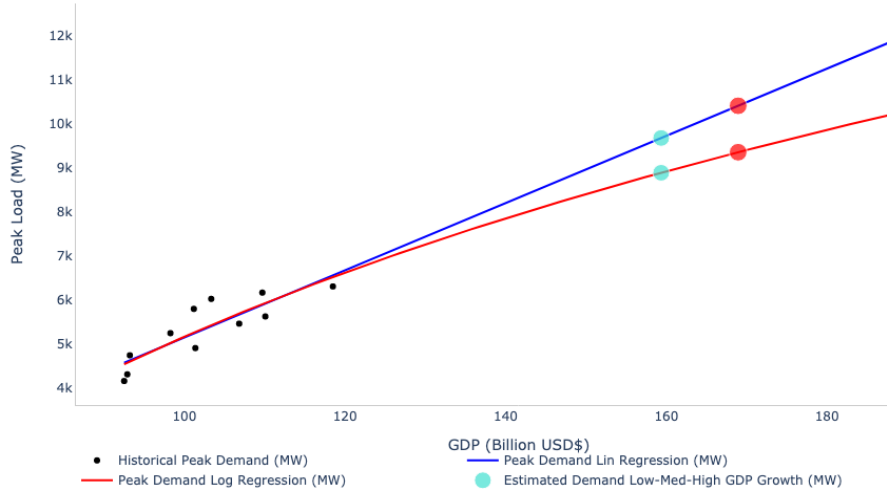
- Drivers of GDP growth are often energy-intensive; and
- Increased GDP can also promote spread of energy-intensive technologies.



