

# Optimization for Energy System Integration

Prepared By:

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Prepared For:

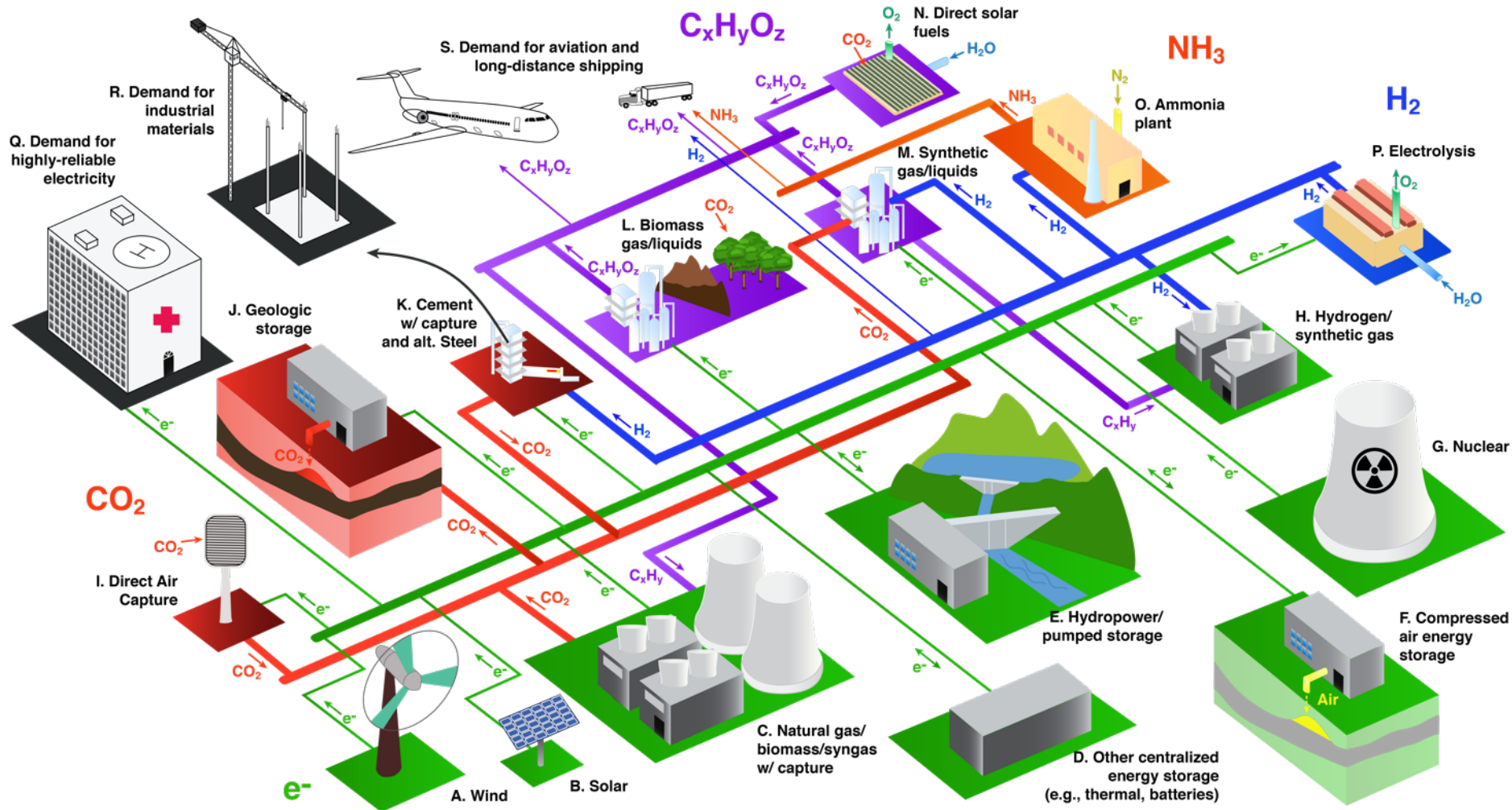
**ESIG Spring Technical Workshop 2020  
(Online)**

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# The Whole Economy Needs Energy



Davis et al. *Science*, 2018

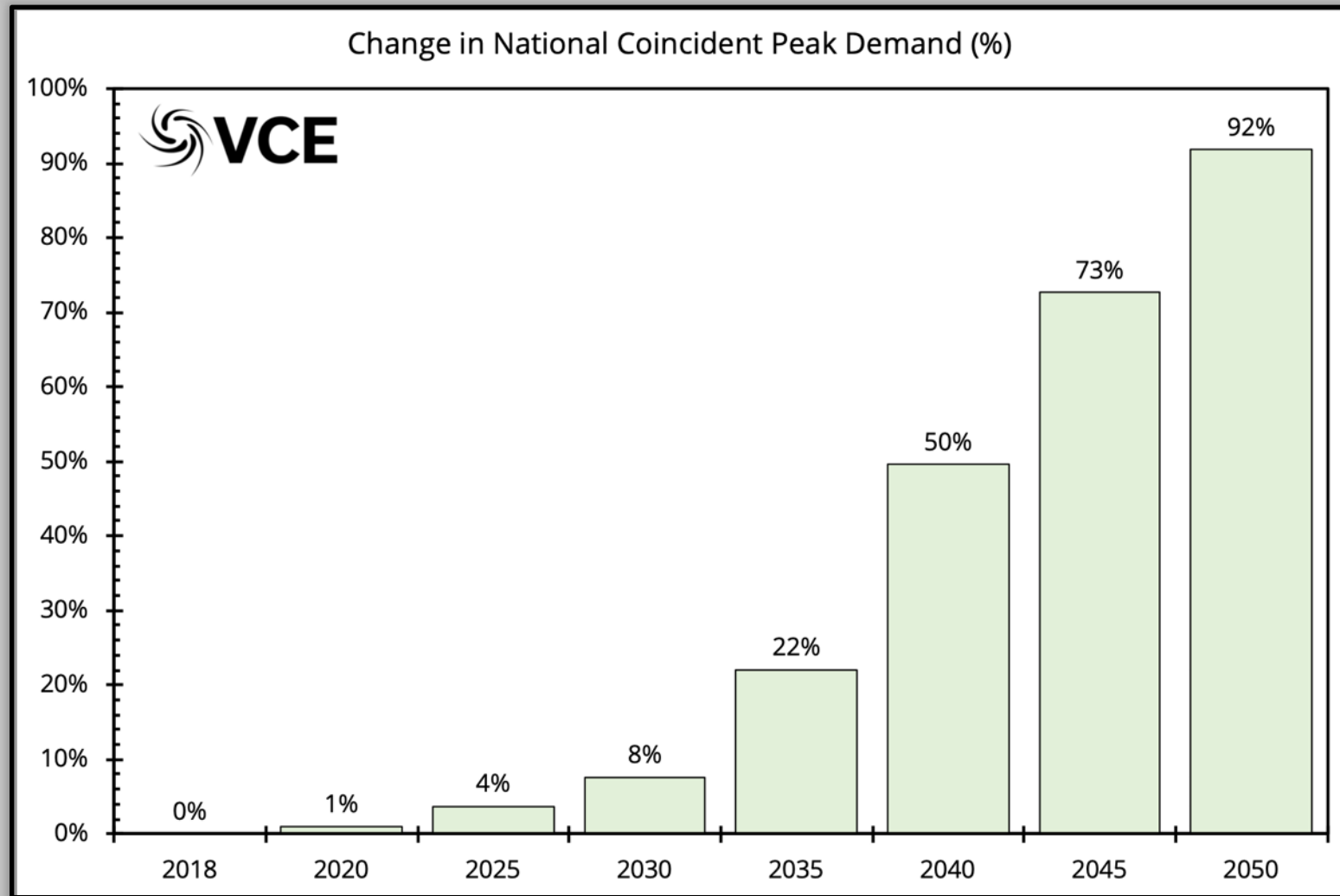
# Electrification that WIS:dom® Considers

The WIS:dom® optimization model considers **electrification through:**

1. Light Duty Vehicles,
2. Heat pump Water Heaters (residential & commercial),
3. Heat pump Space Heating (residential & commercial),
4. Transportation,
5. H<sub>2</sub> production for:
  - *Medium / Heavy Duty Trucking,*
  - *Industrial Demands,*
  - *Space heating (residential and commercial),*
  - *Other processes (Sabitier to Fischer-Tropsch Processes).*

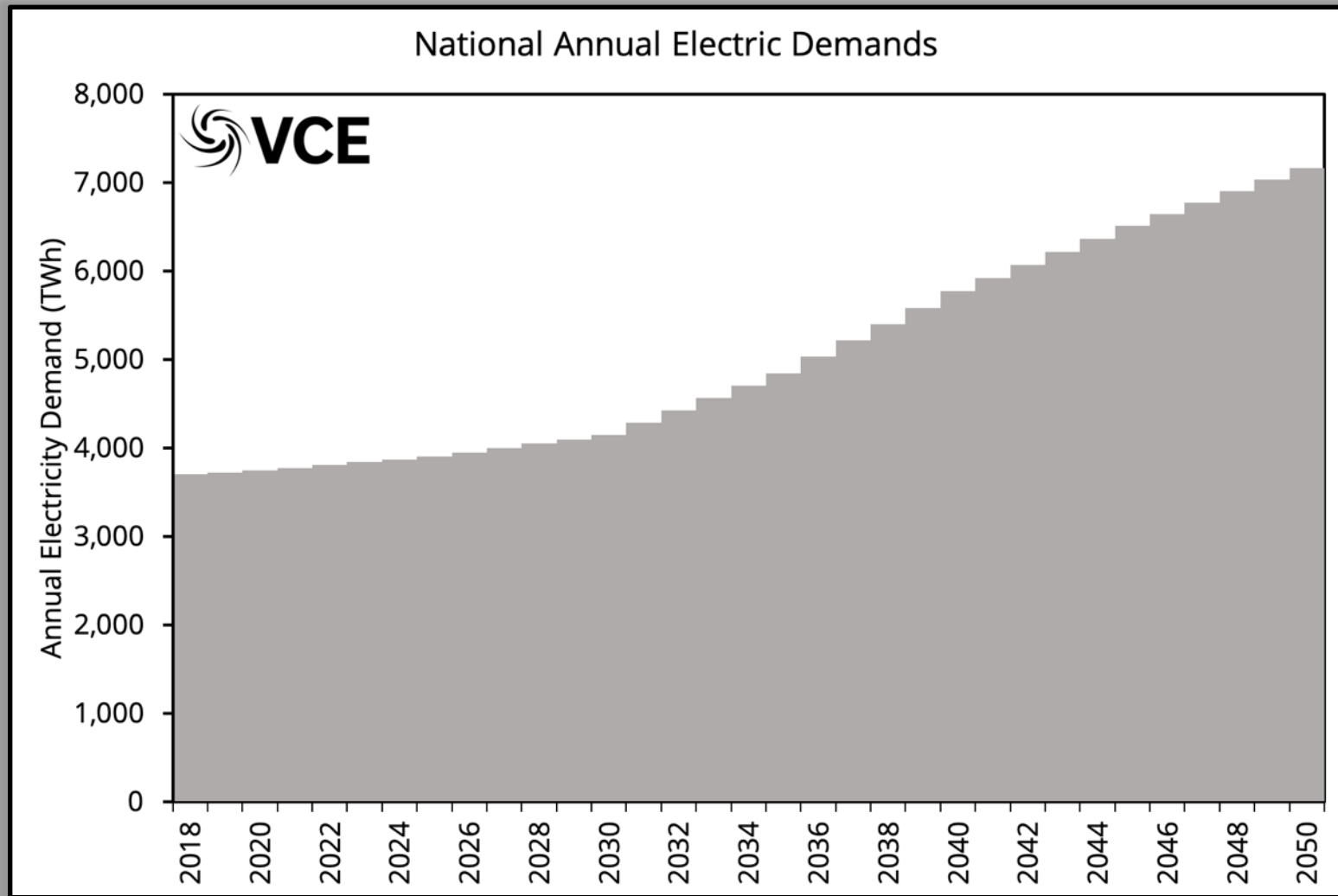
**Note: WIS:dom® does this while also considering weather and climate change impacts on each area of the energy system.**

# Electrification Changes US Electricity Needs

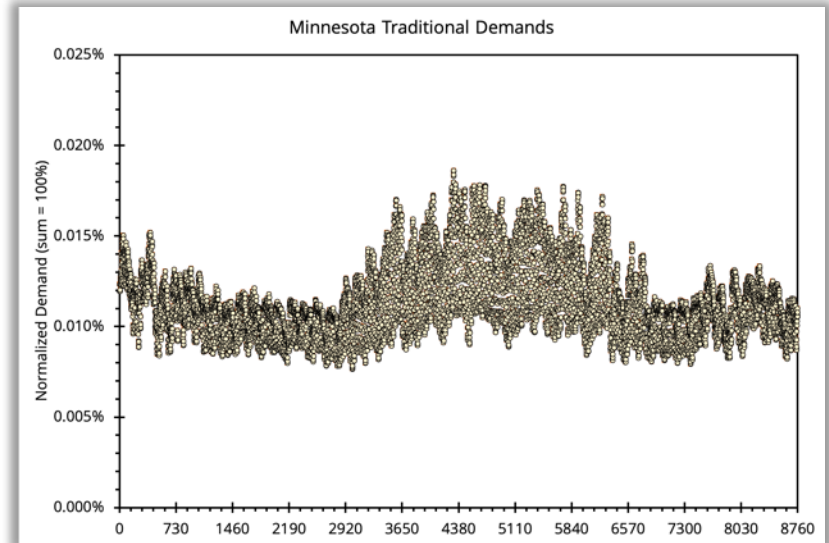
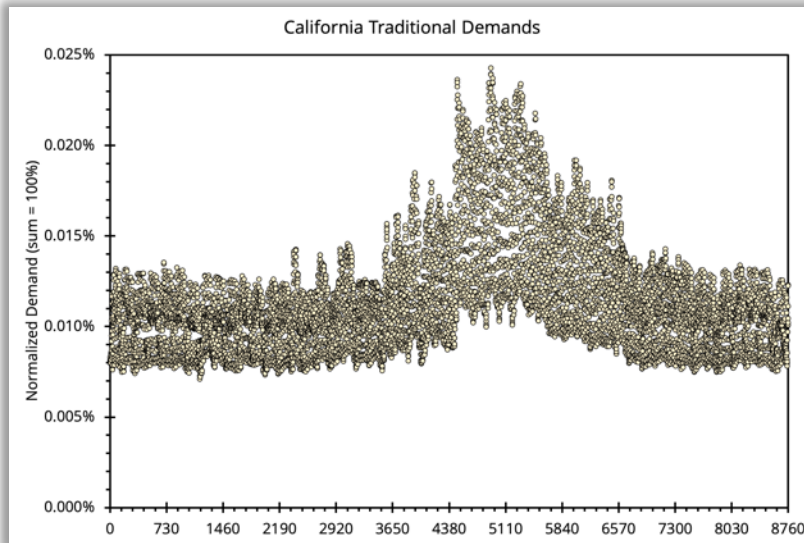
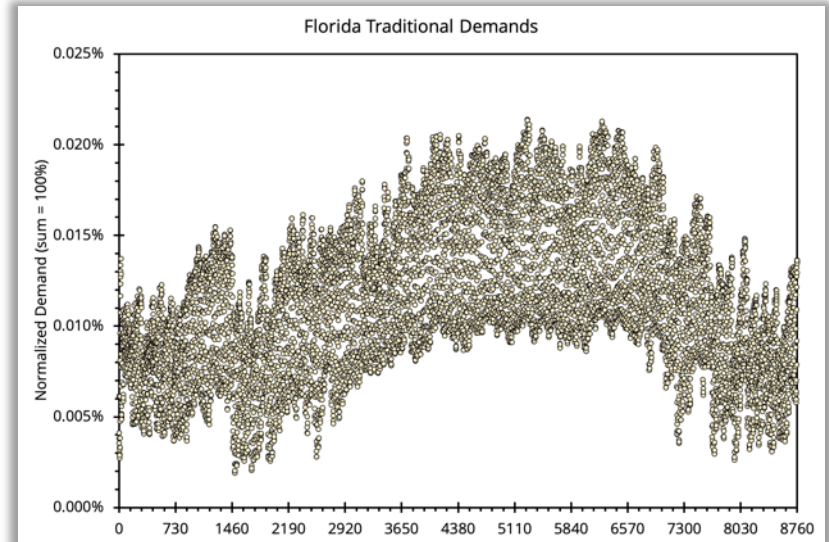
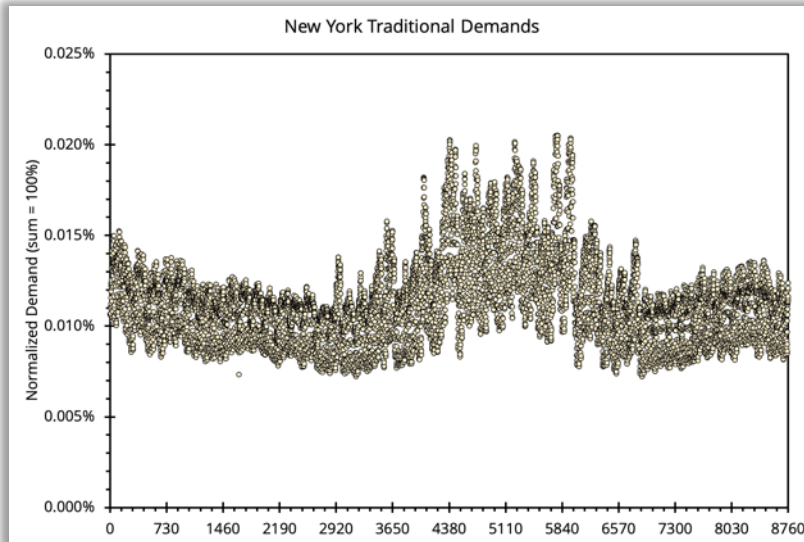




