

GCAM-USA Electric Sector: Separating Investment and Dispatch

Pralit Patel

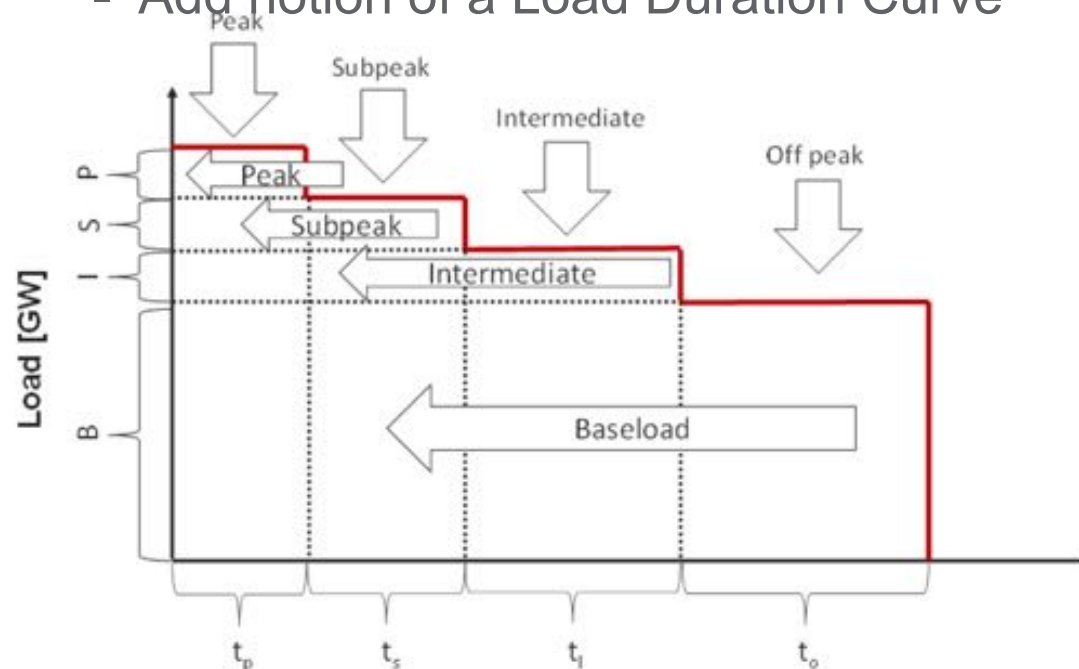
Marshall Wise; Zarrar Khan; Gokul Iyer;

Son Kim; Mohamad Hejazi



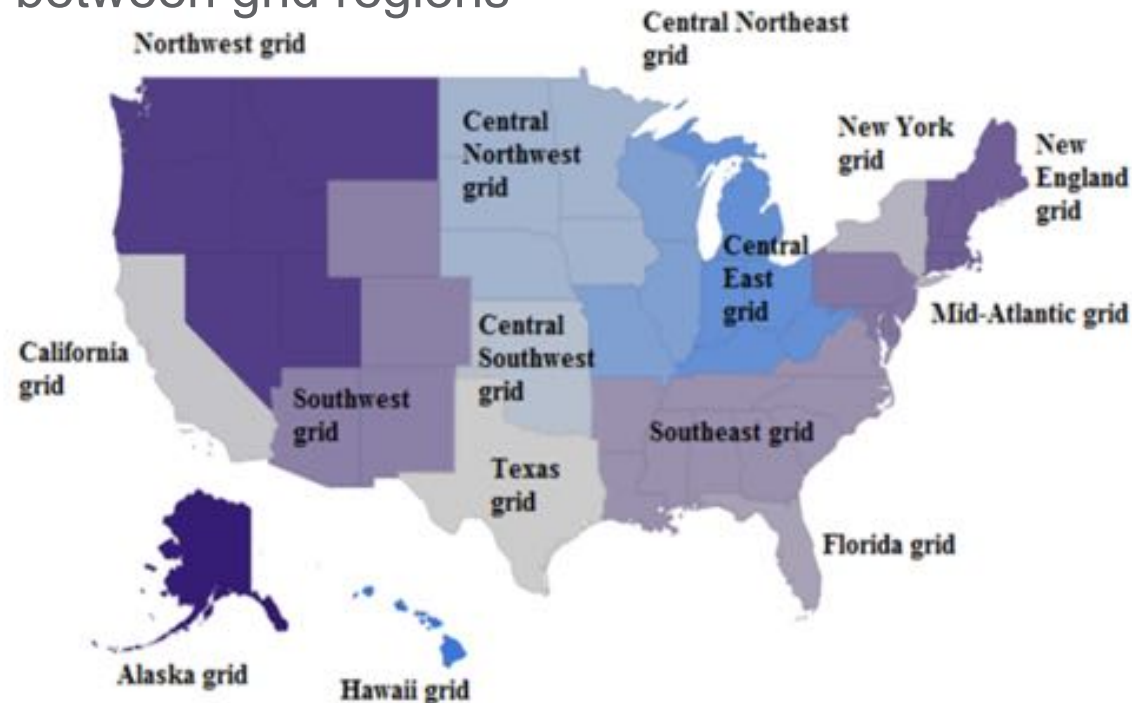
Goals and development challenges

- Improve sub-annual dynamics in GCAM-USA's power sector to be able to answer science questions related to the implications of changing sub-annual load profiles due to various stressors including temperature and precipitation
 - GCAM does not explicitly track electricity capacity, only generation
 - Capture some notion of electricity capacity operation
 - Add notion of a Load Duration Curve*