GDP and Demand Growth



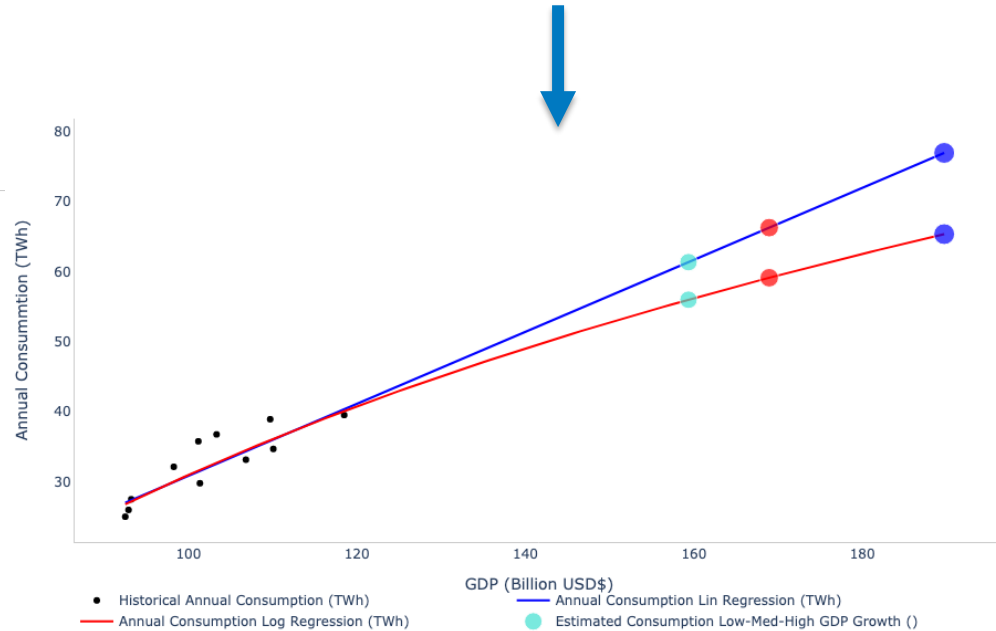
Peak Load and GDP



Peak load vs. GDP



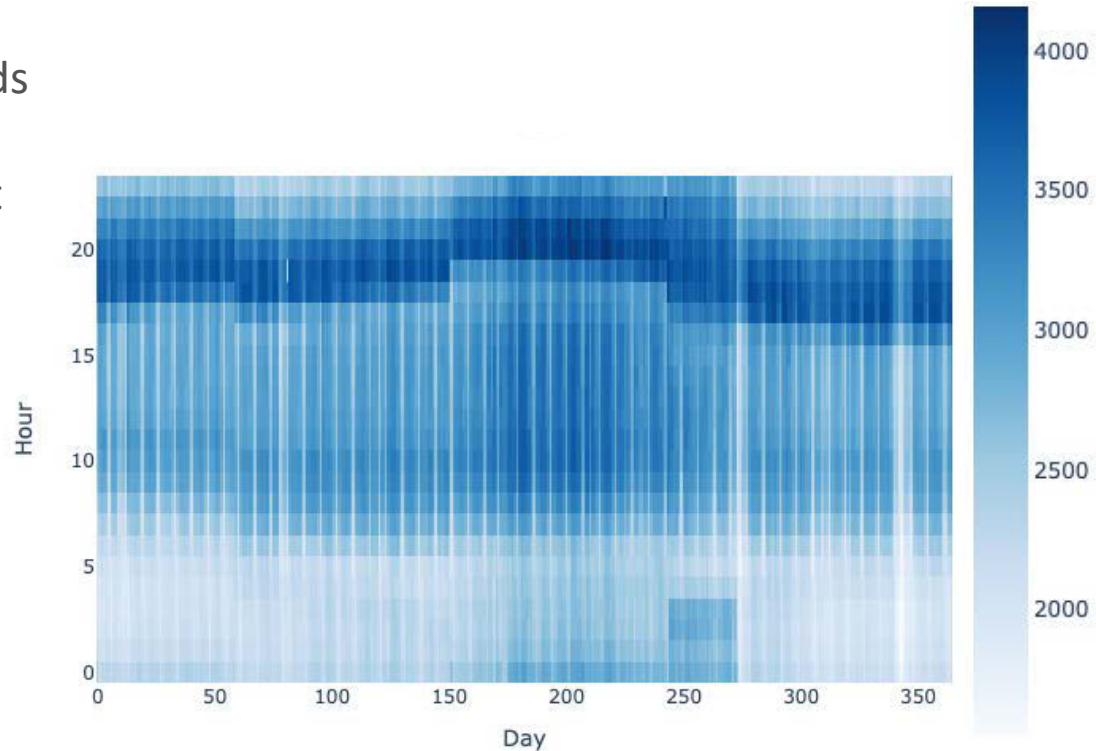
Annual consumption vs. GDP



Load Shapes

What do load shapes look like today, and how might they look in the future?

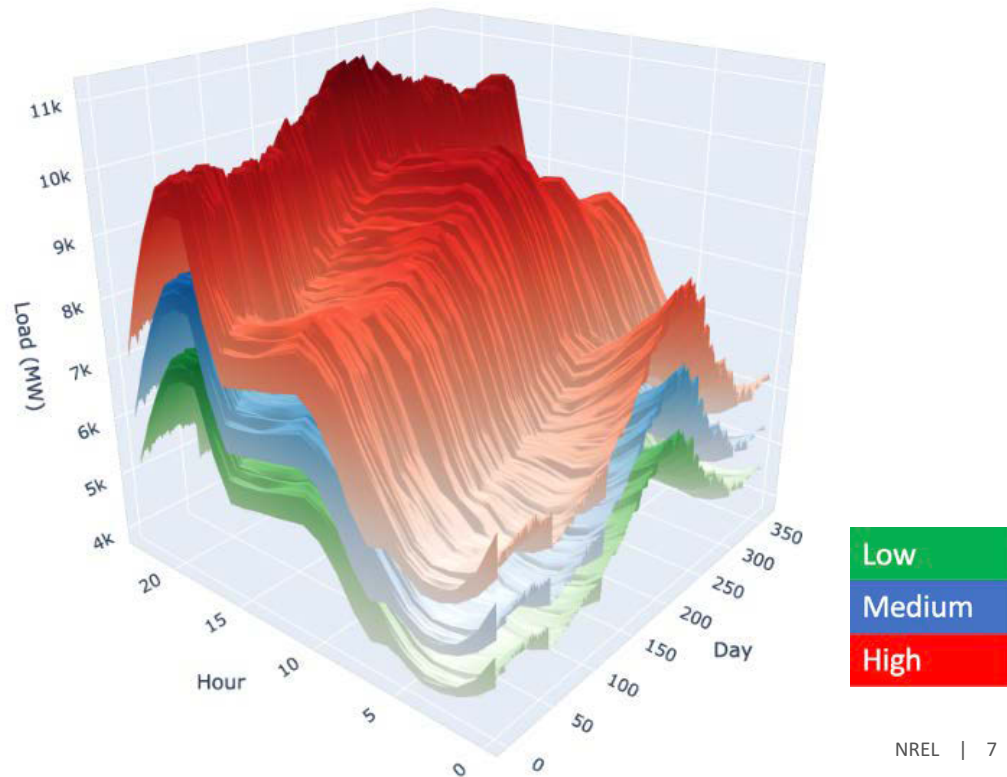
- Understanding how loads vary by time of day and season is also important
- 2008 load data shows how peak daily demand occurs in the evening during all seasons in Morocco.
- Highest absolute load occurs in summer (July/August).