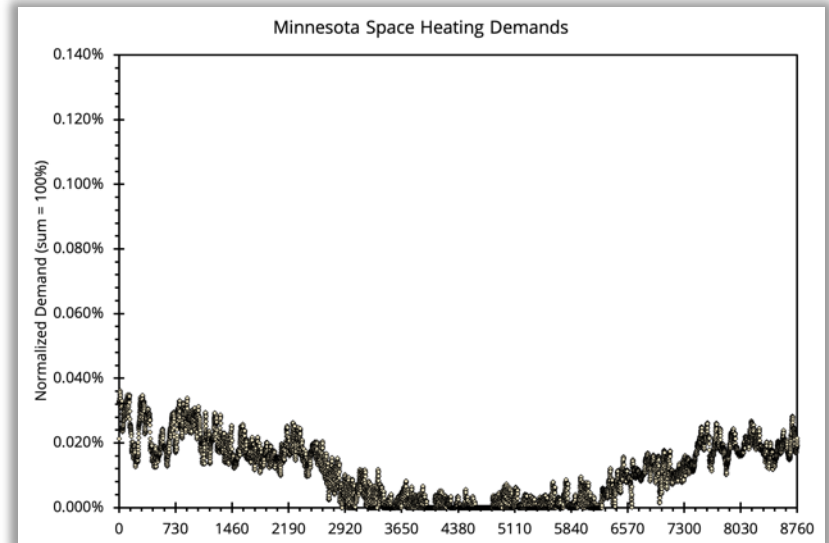
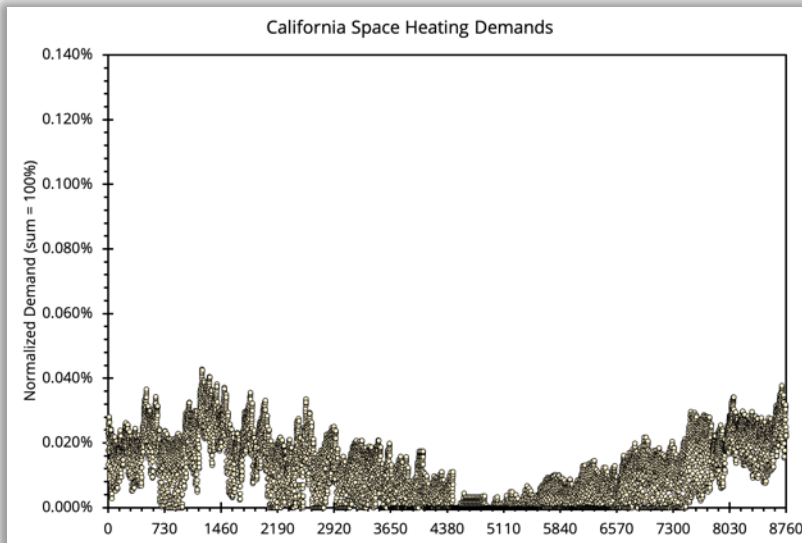
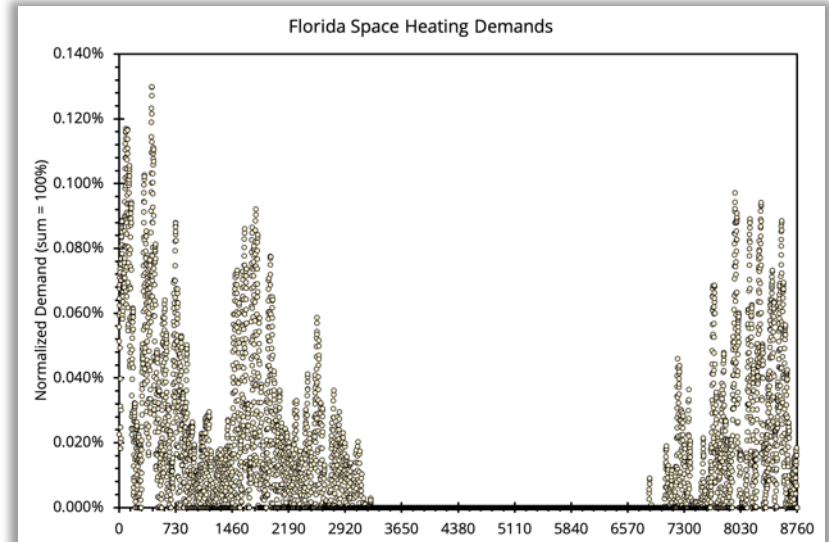
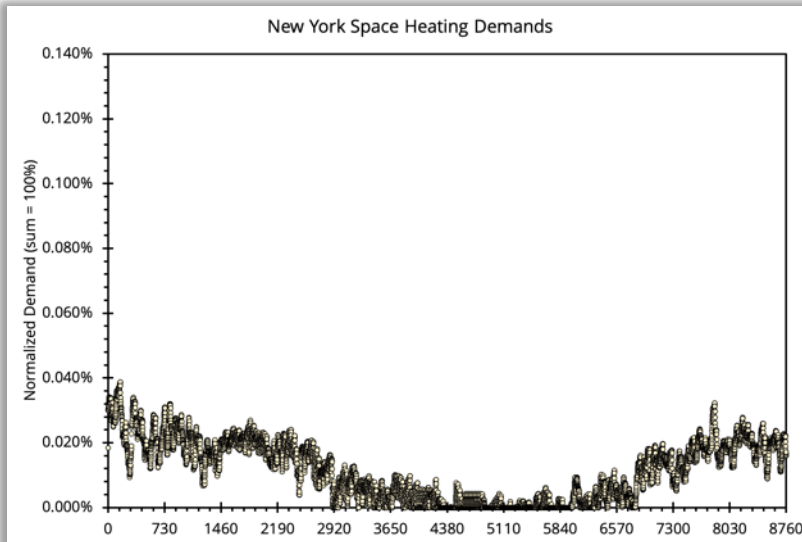
# Electrification Changes US Electricity Needs



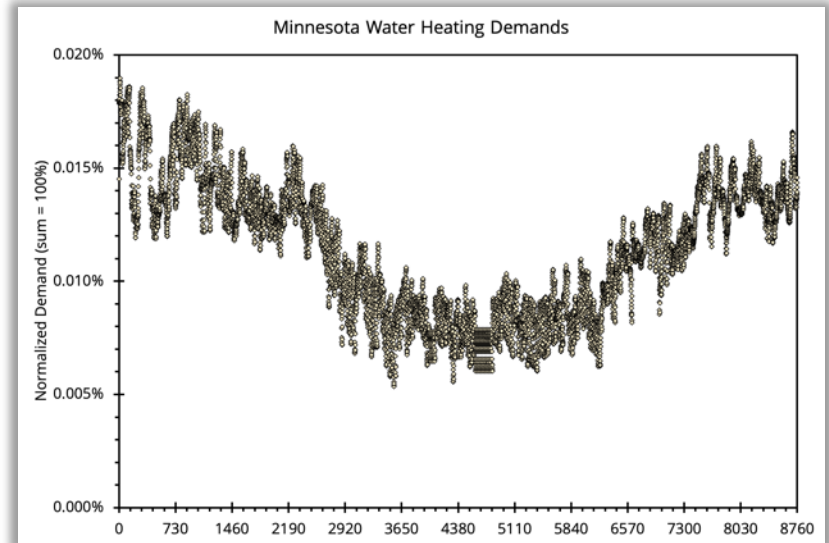
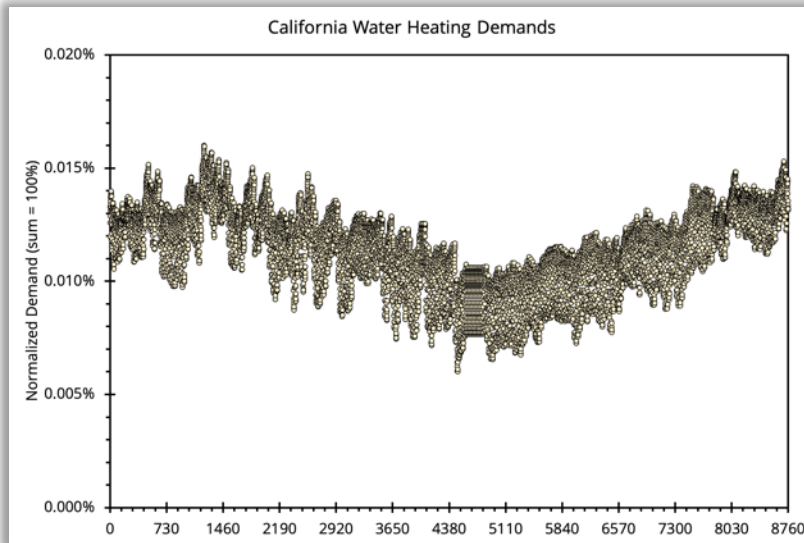
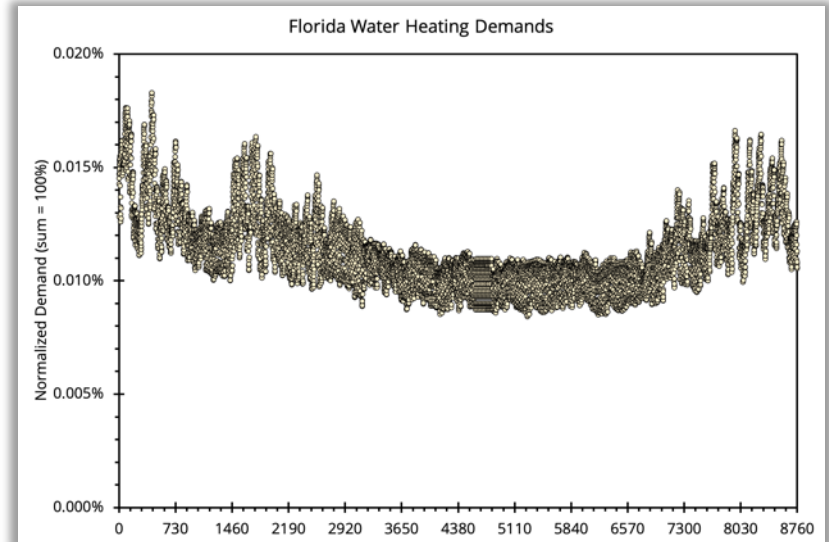
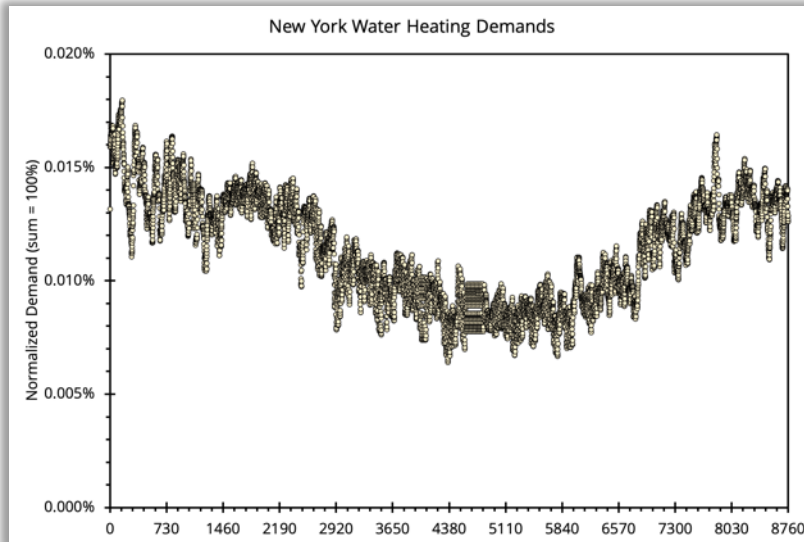
# WIS:dom® Estimated Traditional Demands (Examples)