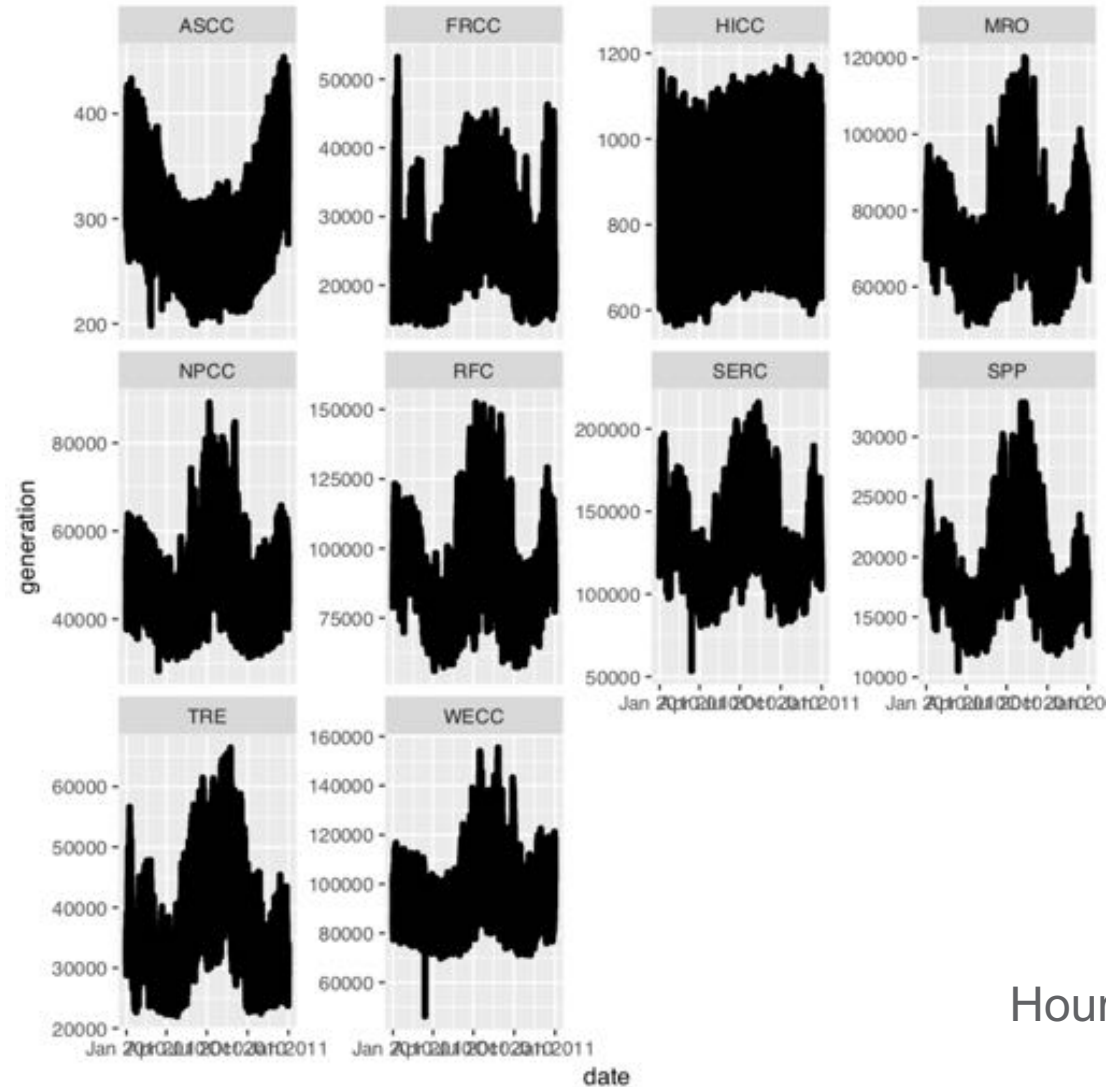


Electricity Modeling in GCAM-USA

- Electricity Generation modeled at the 50-States
- Electricity Demands modeled at the 50-States
- Demands resolved at “Grid-Regions”
 - Limited trade between grid regions