Load Shapes

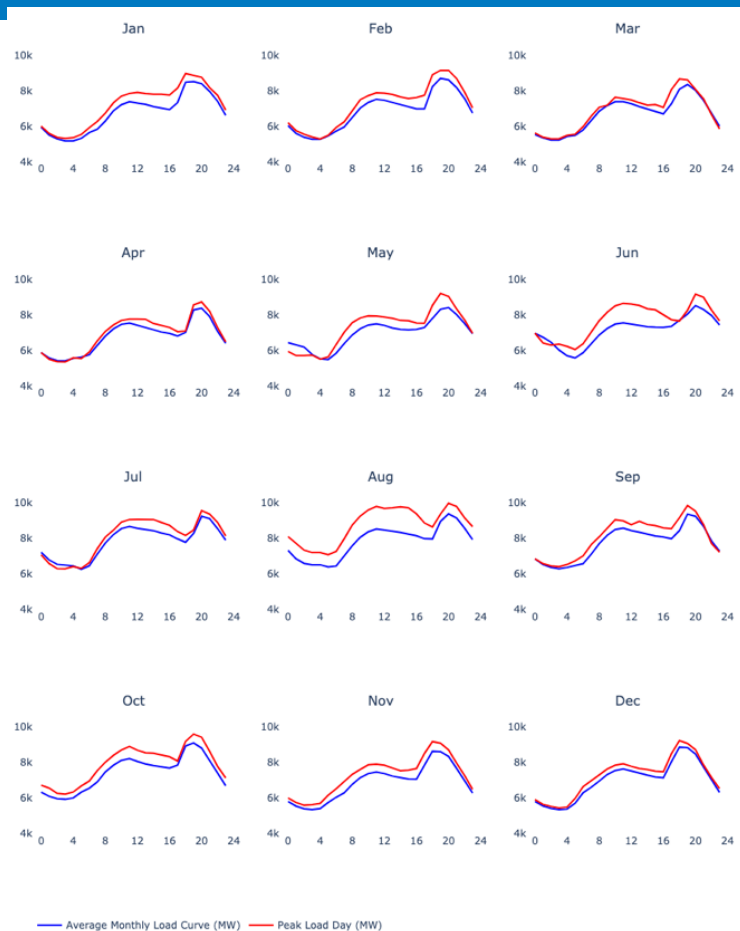
What might load look like in the future?

- Based on the linear relationship between GDP and load – scaling up hourly load to meet projected levels
- Shows how the magnitude (though not the shape) might change.