# WIS:dom® Estimated Space Heating Demands (Examples)

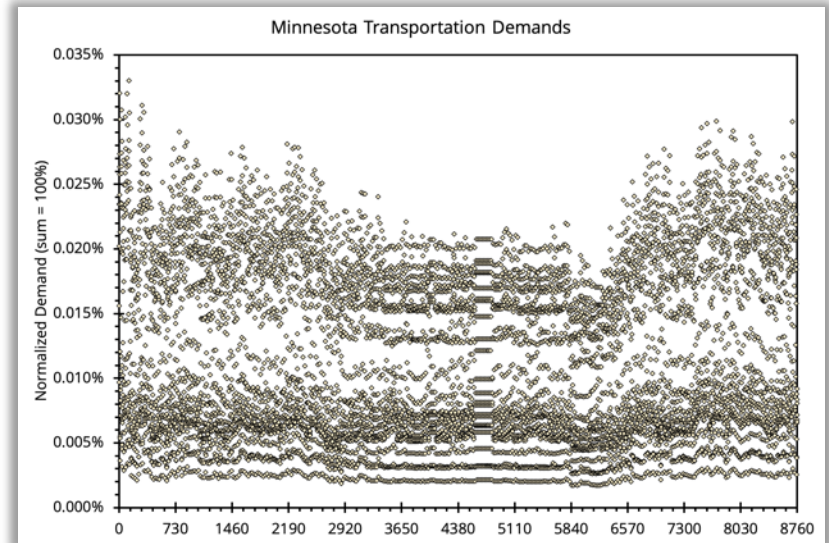
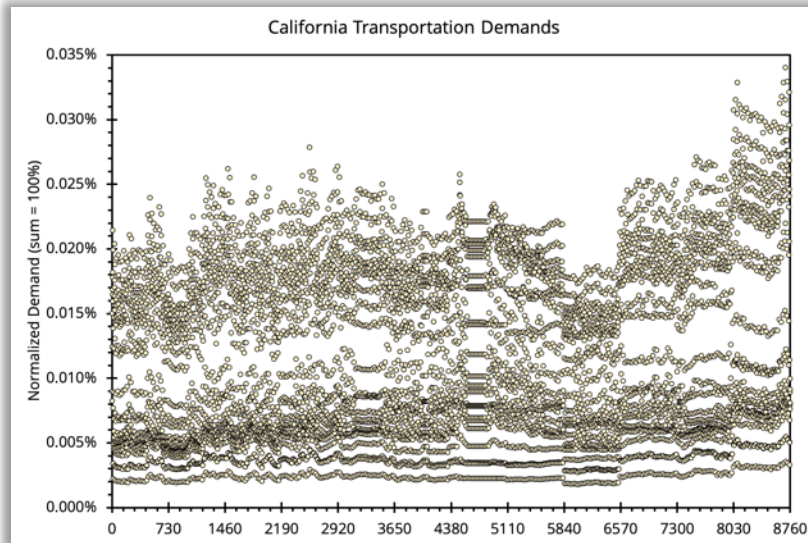
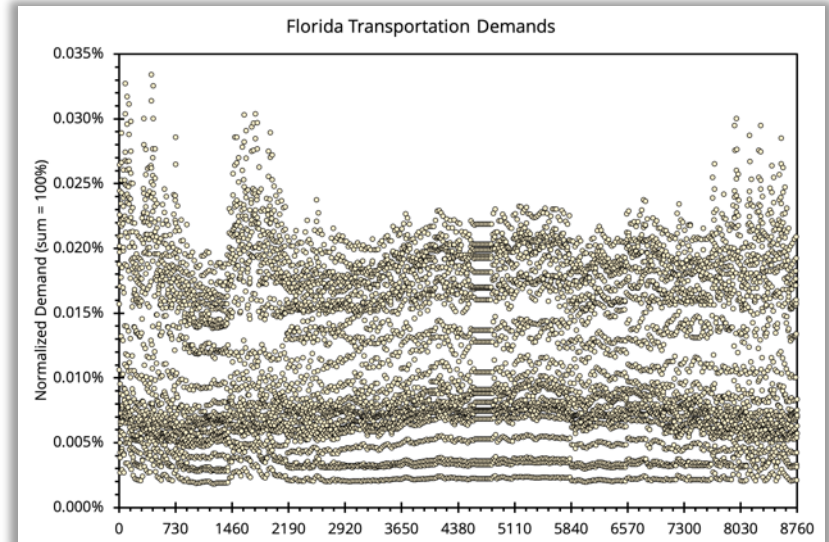
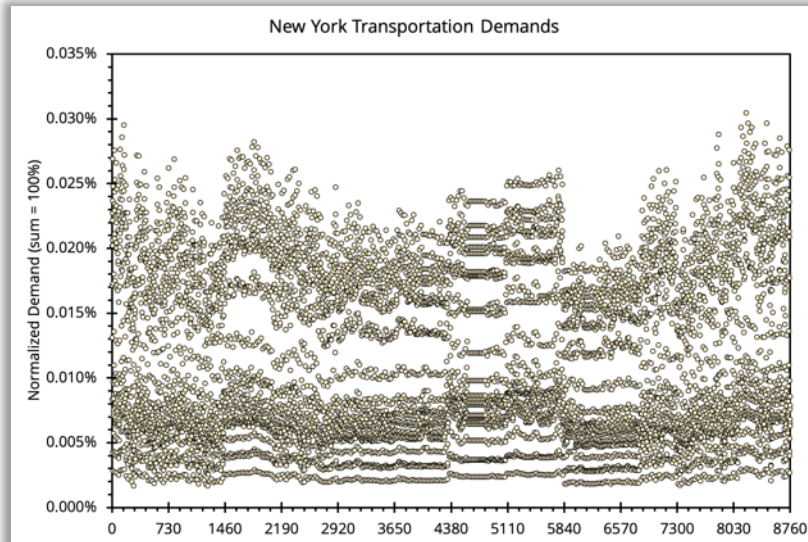