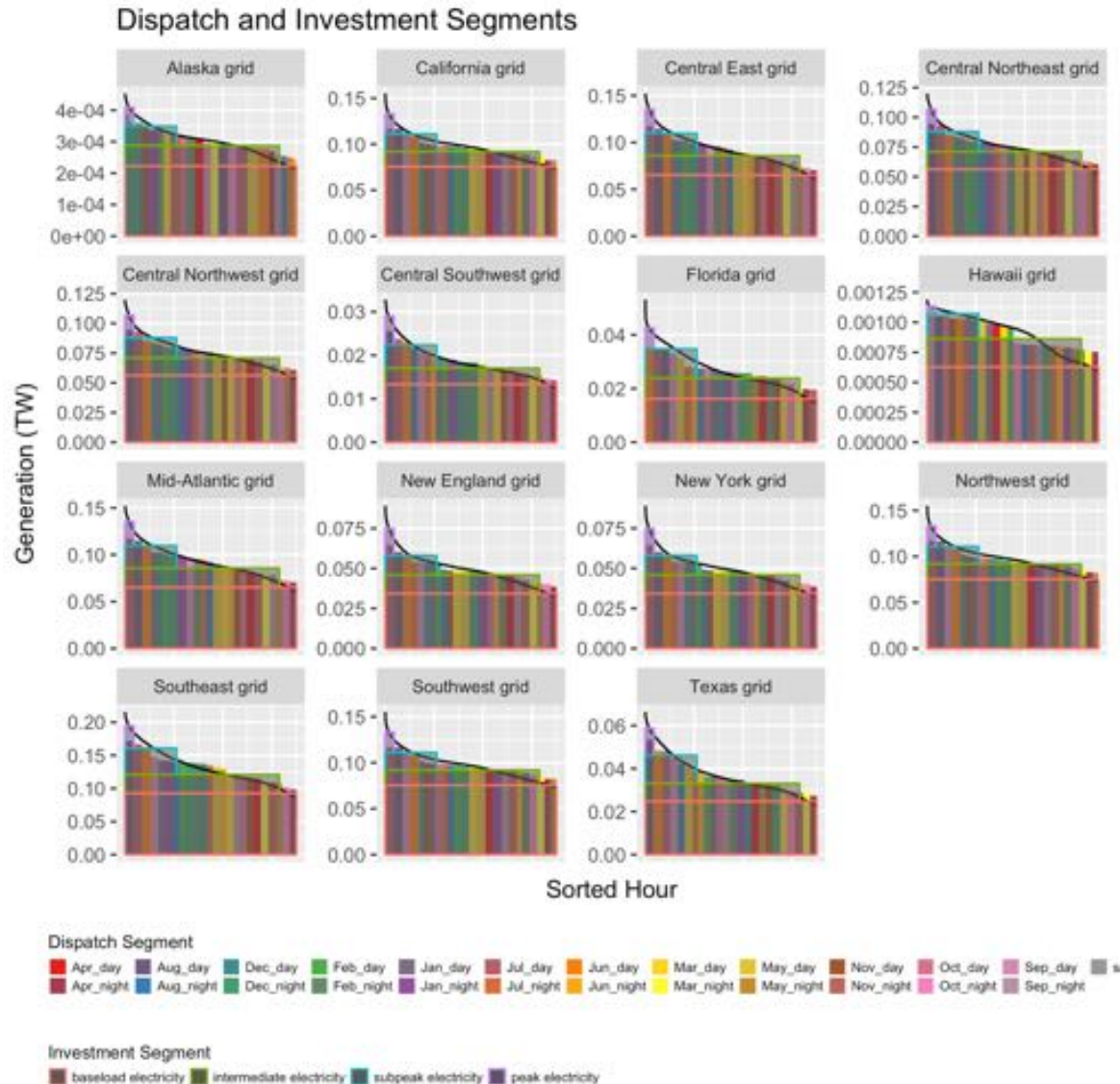


Step one: Develop Load “Segments”

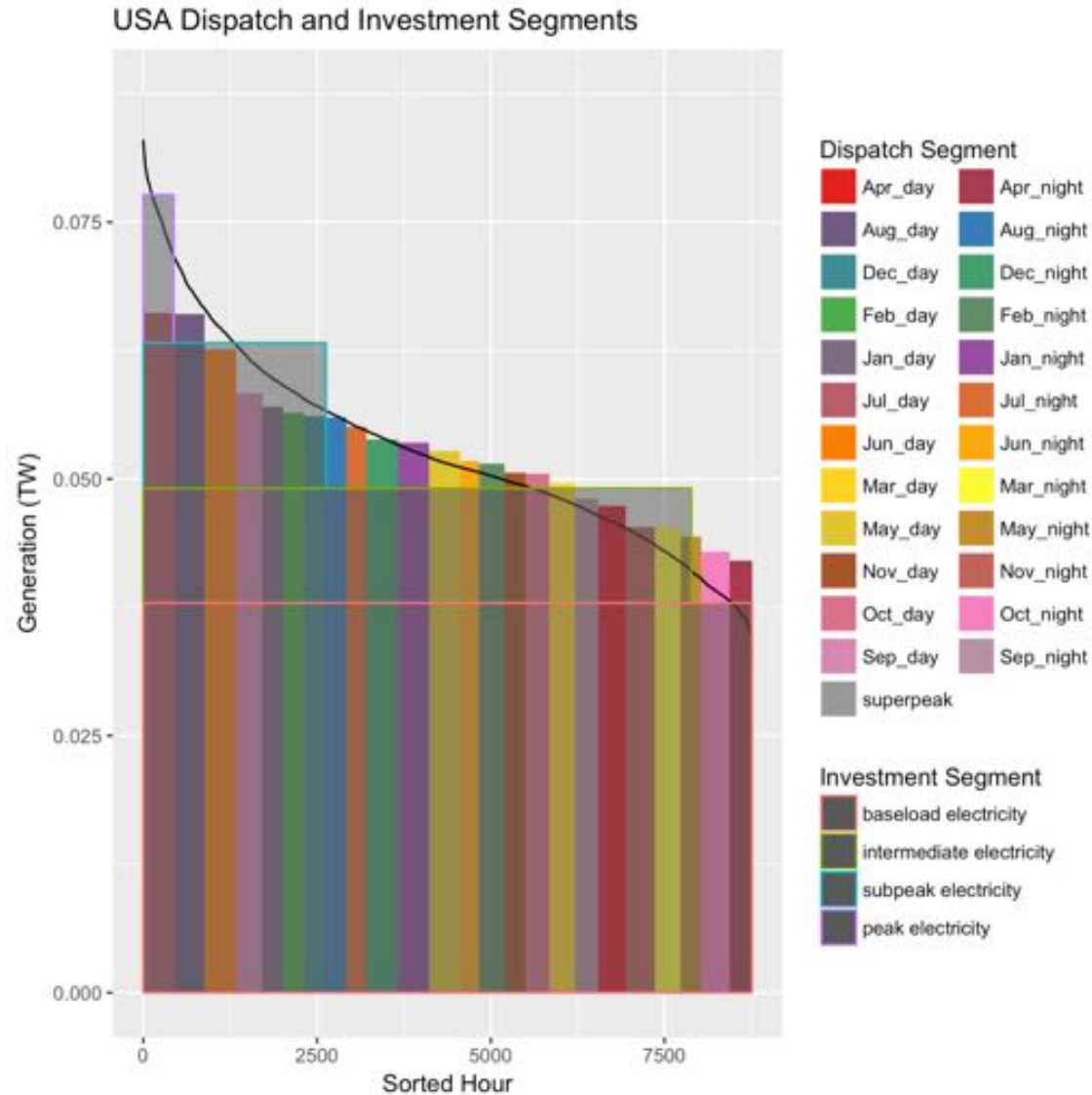


Hourly Generation from FERC-714

Step two: Develop Load “Segments”