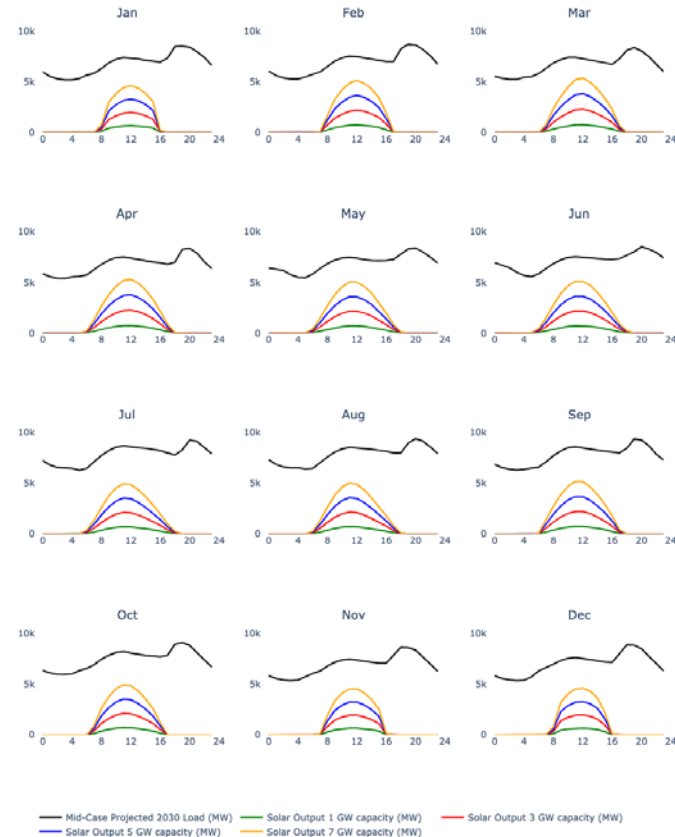
Monthly Load Shapes for 2030

- Similar load shapes for most months with varying magnitudes
- We see a fairly “peaky” system, which could benefit from time-of-use rates or demand response programs.
- Also important to consider changing sources of load and the impact that widespread air-conditioning or electric vehicles may have.



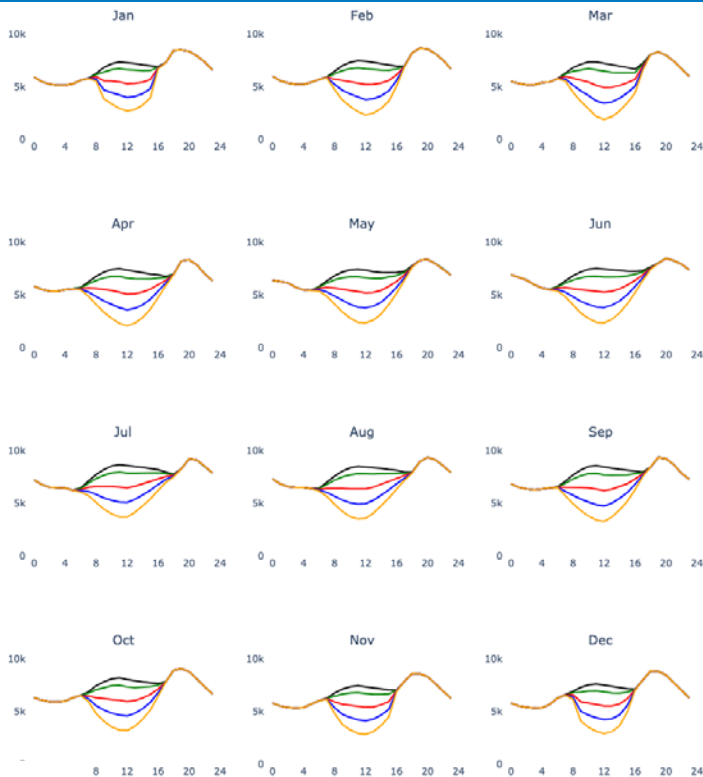
Variable Generation Changes the Shape of Net Load

- Variable generation (such as photovoltaics [PV] in this case) is a zero-marginal cost source of generation and usually dispatched first.
- With lower amounts of PV penetration, the extra generation during the day may not require dramatically different system operation.
- But at higher penetrations...



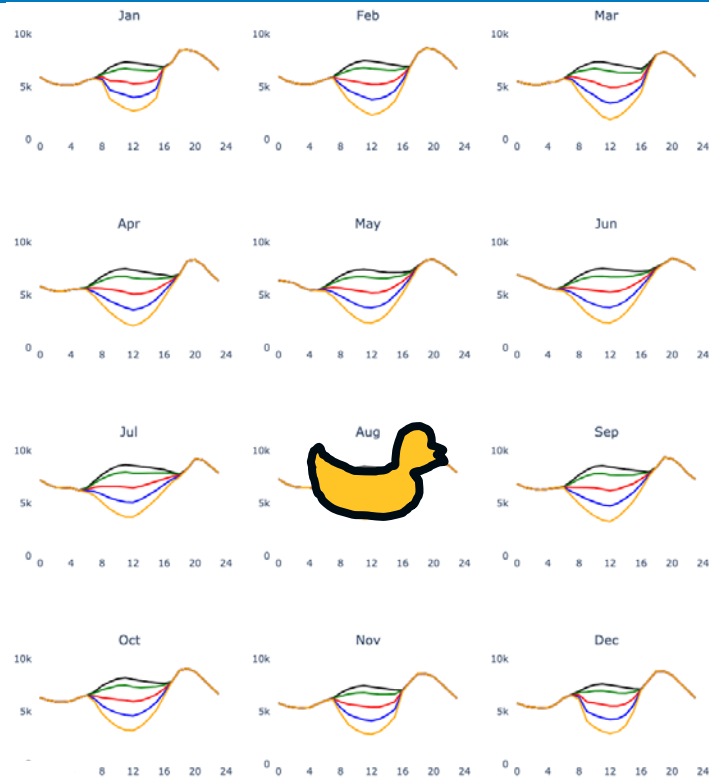
Variable Generation Changes the Shape of Net Load