# WIS:dom® Estimated Water Heating Demands (Examples)

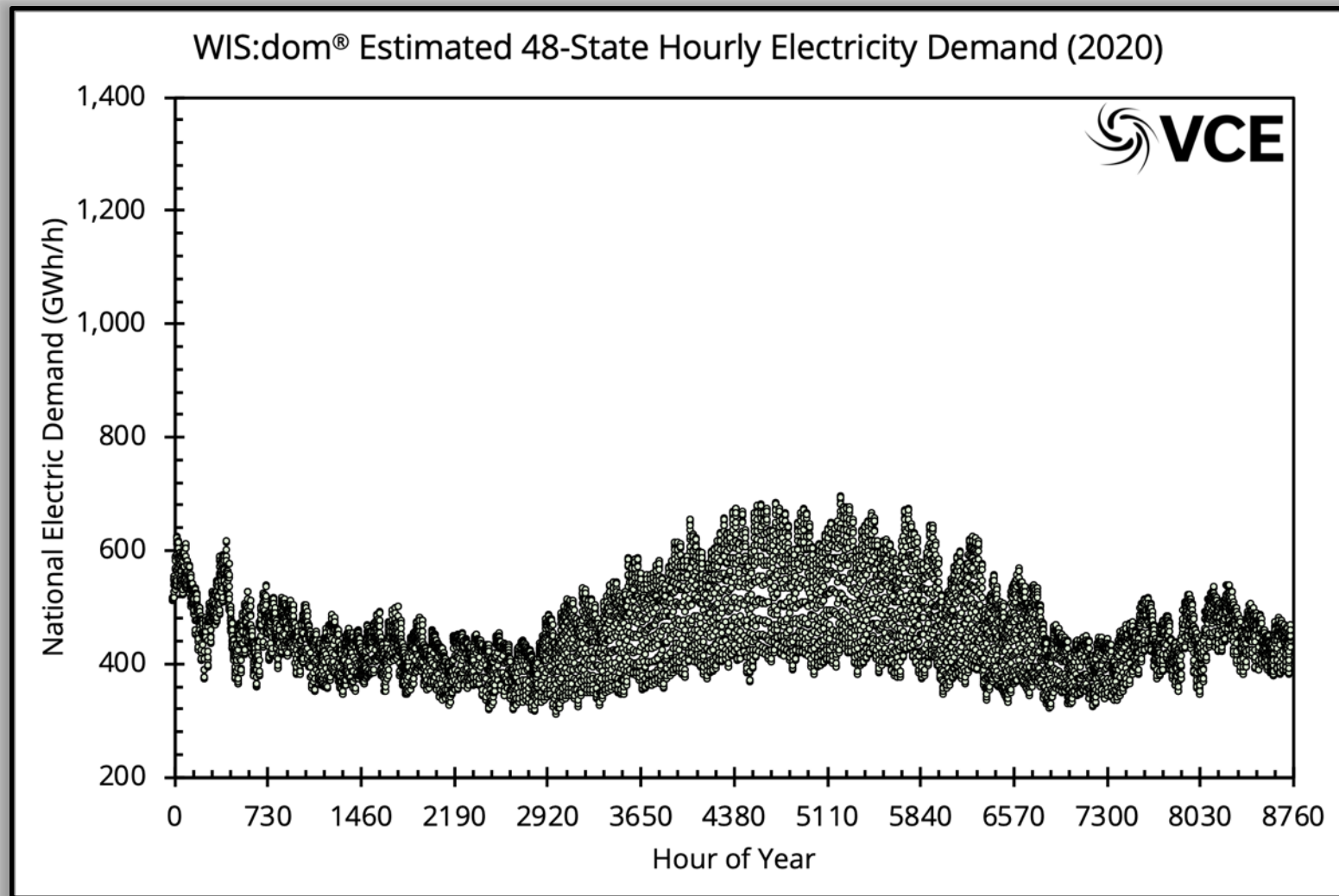




# WIS:dom<sup>®</sup> Estimated Transportation Demands (Examples)

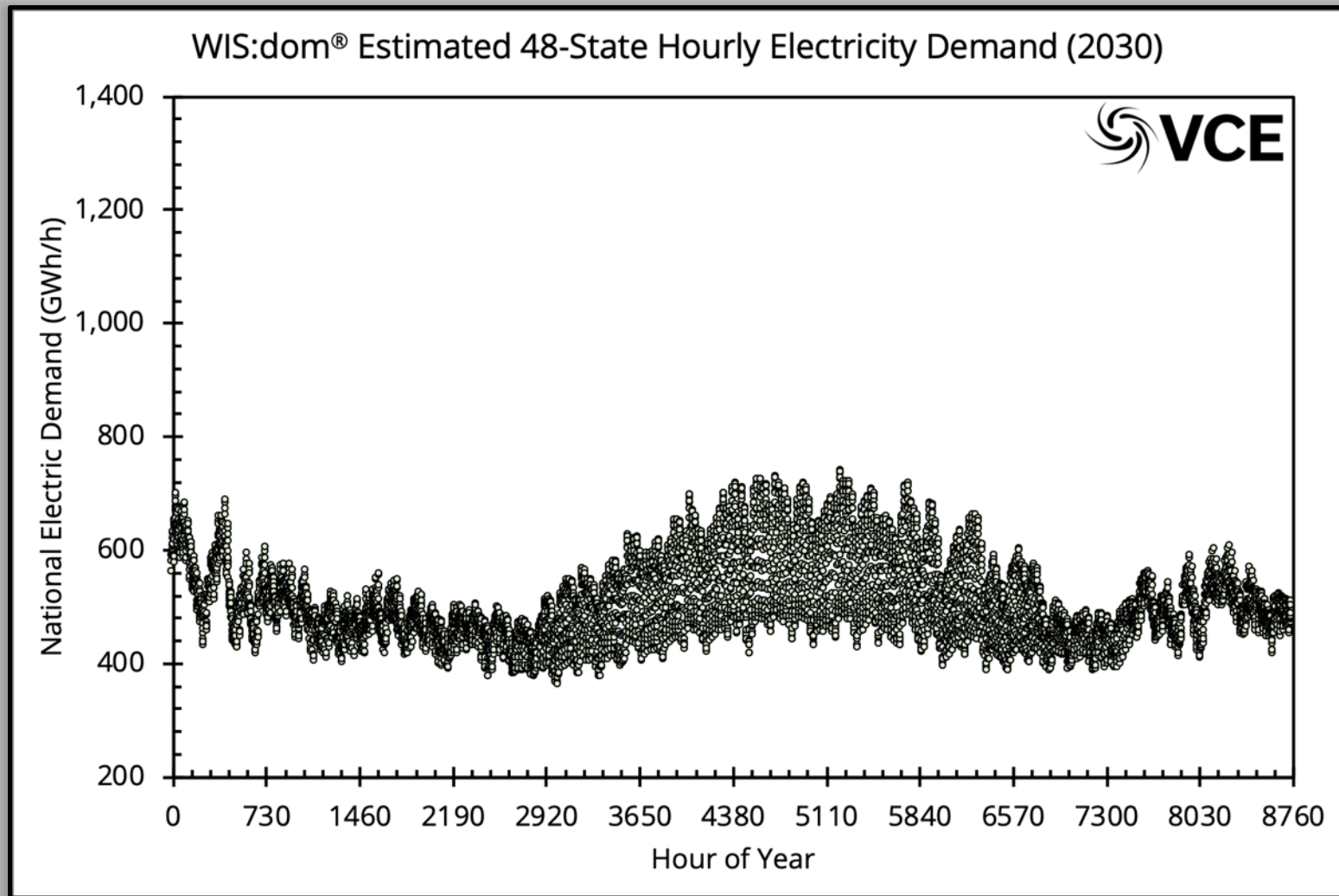


# How Electrification Changes US Electricity Demand Profiles

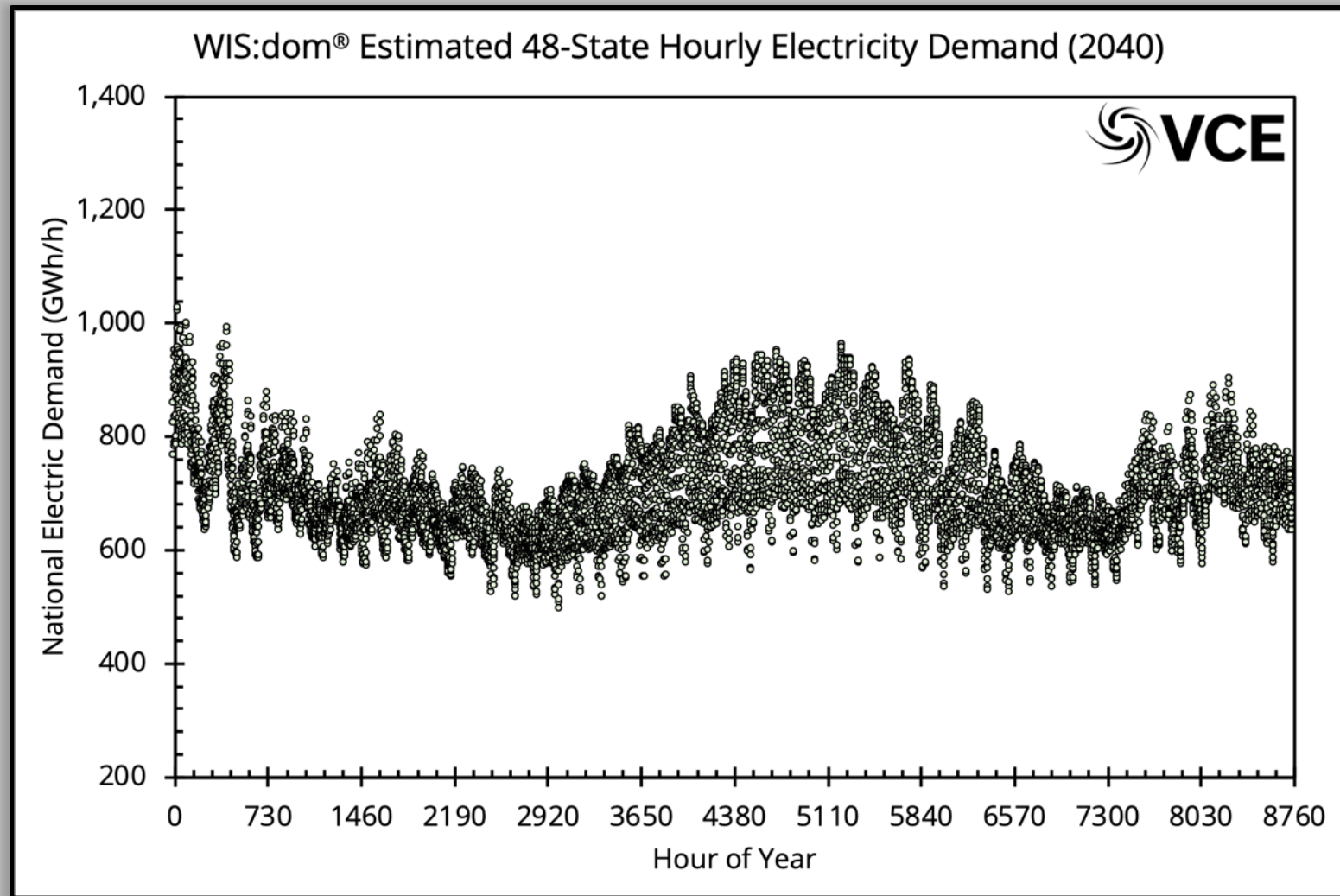




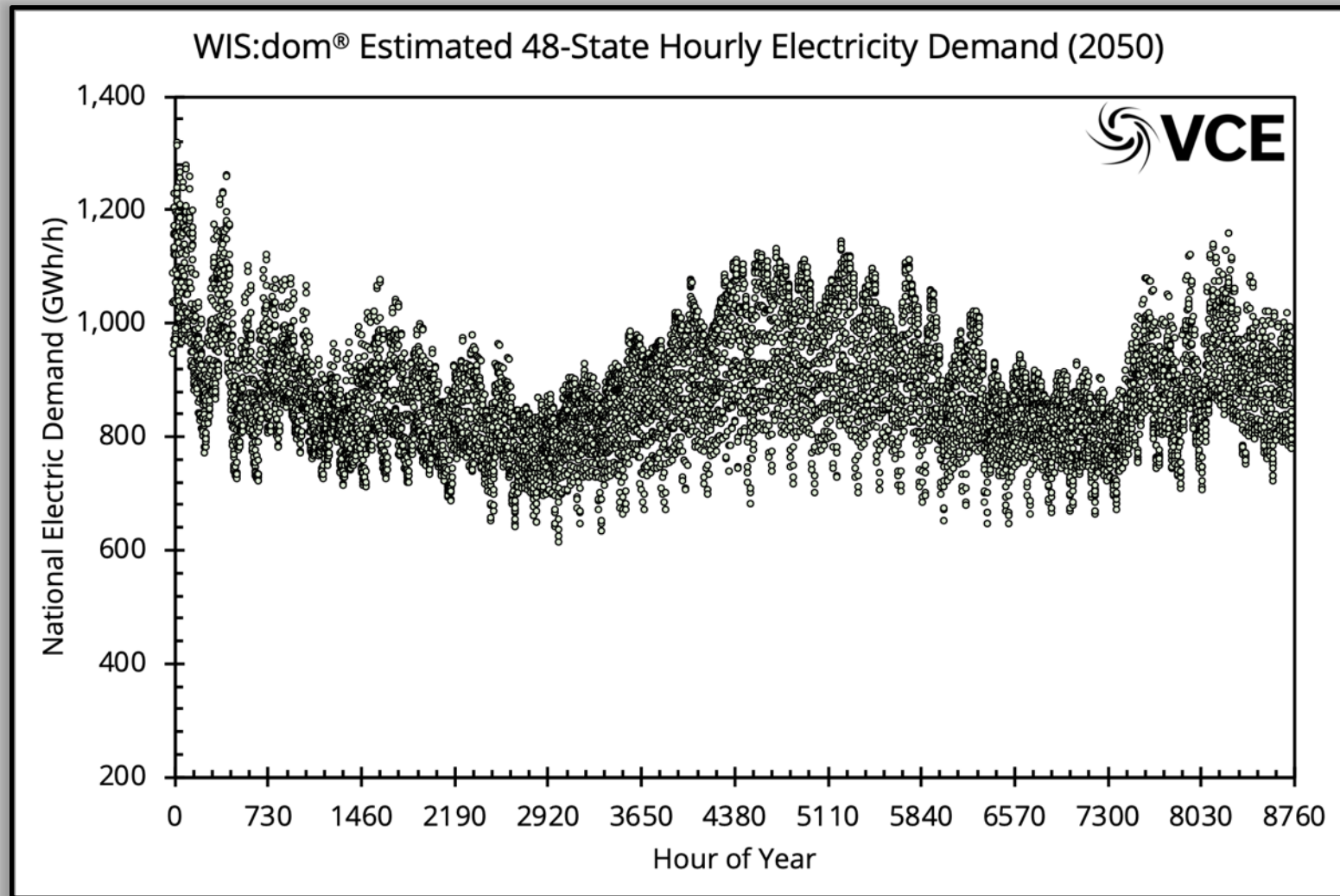
# How Electrification Changes US Electricity Demand Profiles



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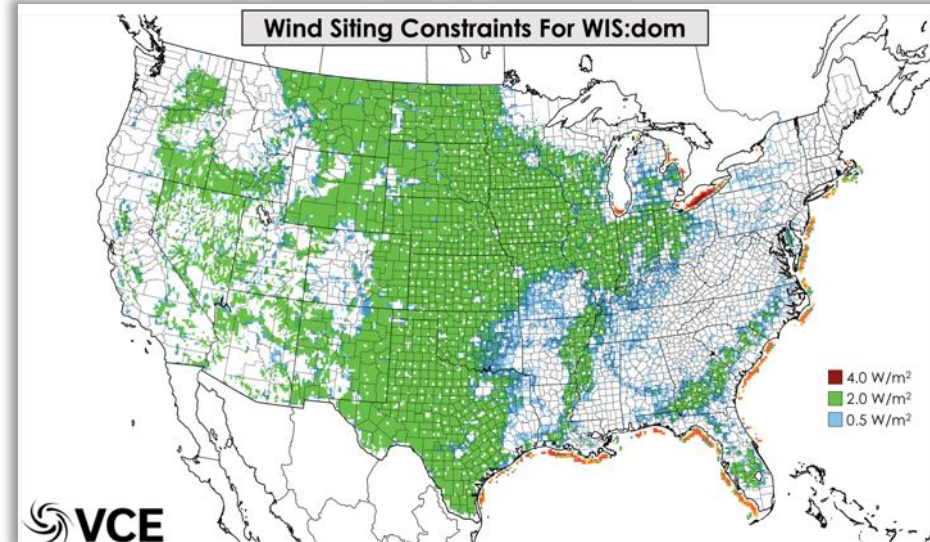
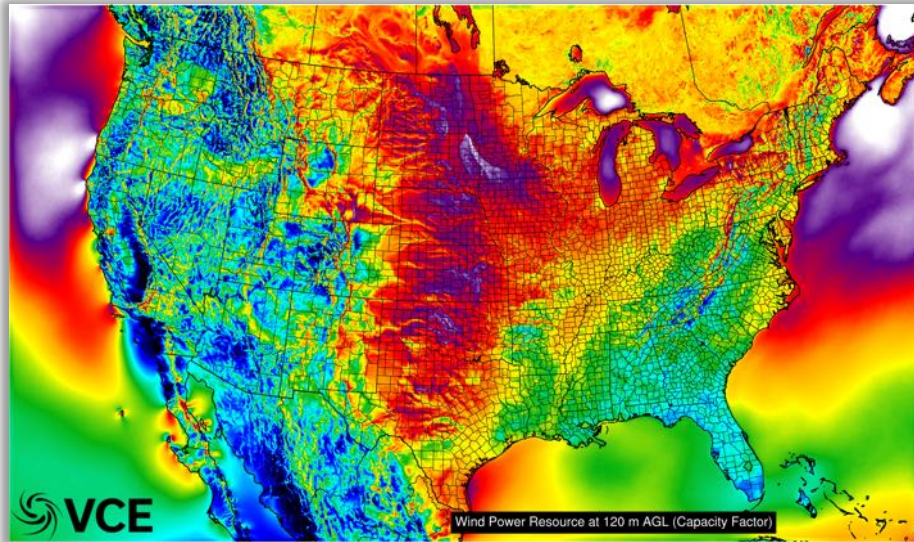
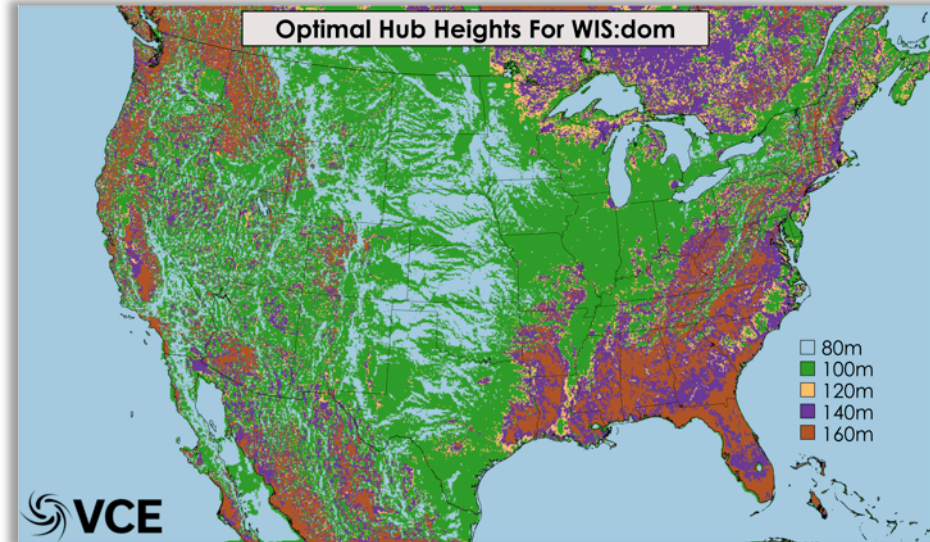
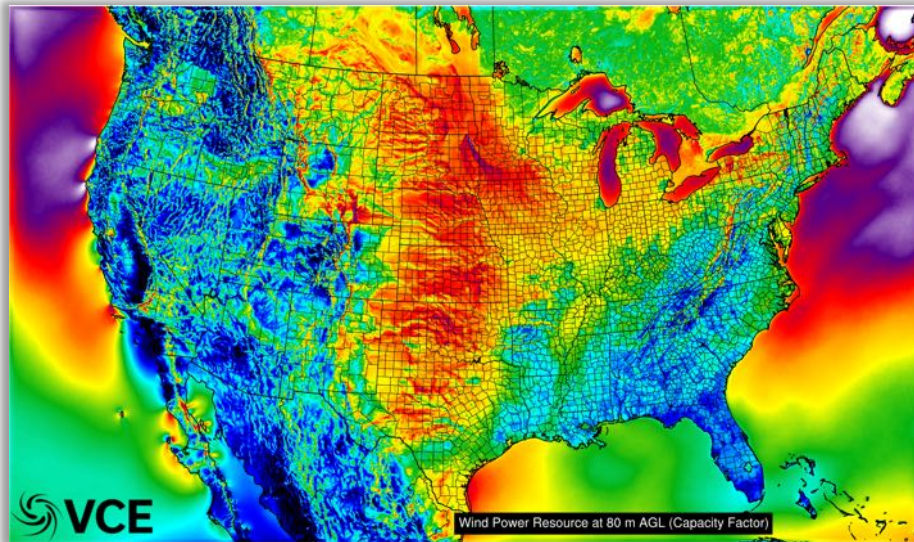


# How Electrification Changes US Electricity Demand Profiles



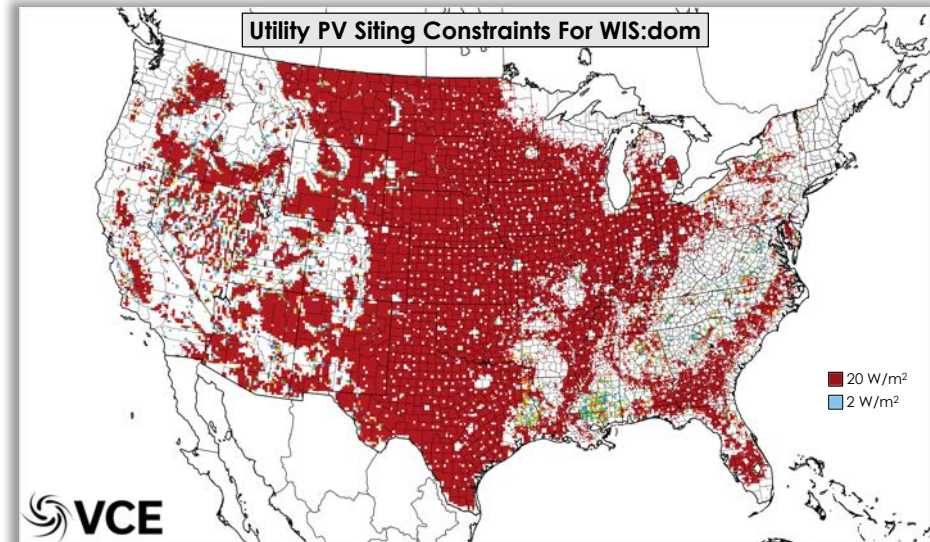
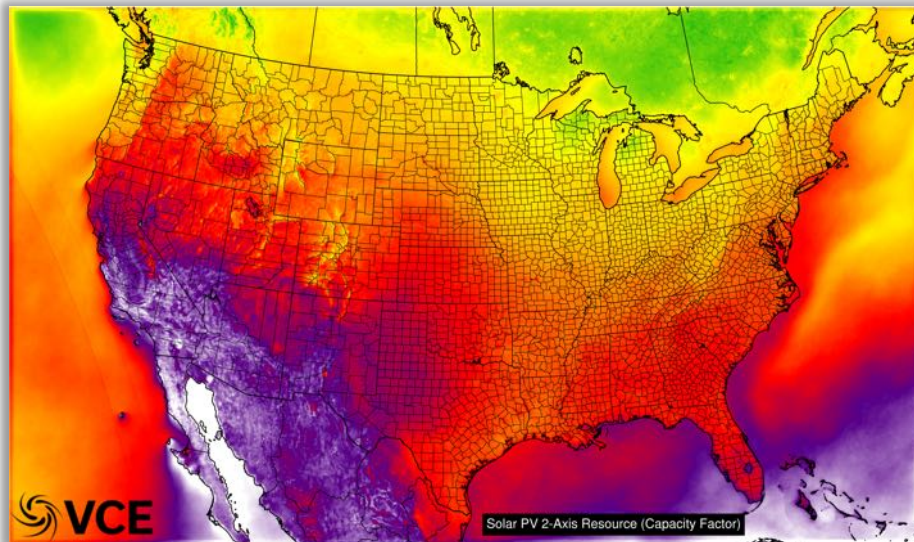
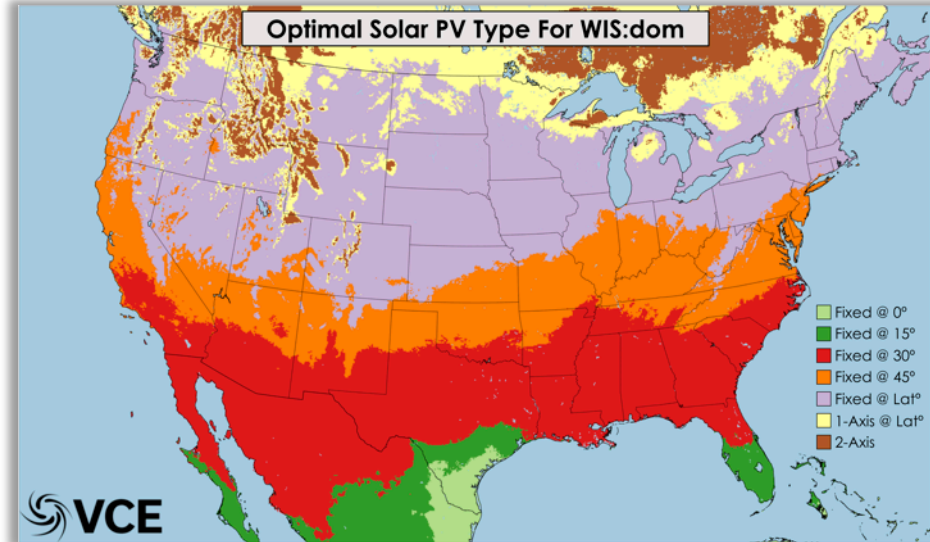
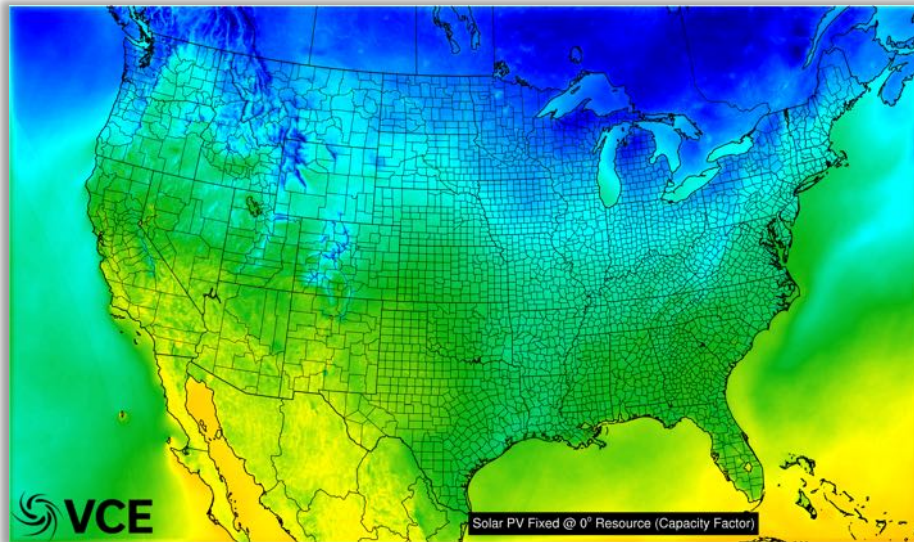