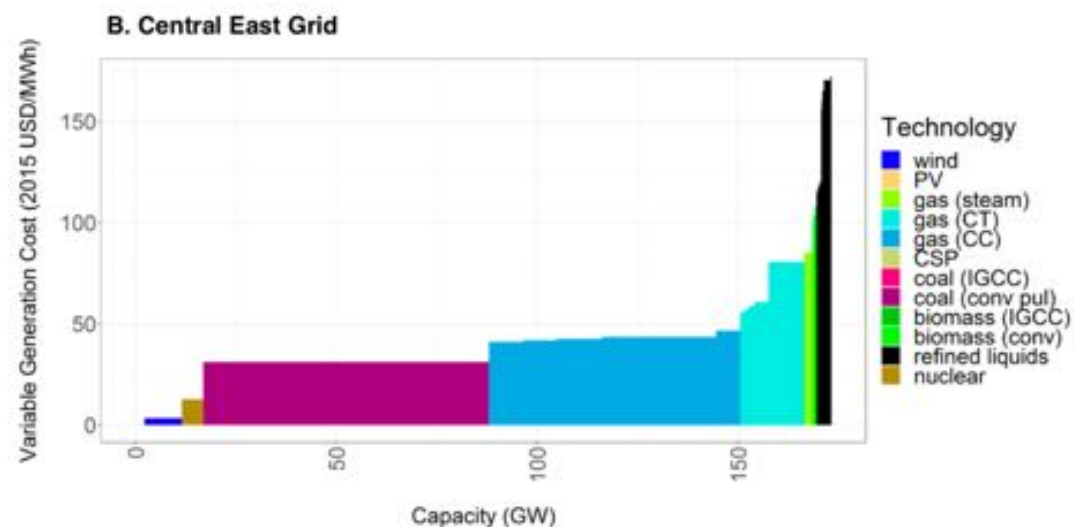
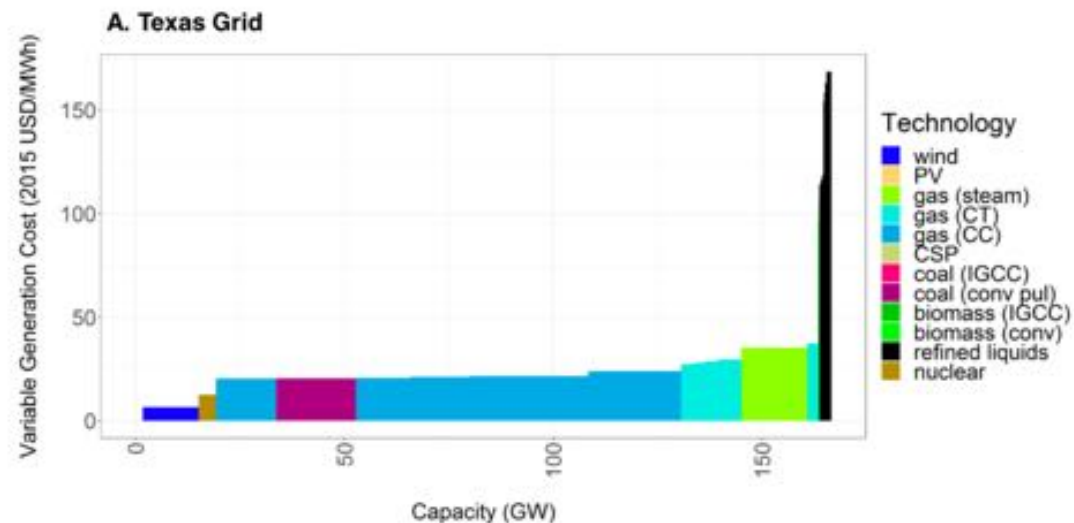
Step two: Develop Load “Segments”