- Infamous “duck curve” in the shape of the net load
- Characterized by:



Variable Generation Changes the Shape of Net Load

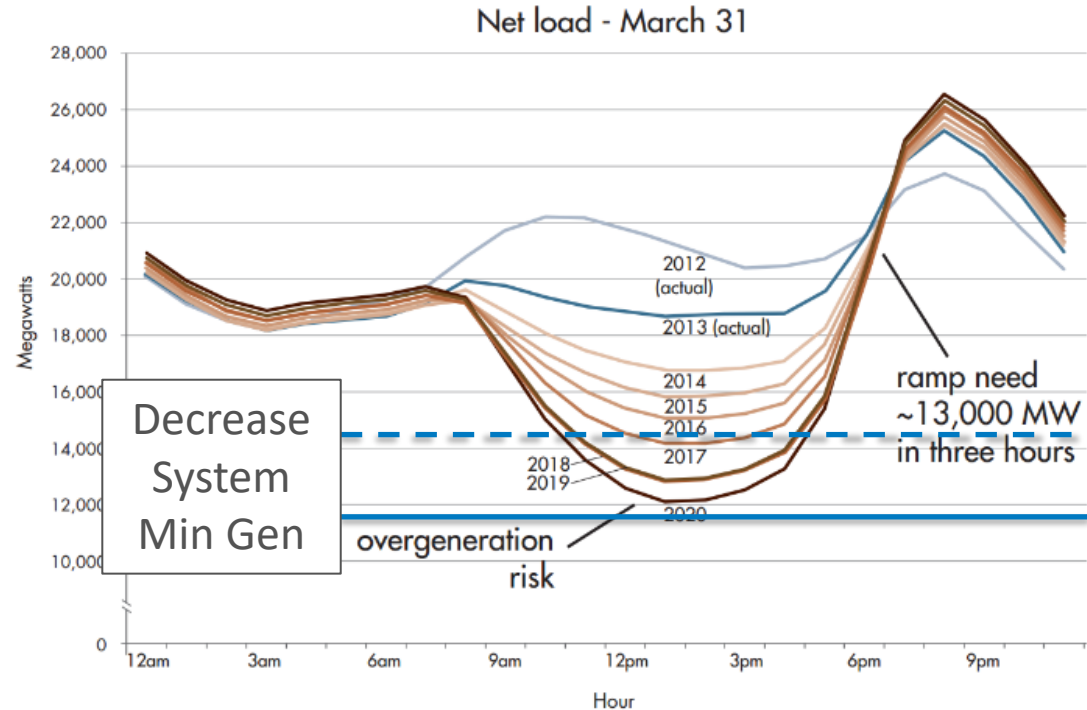
- Infamous “duck curve” in the shape of the net load
- Characterized by:
 - Dip in the middle of the day when solar output is the highest
 - Steep ramps in the morning and afternoon during sunrise and sunset.
- Creates new challenges for system operators.



Operational Considerations for the Duck Curve

- **Fattening the duck:**

- Changing operational practices to allow more cycling
- Minimizing the amount of thermal units on by improving PV forecasts and not holding excessive reserves—even letting PV provide reserves.



Source: California ISO. 2016. "What the Duck Curve Tells Us about Managing a Green Grid." California Independent System Operator.