# Detailed wind datasets are critical for resource siting

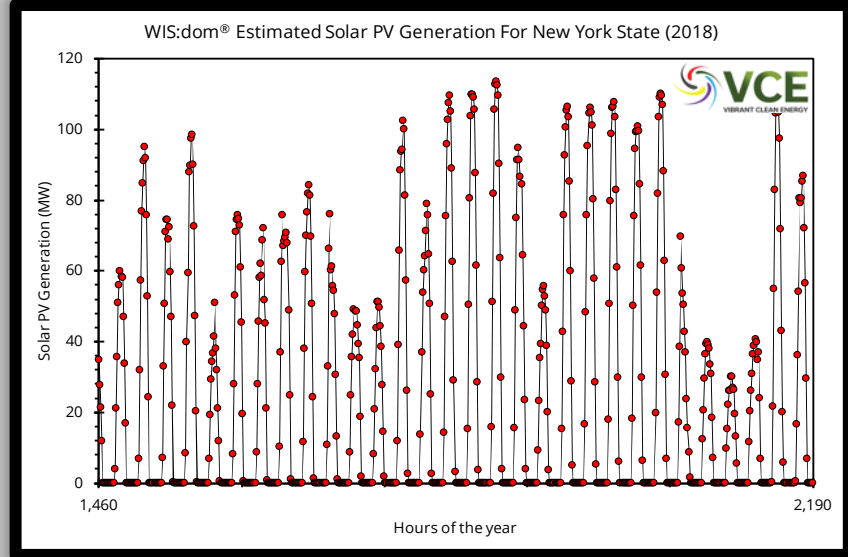
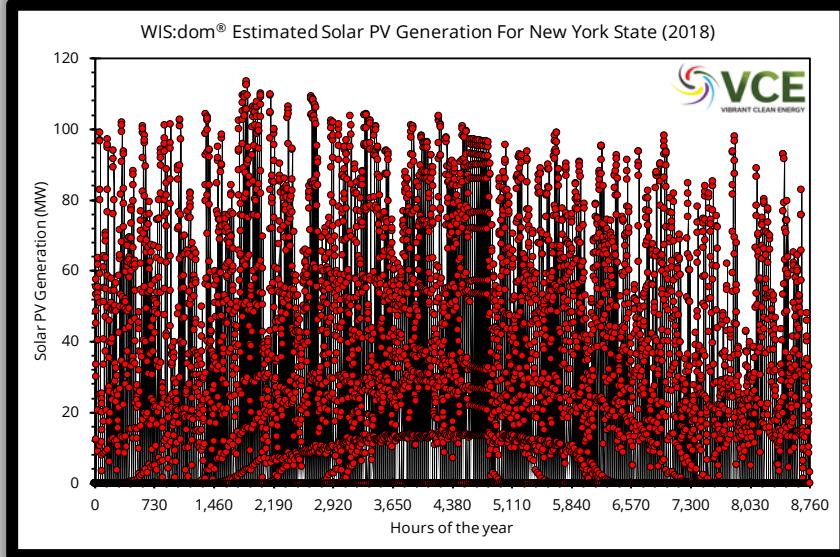
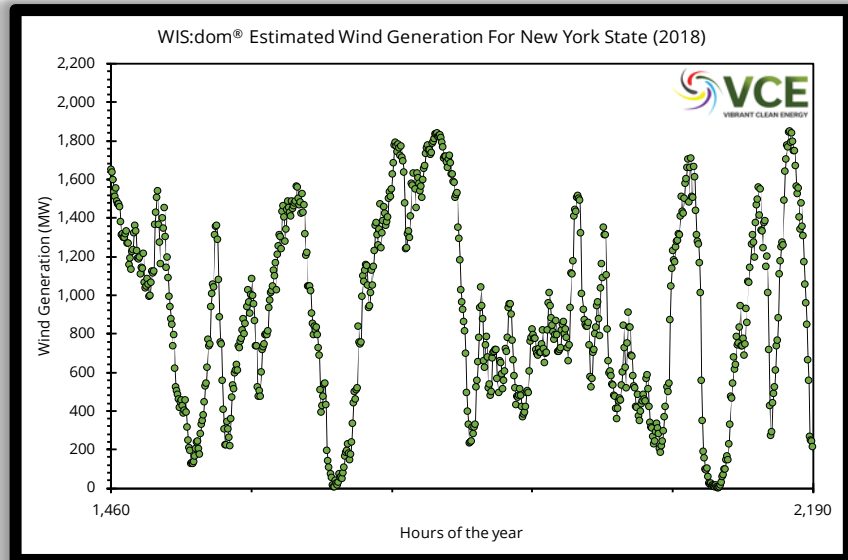
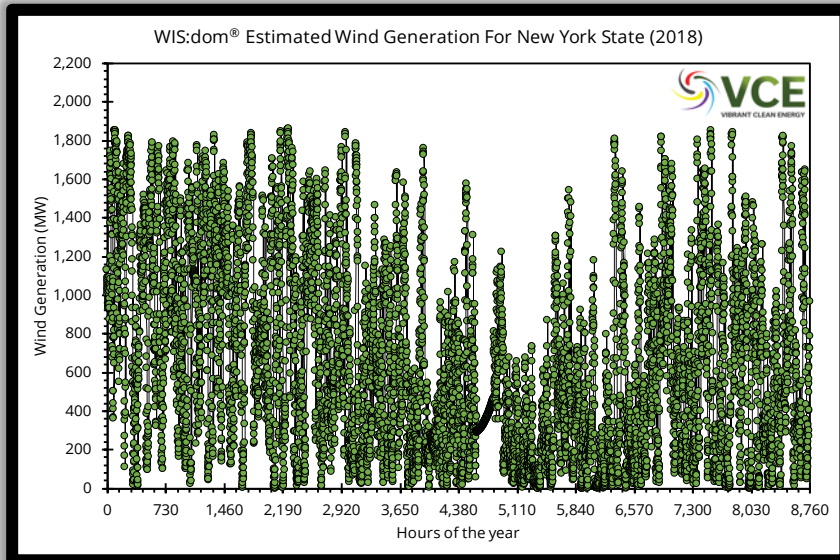




# Detailed solar datasets are critical for resource siting

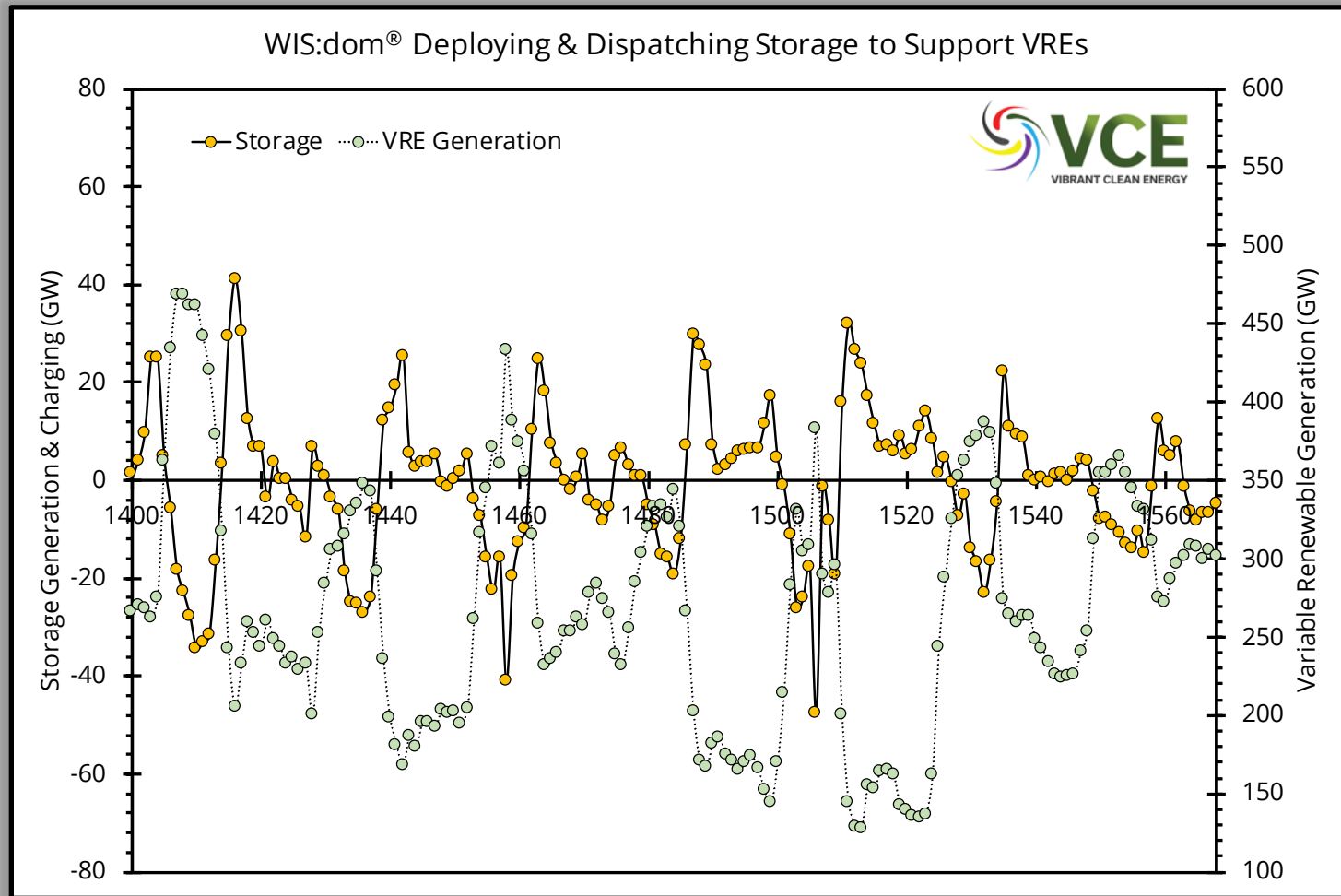


# Use of hourly, and sub-hourly is essential

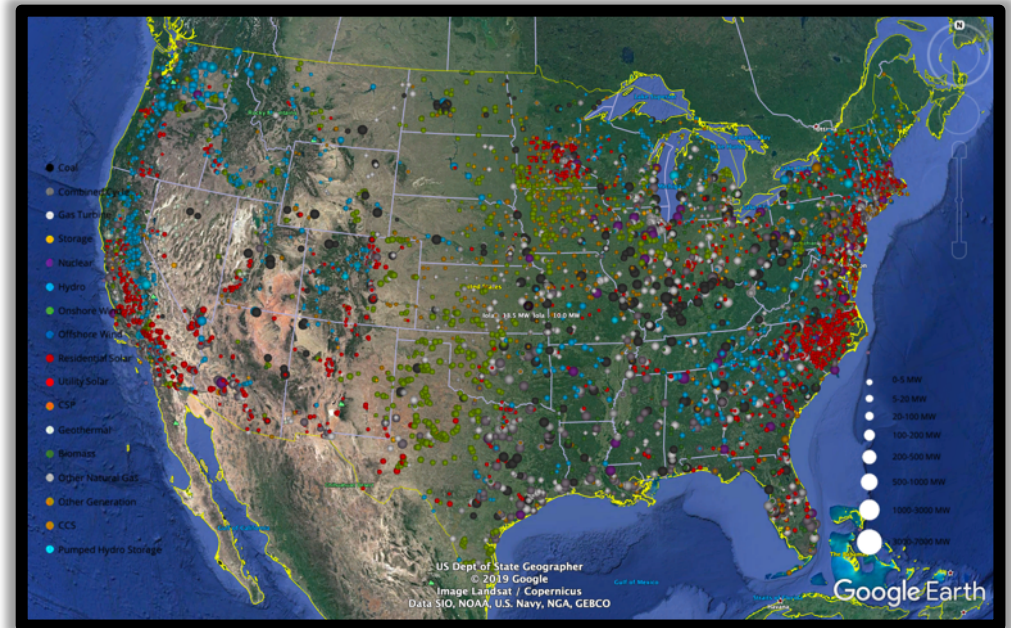
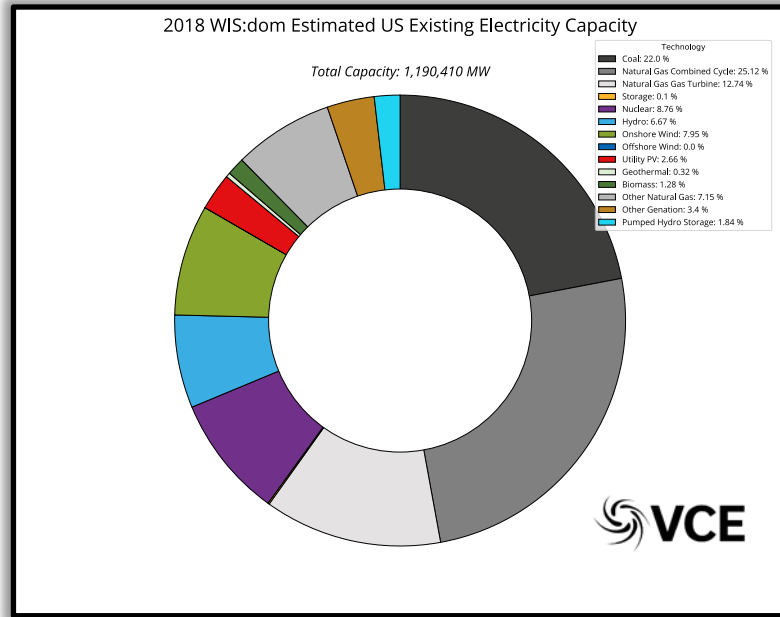




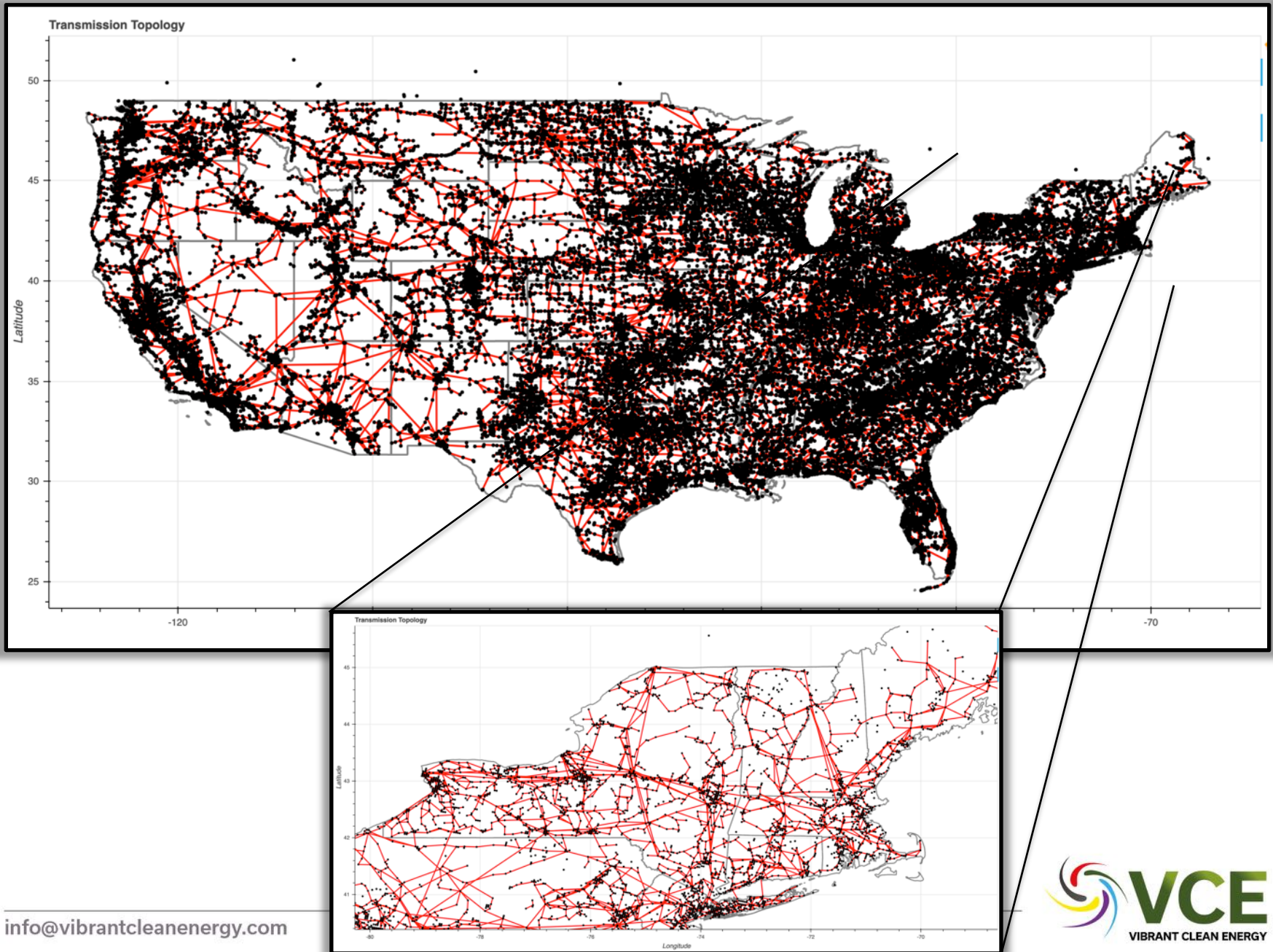
# The behavior of storage becomes more important over time