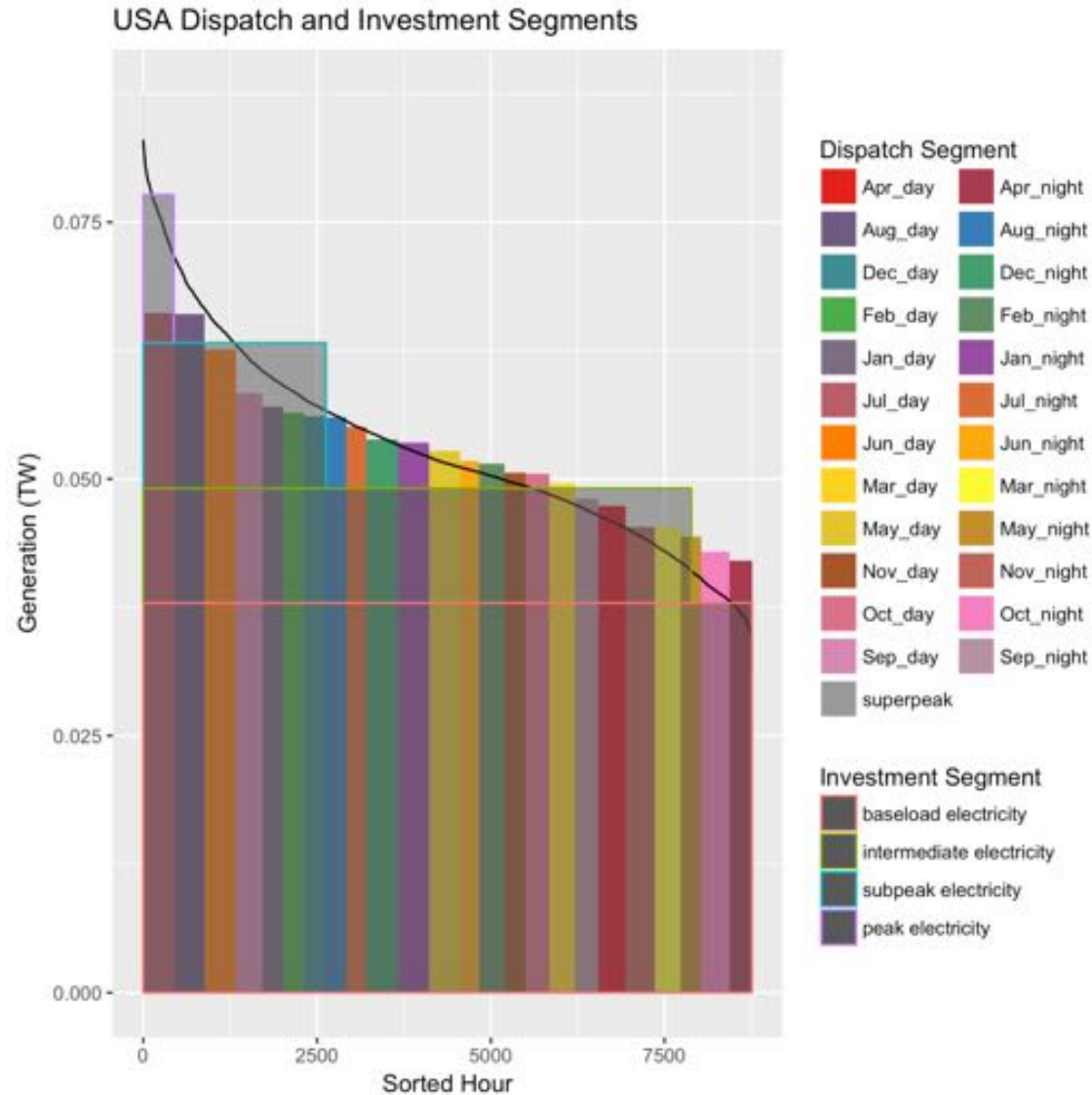
Investment Segment

- Four segments representative for how a technology will be anticipated to be used
 - Same technology costs – different capacity factors
- Use our logit choice model to share out investment in each state