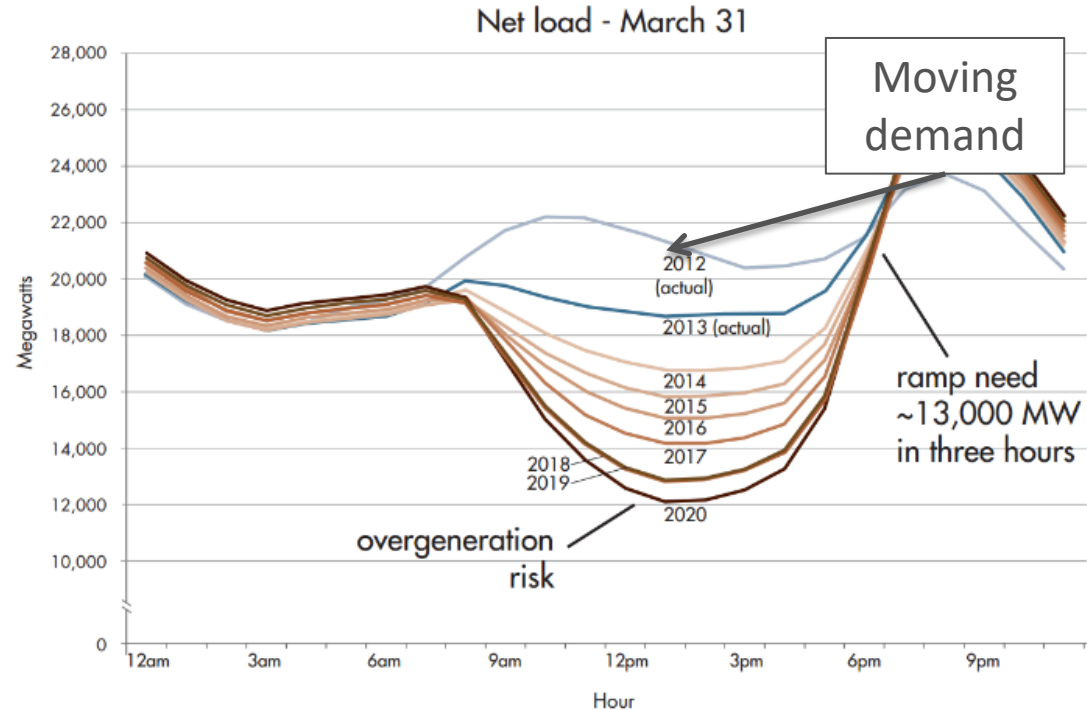
Operational Considerations for the Duck Curve

- **Flattening the duck:**

- Shifting supply/demand patterns to better align with PV availability
- Responsive demand or energy storage.

- **Other considerations:**

- More balanced mix of renewable energy (rather than PV-heavy)
- Additional interchange with neighbors
- The **cost** of these solutions need to be compared to the **value** to ultimately determine the best solutions.



Source: California ISO. 2016. "What the Duck Curve Tells Us about Managing a Green Grid." California Independent System Operator.

Conclusions and Next Steps

Long-term load forecasting is *important* but *challenging*:

- Power system investments are capital-intensive and take time; and
- Many factors influence electricity demand (GDP, population size, degree of electrification).

Next steps:

- Some factors may involve consumer behavior (customer adoption of technologies or distributed generation);
- An analysis of these factors (and others) can feed a bottom-up load analysis that can start to capture complicated interactions:
 - Air conditioning deployment
 - Energy efficiency and demand response programs
 - Electric vehicle adoption
 - Distributed generation.
- Better understanding the underlying demand can help with integrating variable generation—and if further mitigation efforts will be necessary

Key Points

- Long-term load forecasting is challenging because it depends on many factors, but historically the biggest impact comes from growth in GDP; which is why forecasting GDP is often the first step.
- Logarithmic and linear regression methods are often applied to relate GDP to demand.
- We can use simple normalization techniques to estimate how hourly load may scale into the future, although that method ignores several important factors—such as how technology diffusion (for instance, air conditioning or electric vehicle deployment) may change load shapes in the future.
- Variable generation such as solar can also impact the future load shapes by reducing net load in the middle of the day.
- Next steps are bottom-up load modeling, which would incorporate impacts from changing load (including air conditioning loads, electric vehicle loads, distributed generation, solar) to get a more complete picture of how load and load shape may change in the future.



Thank you!

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