# We must start from the grid we have

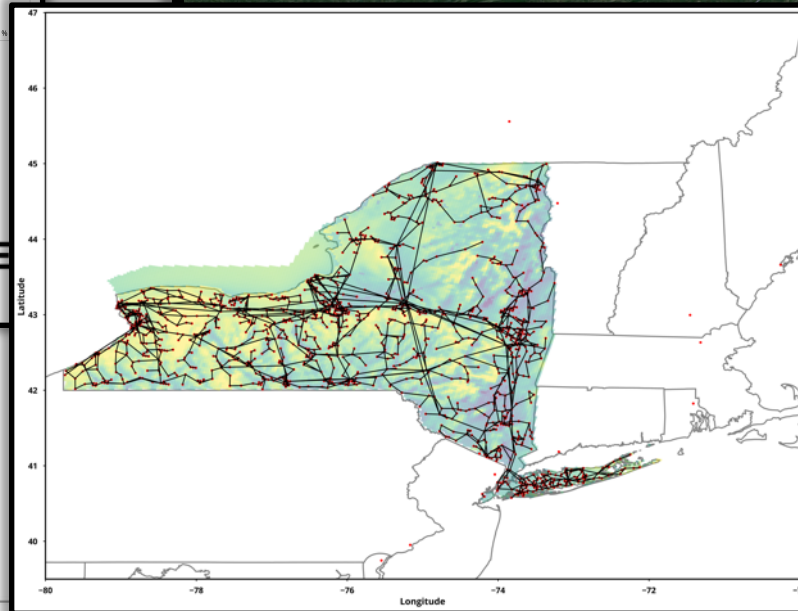
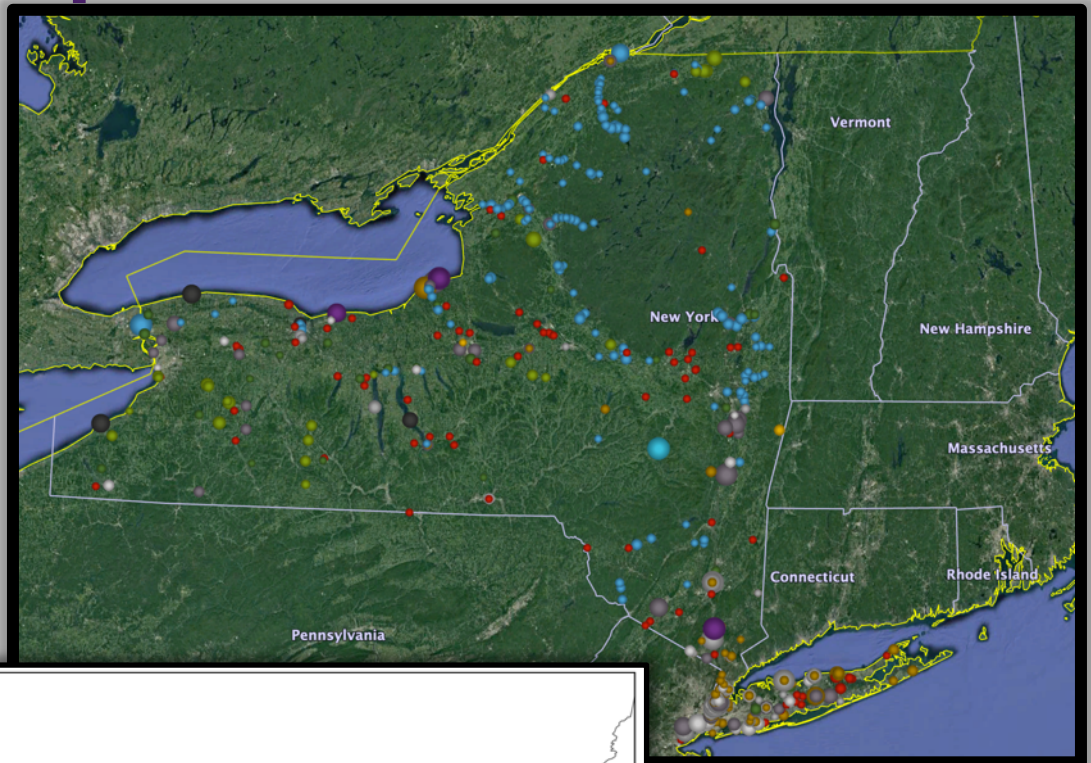
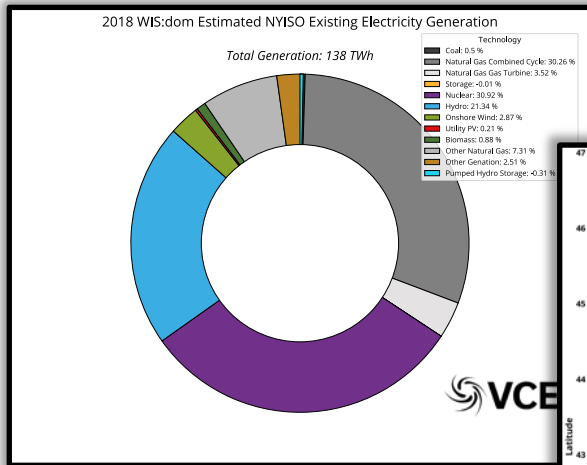
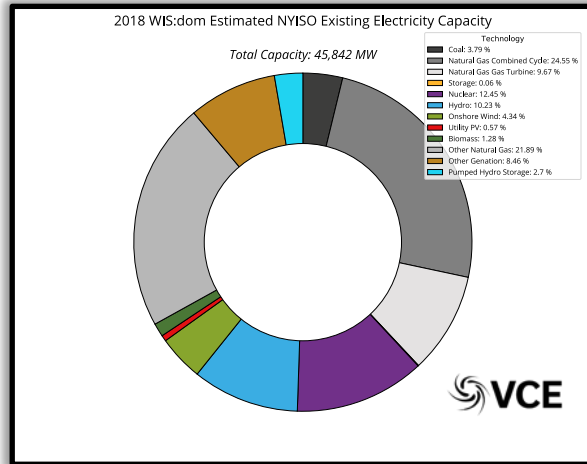


# Resolving the transmission grid topology





# Close up of New York

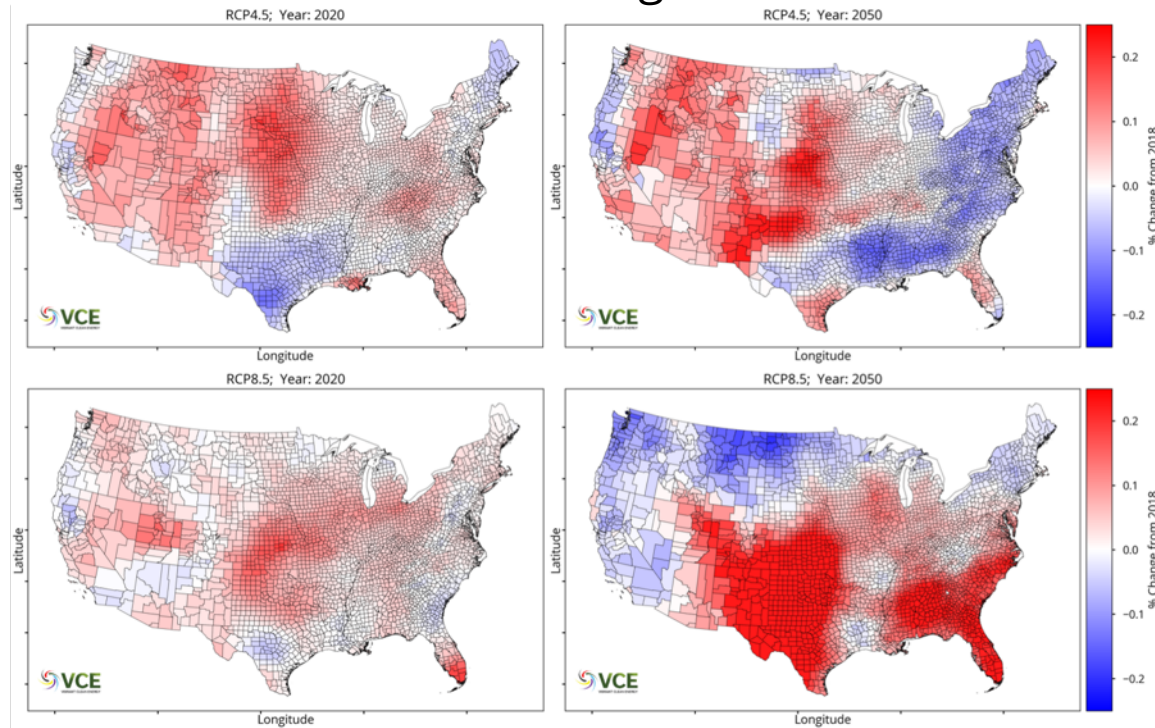


# Climate change should be incorporated

## Overview:

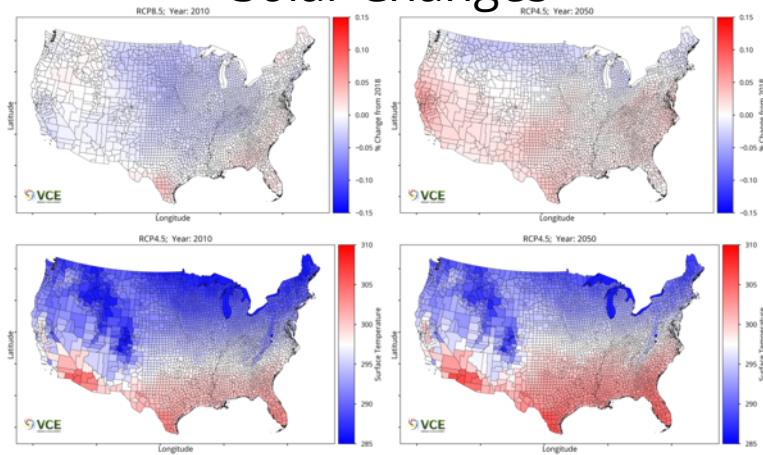
- The CMIP5 datasets allow WIS:dom® to incorporate the changing climate and its impacts on energy infrastructure. Currently this is achieved through:
  - ✓ Changes to the demand profiles;
  - ✓ Changes to the wind and solar power production;
  - ✓ Changes to the water supply for thermal generation and hydroelectric power plants;
  - ✓ Changes to the transmission line ratings and line losses via the dynamic line rating;
  - ✓ Changes to the heat rates of the power plants due to thermal efficiency;
  - ✓ Changes to the flexibility profiles for the demands.