- The total investment is calculated as the additional investment required beyond the existing capacity + capacity margin to meet current demand
- Once capacity is invested it is not “pigeon holed” to the segment it was invested in

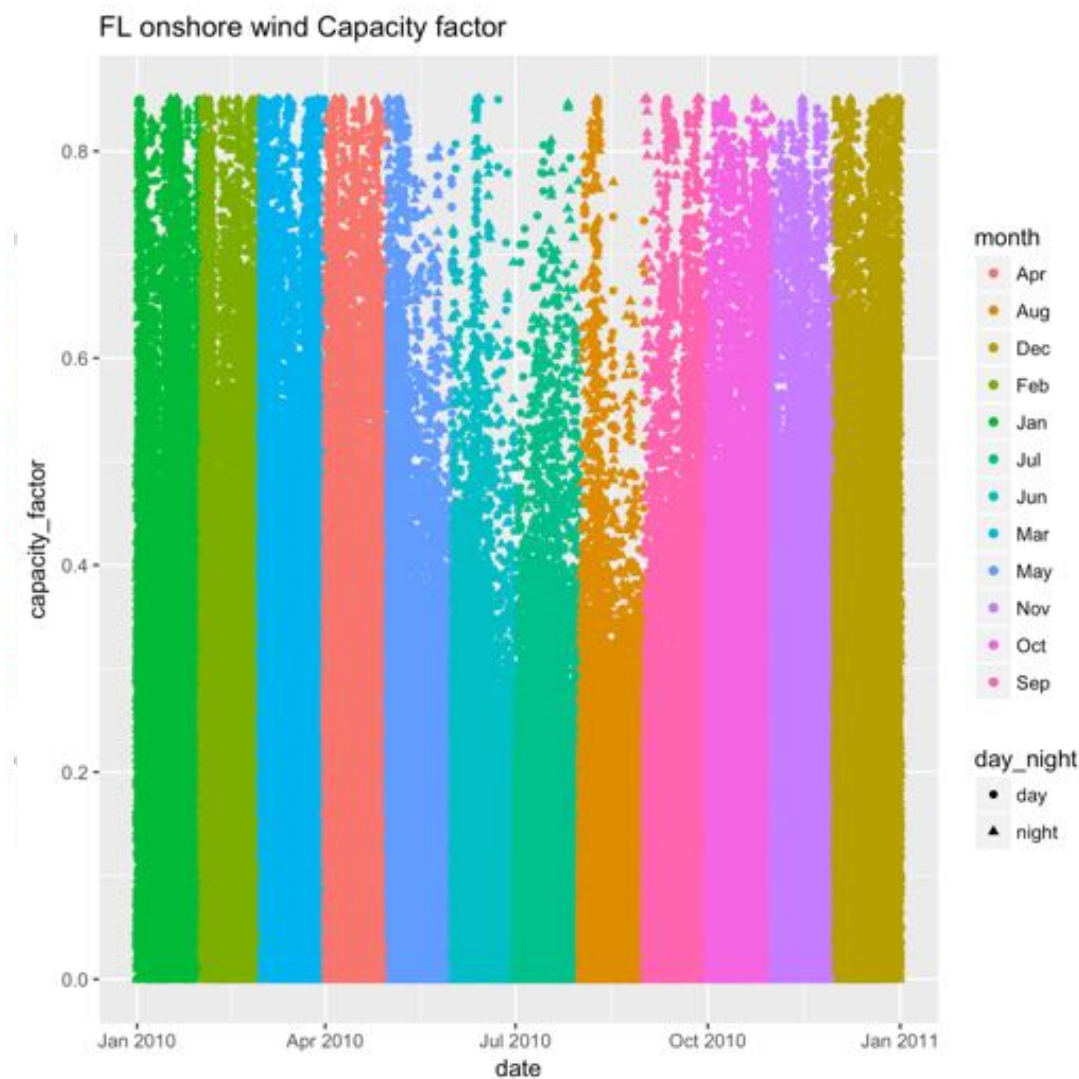
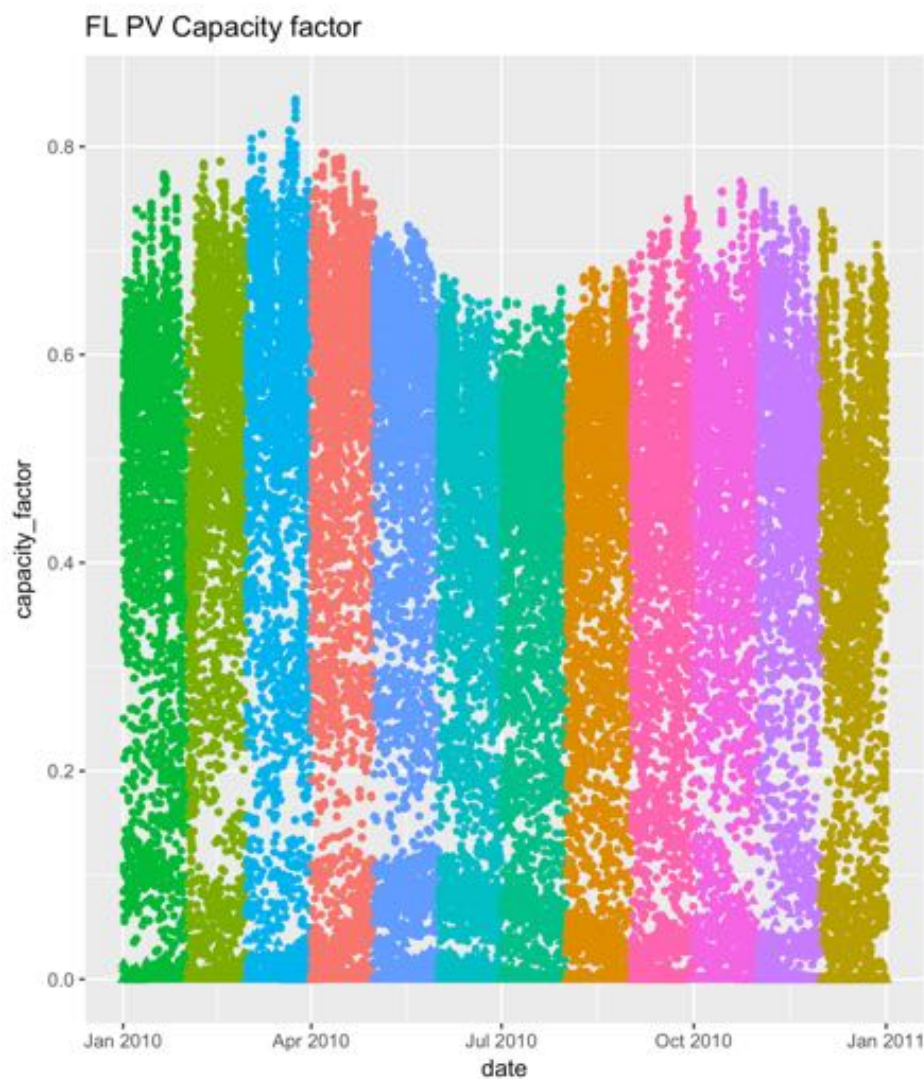
Linear least cost dispatch