## Wind Changes

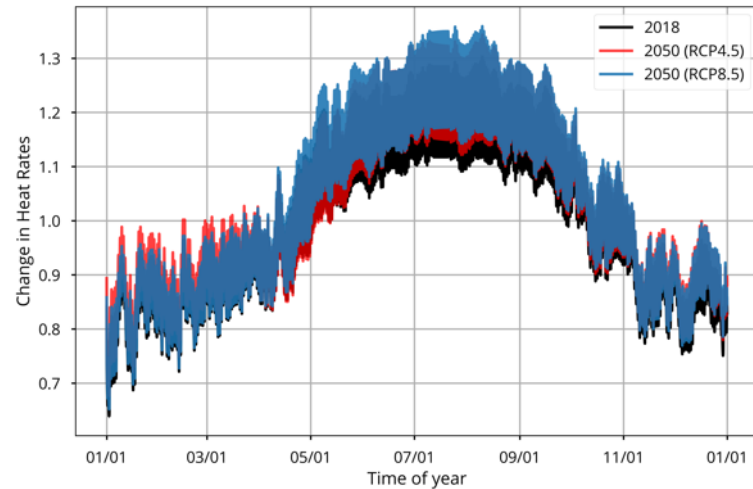


# Overview of Climate Input Data

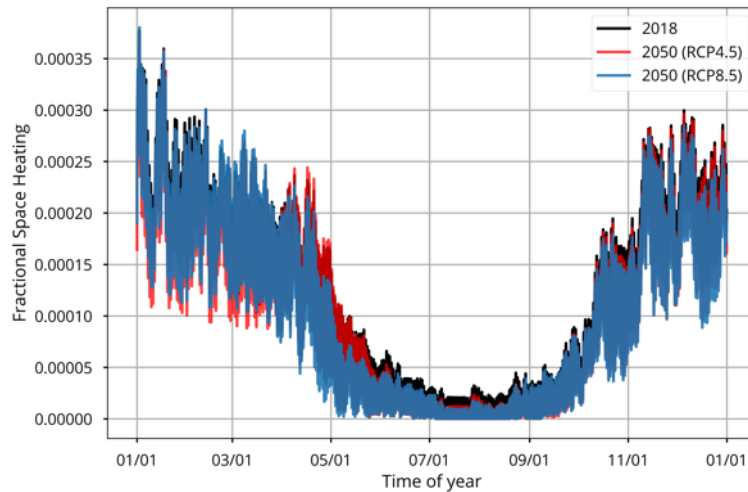
## Solar Changes



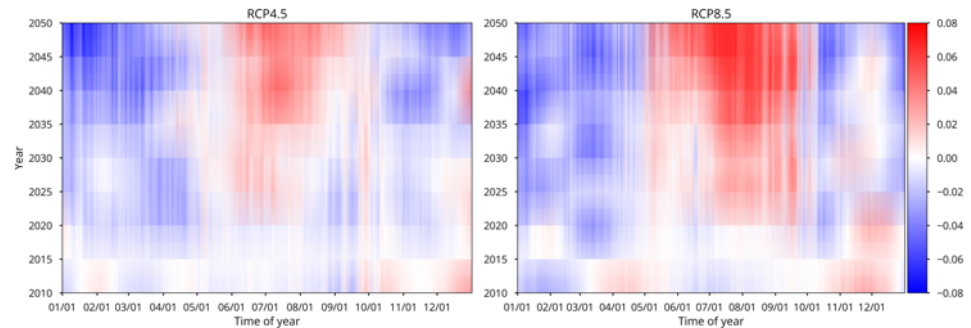
## Heat rate changes



## Space heating changes



## EV charging changes

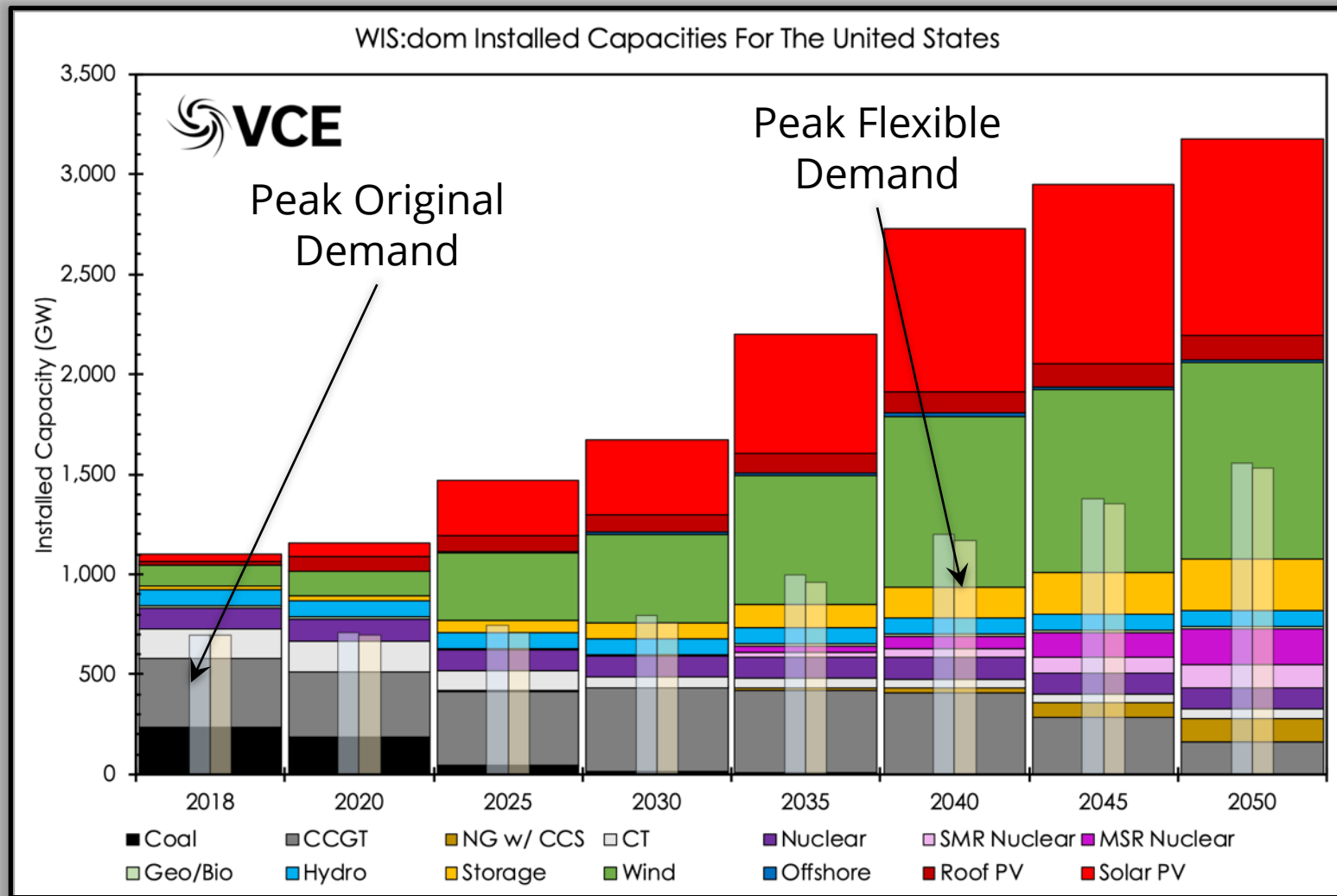




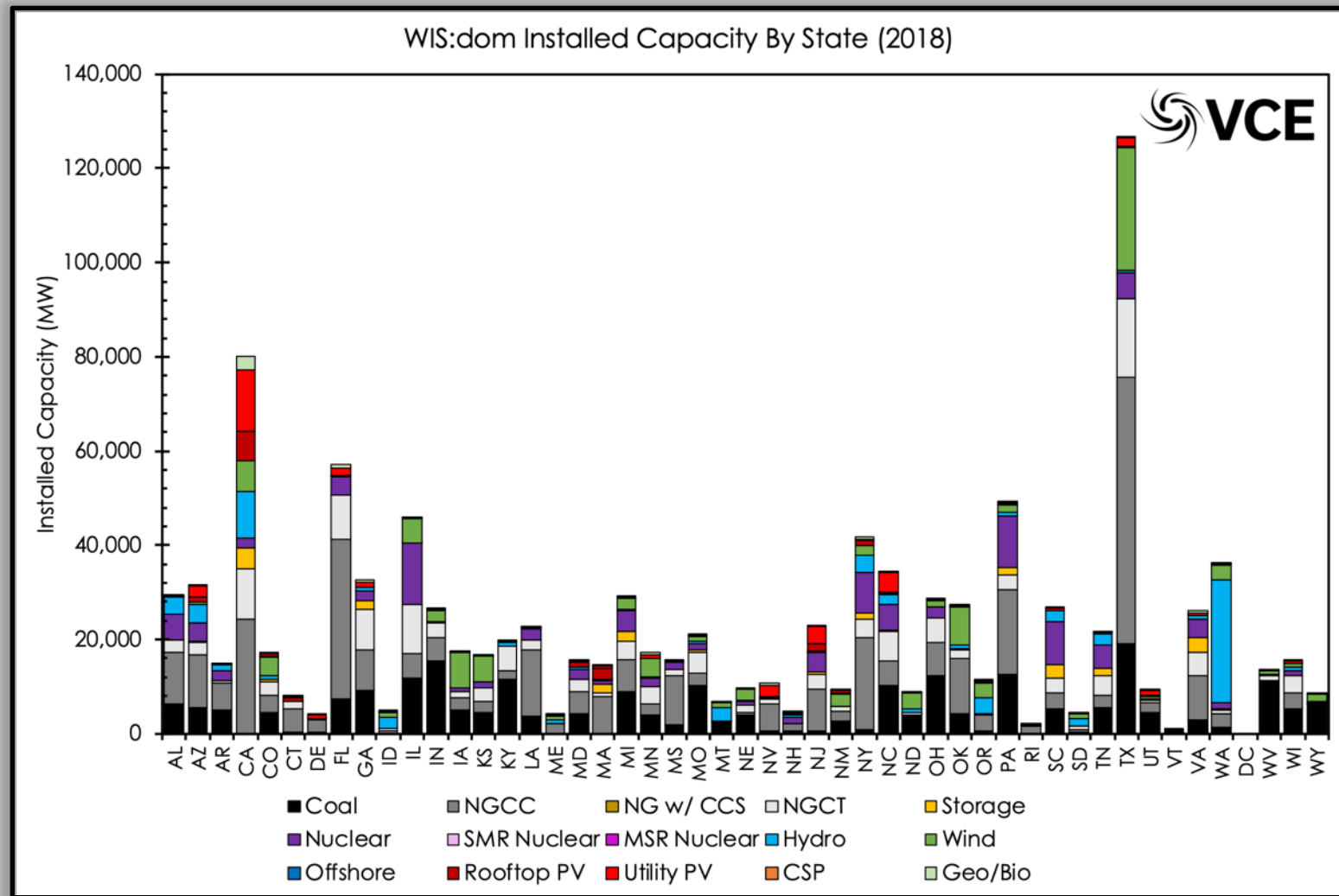
# **WIS:dom<sup>®</sup>-P Case Study**

## *CONUS Deep Decarbonization Study*

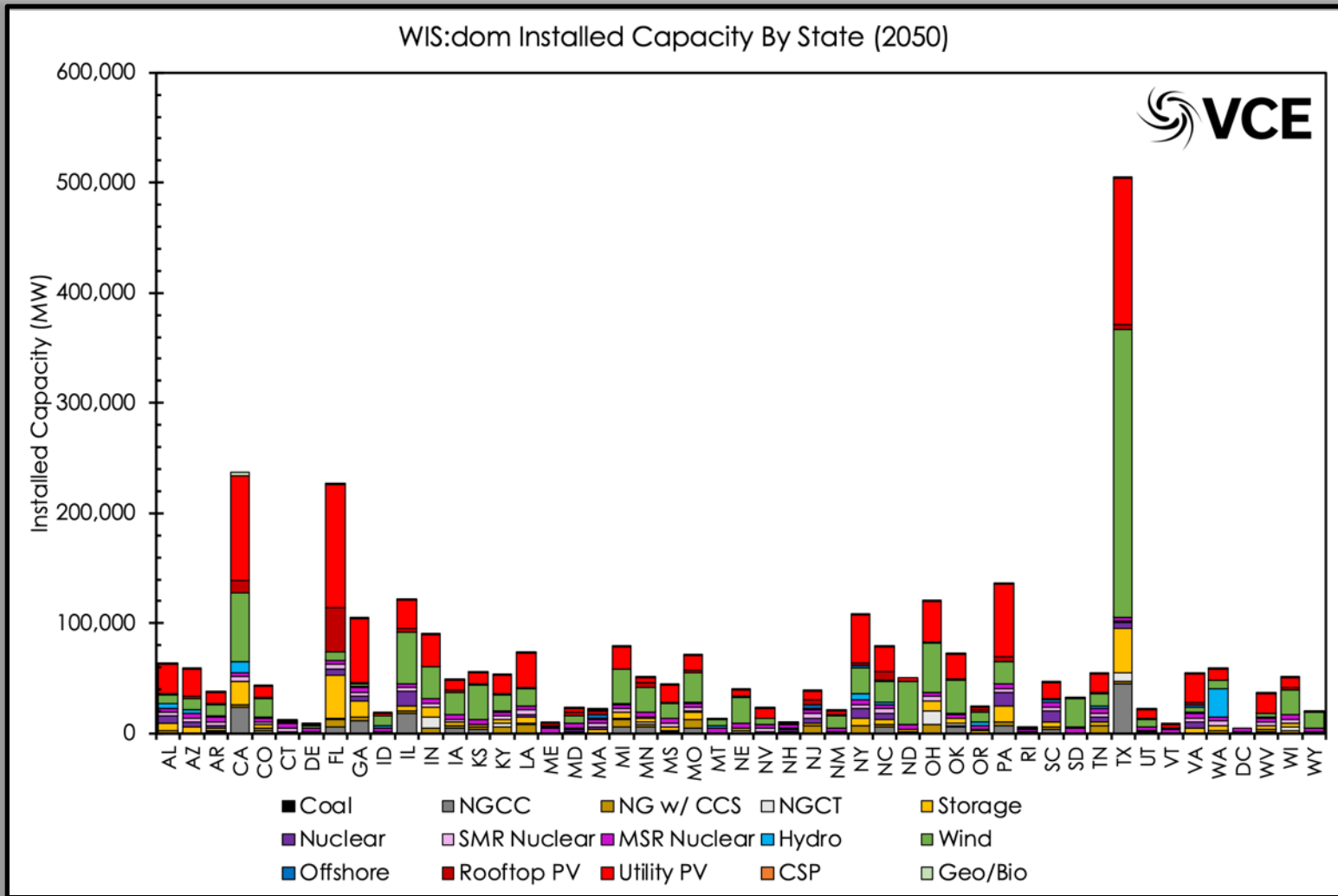
# Installed Capacities



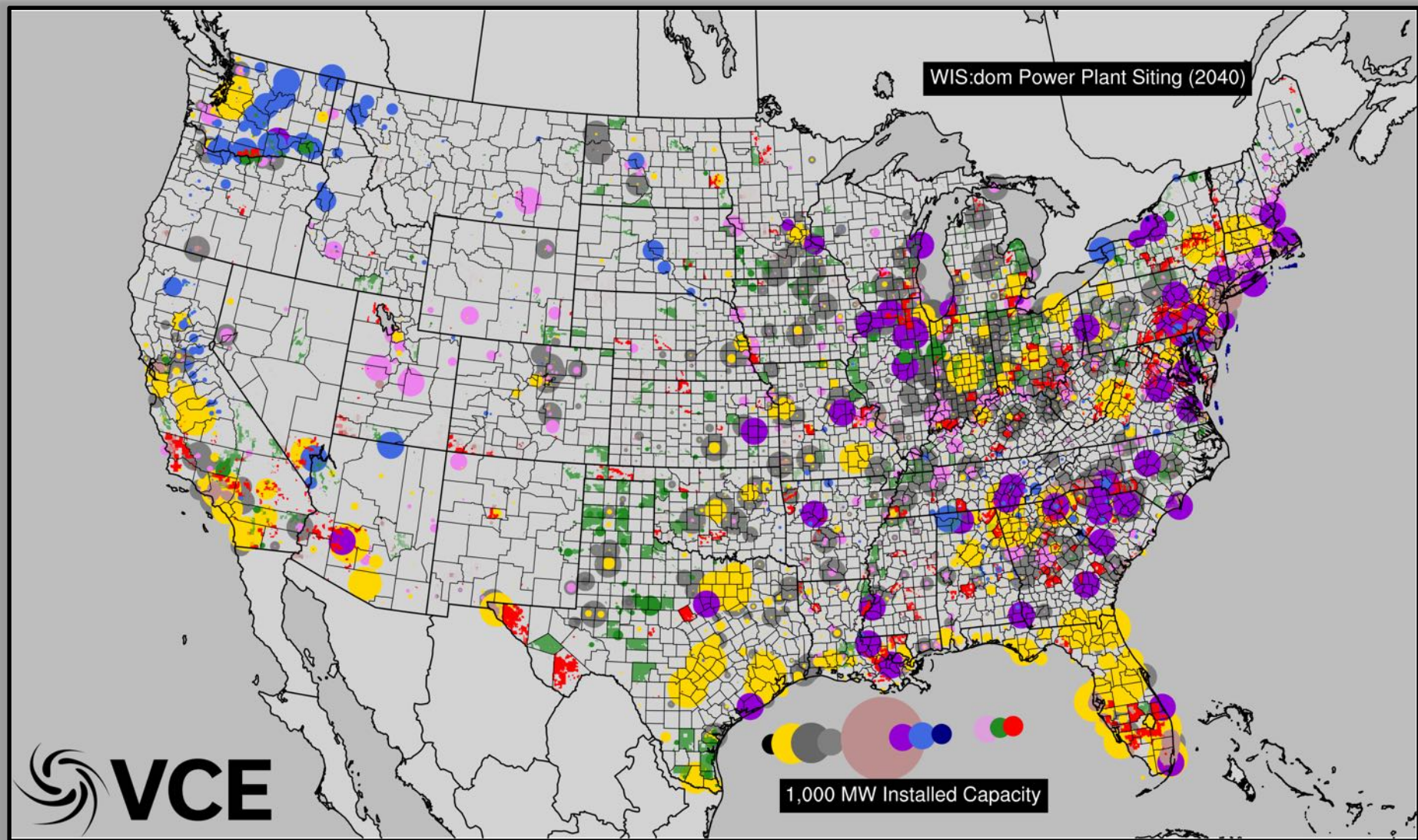
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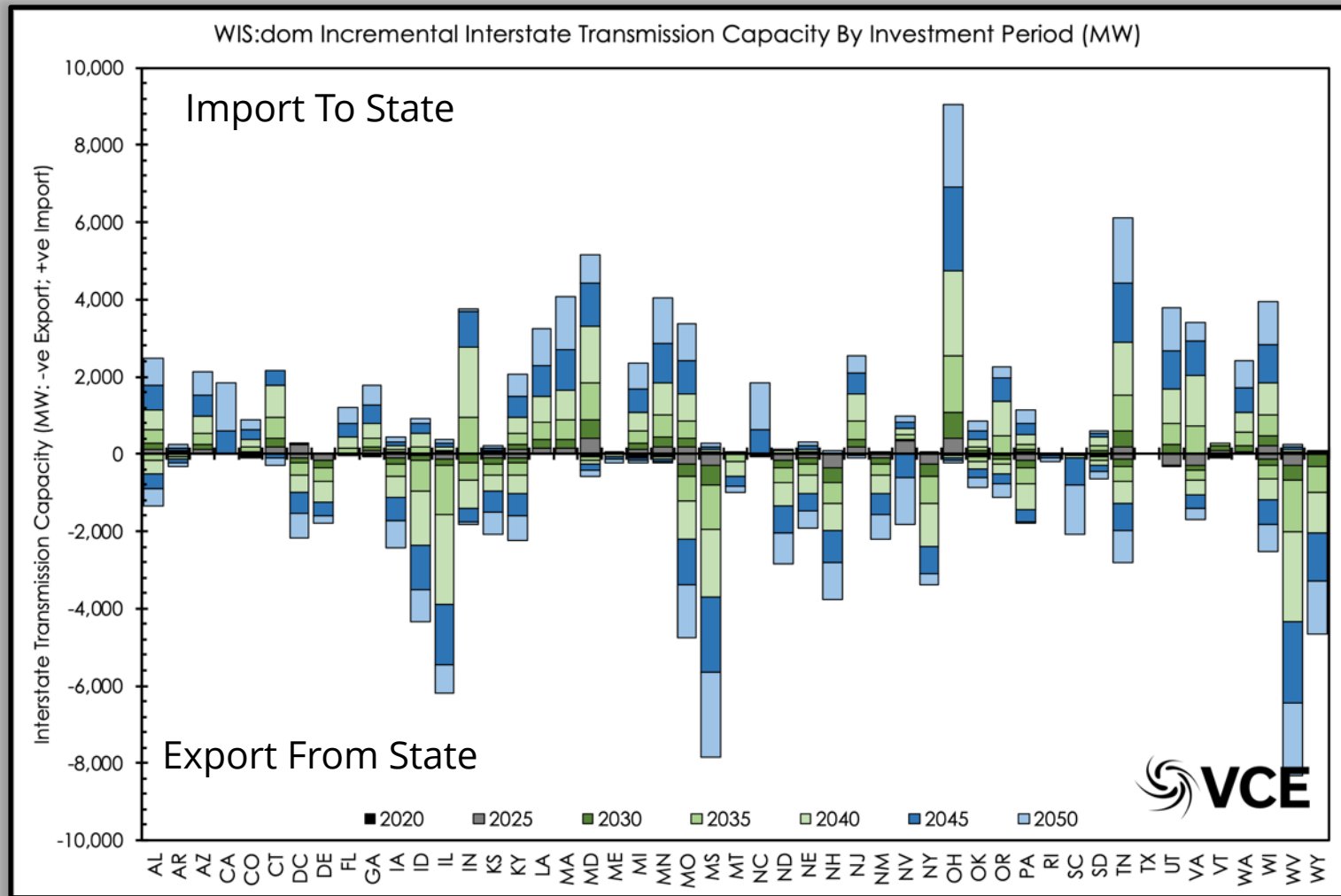
# Installed Capacities