Linear least cost dispatch



Dispatch Segment Specific Max Capacity Factors



Capacity Factors Are Endogenous

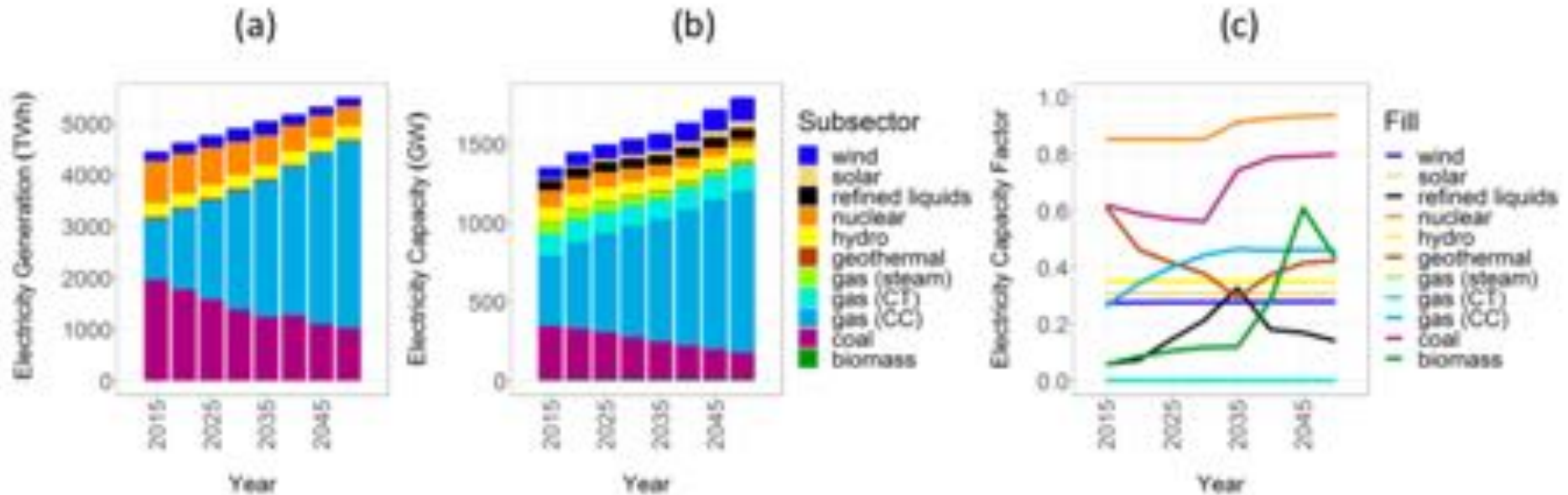
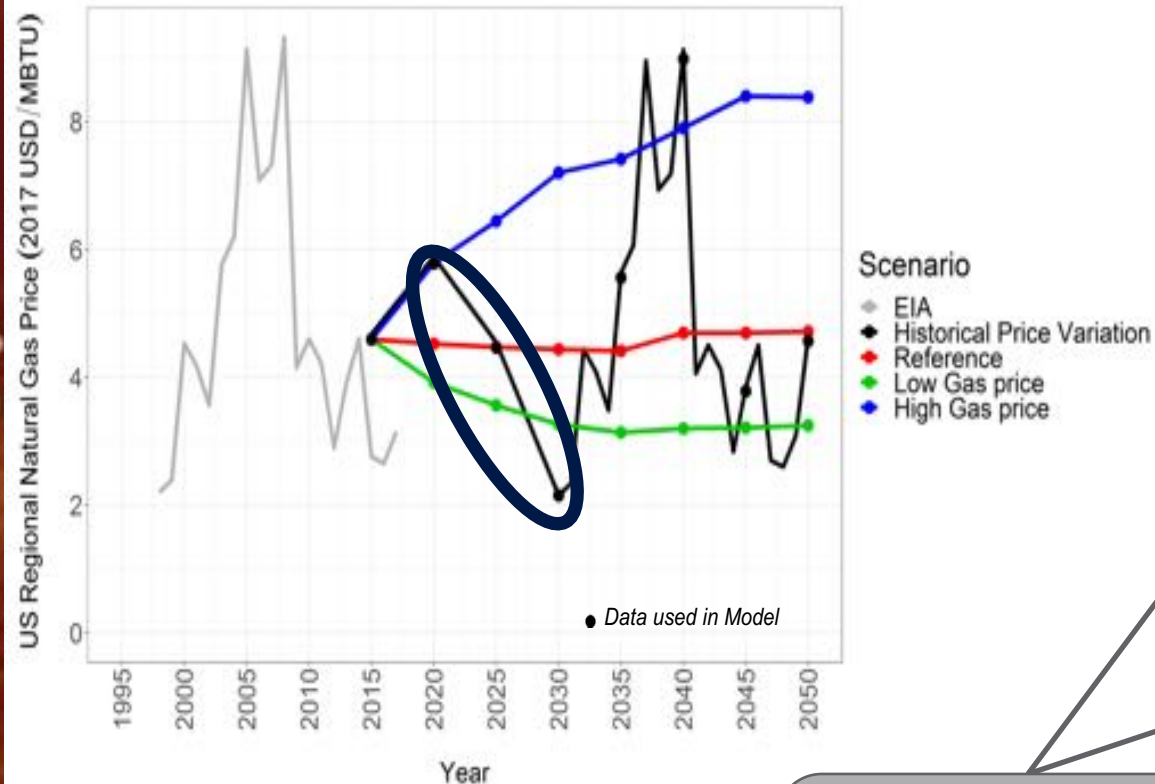


Figure 3 U.S. a.) Electricity generation, b.) Capacity, and c.) Capacity factor by technology in the *Reference scenario*

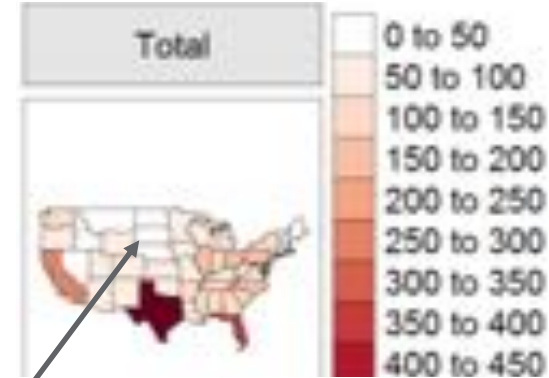
Improved operational flexibility under future stress (e.g. rapid change in natural gas prices)

U.S. Natural Gas Prices

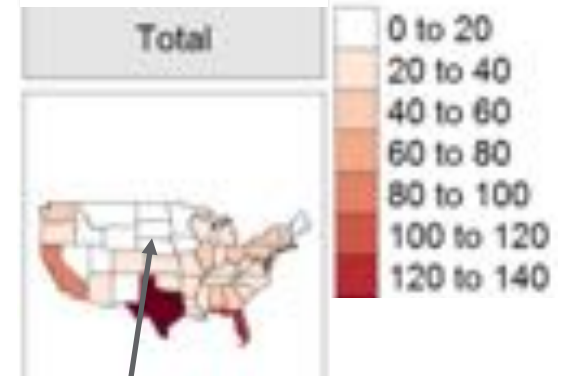


Reference

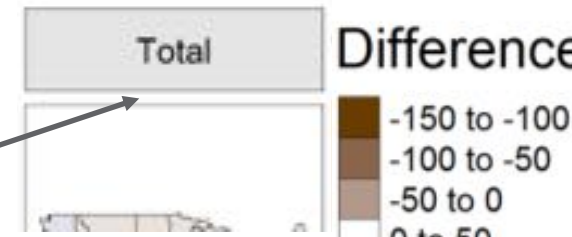
Generation
(TWh)



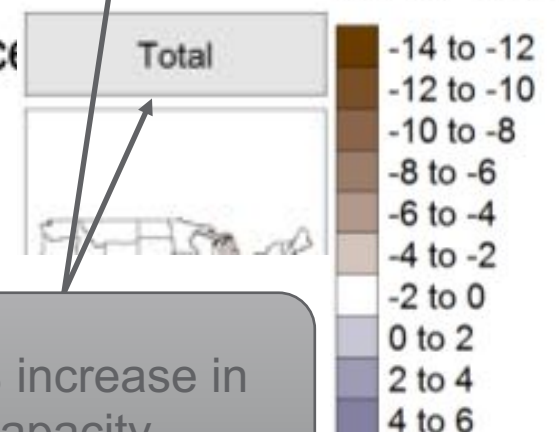
Capacity
(GW)



Historical price
variation



Difference



About 50% increase
in generation

<10% increase in
capacity

Summarize Improvements

- Our improvements allow us to better capture electricity generation and investment fuel mixes within the context of the relative competitiveness
- Our enhancements to separate investment and dispatch decisions in the power sector also enable us to capture the ability of the sector to be flexible in response to various stressors.
- More broadly, our work demonstrates the value of capturing sub-annual decision-making and dynamics in long-term multi-sector models to better understand the resilience of the power sector to future stressors

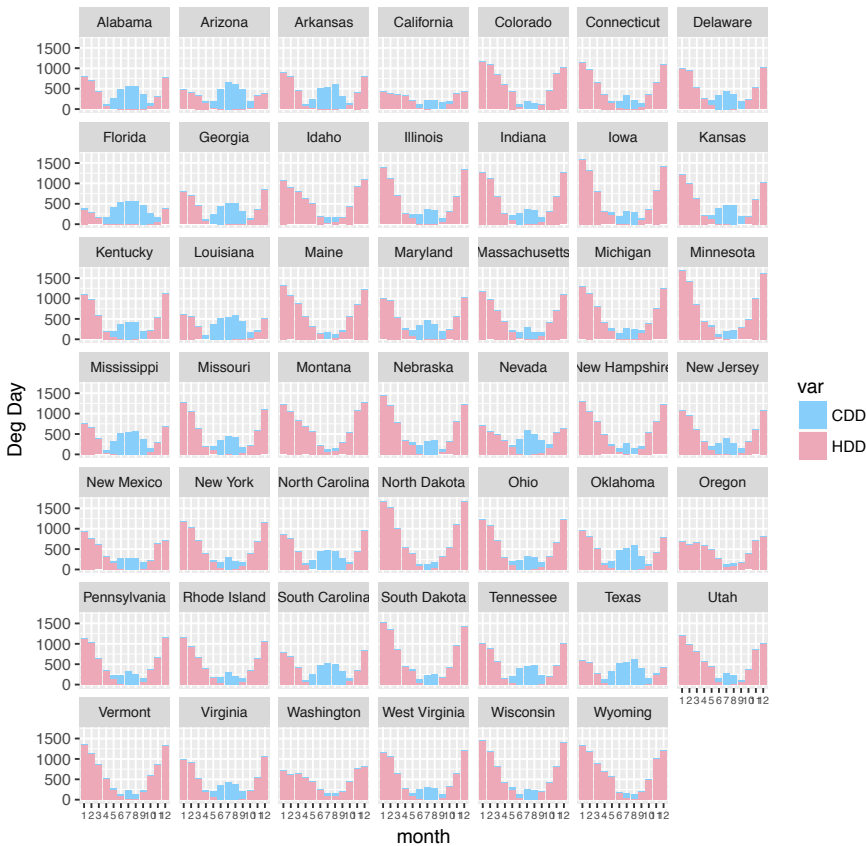
In Progress: Understanding the implications of extreme events on U.S. power sector investments and operations

1. State-level Historical climate data

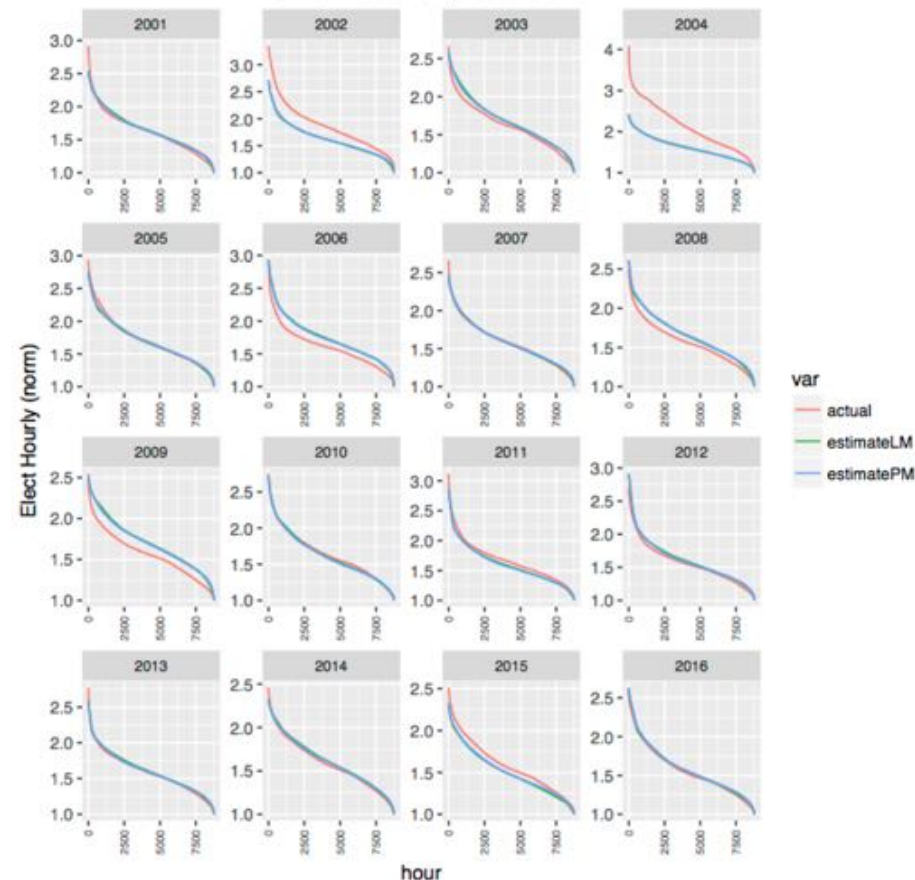
2. Understanding relationship with load profile

3. Change future load profile shapes in GCAM-USA under heat wave/ cold wave scenarios

HDD/CDD by Month: 2010



Hist PJM Electricity Load Curve



Khan, Kim et al., In progress

Thank you