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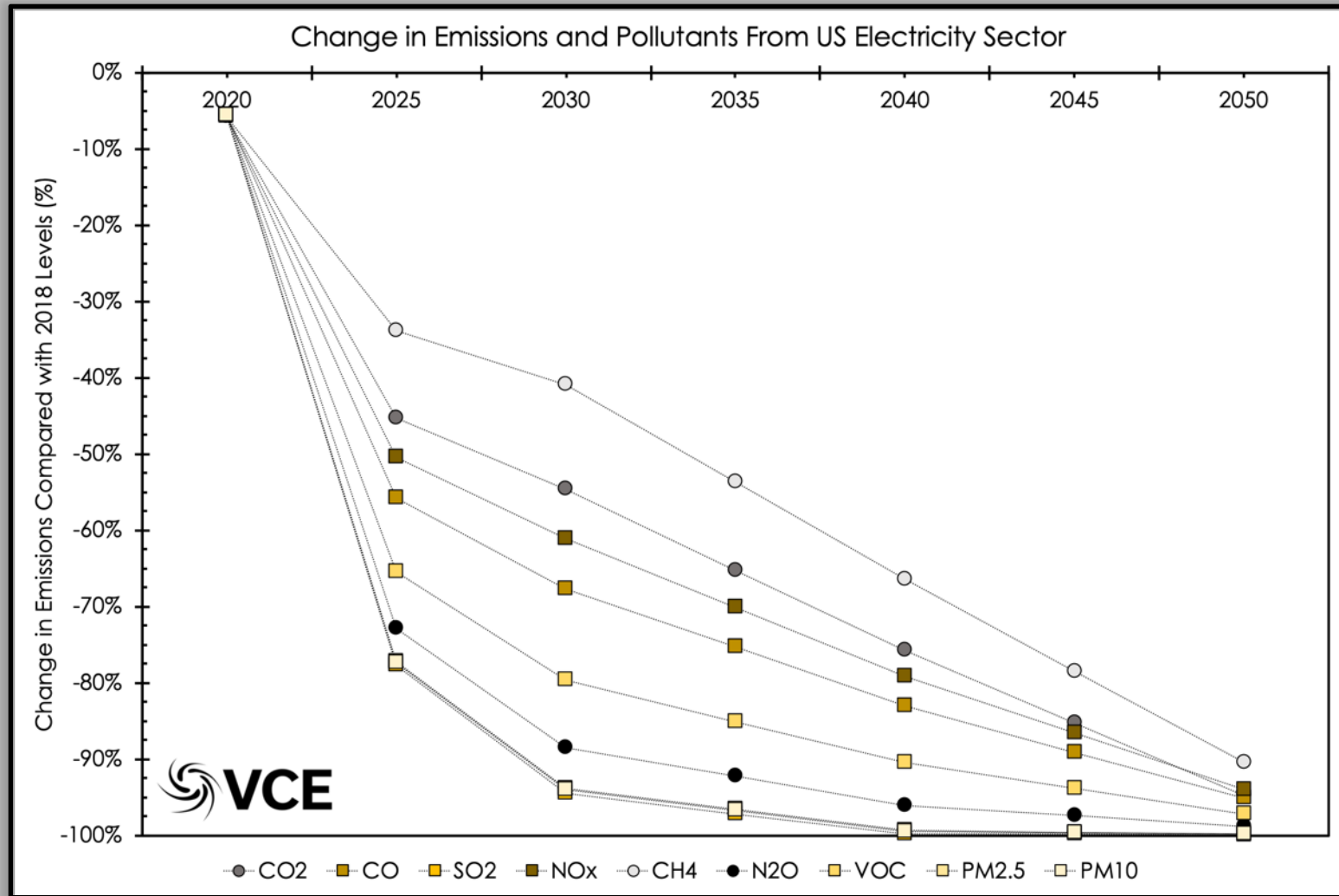


# Installed Transmission Capacities

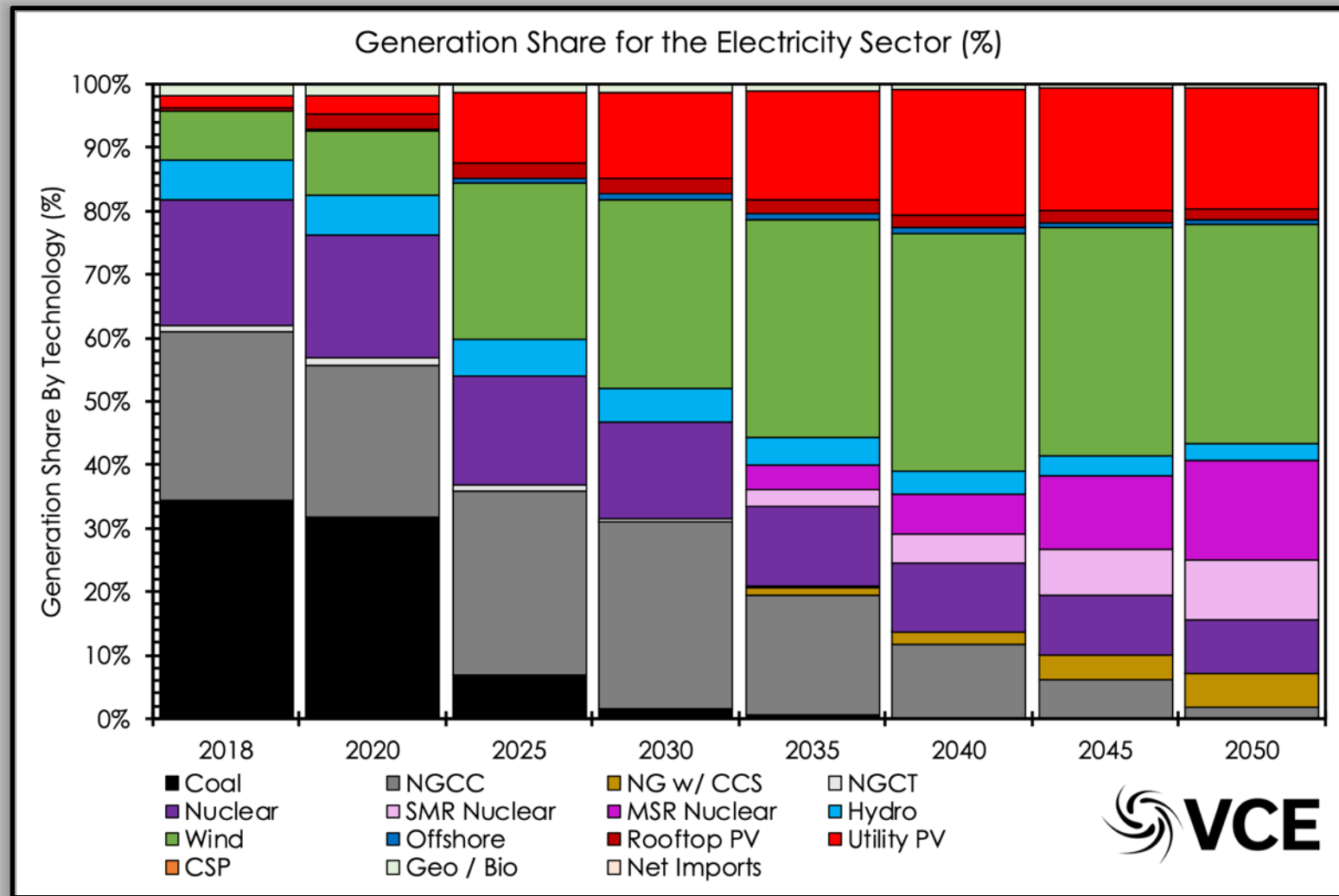




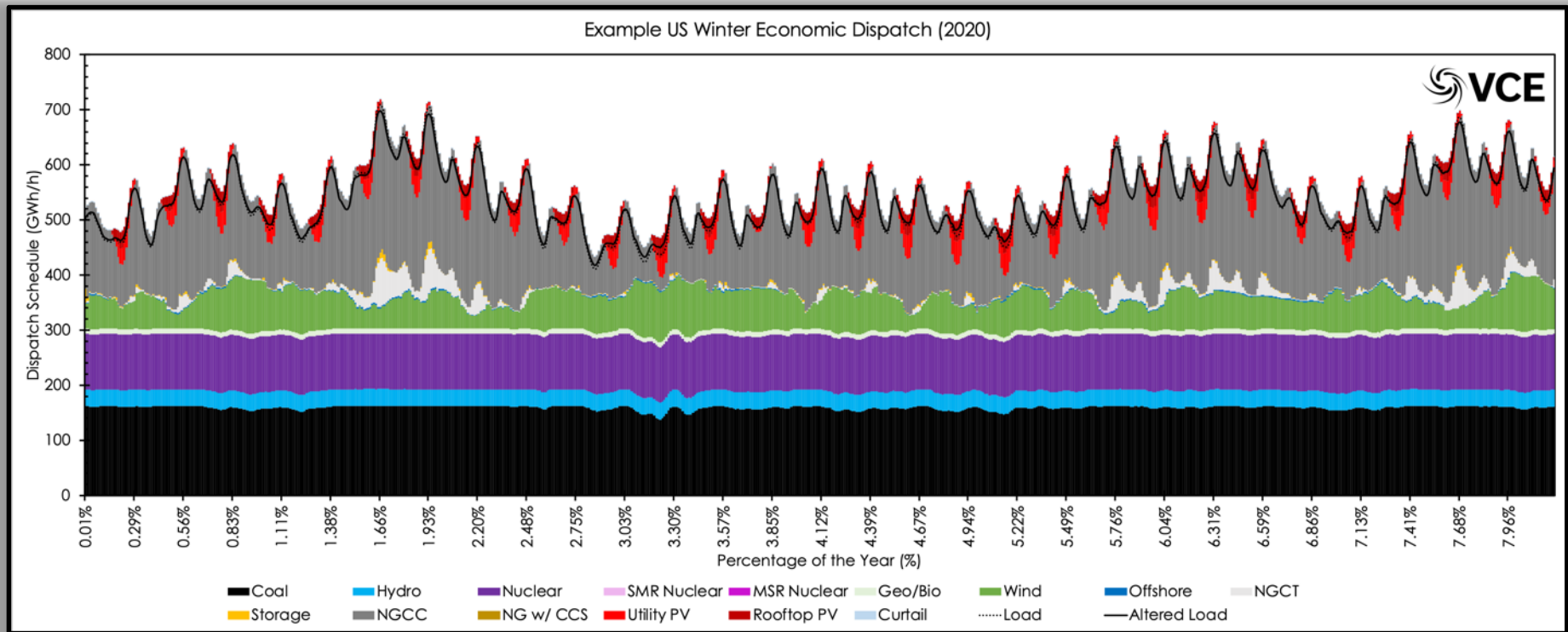
# Changes in Emissions & Pollutants



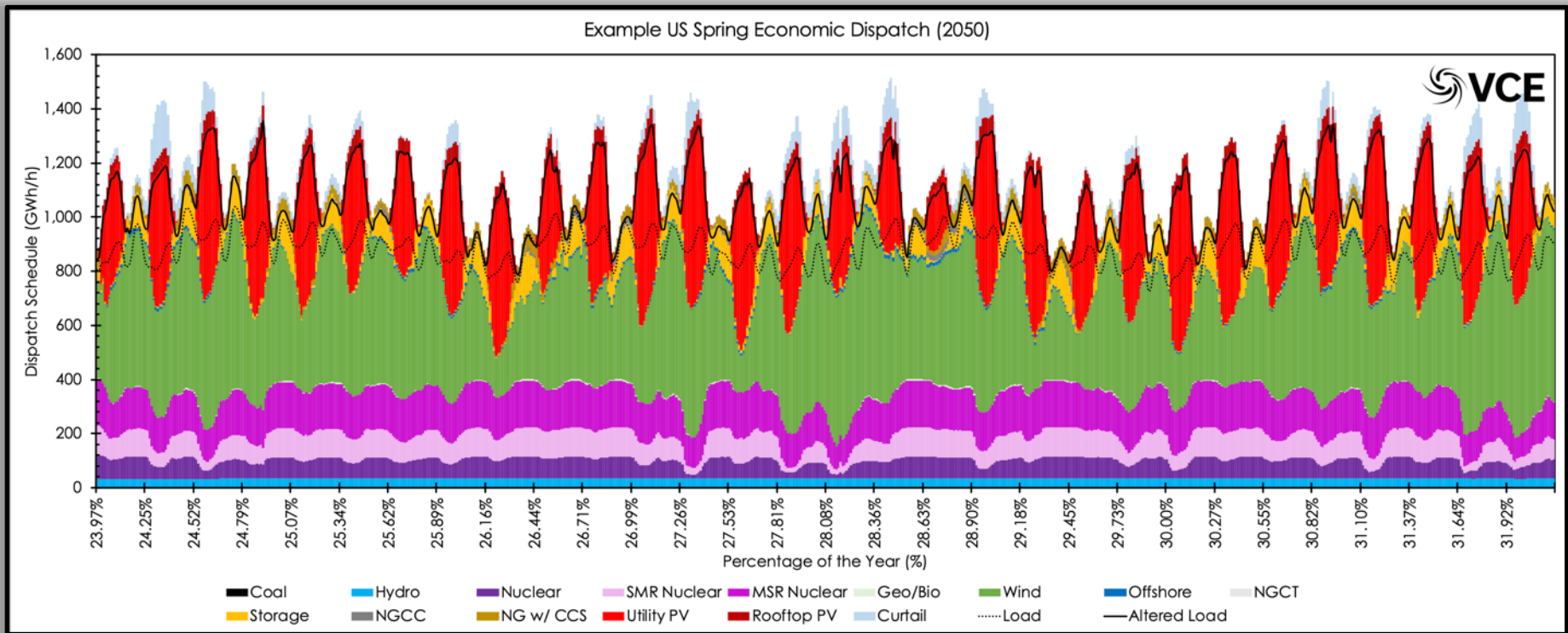
# Generation Mix (%)



# Economic Dispatch

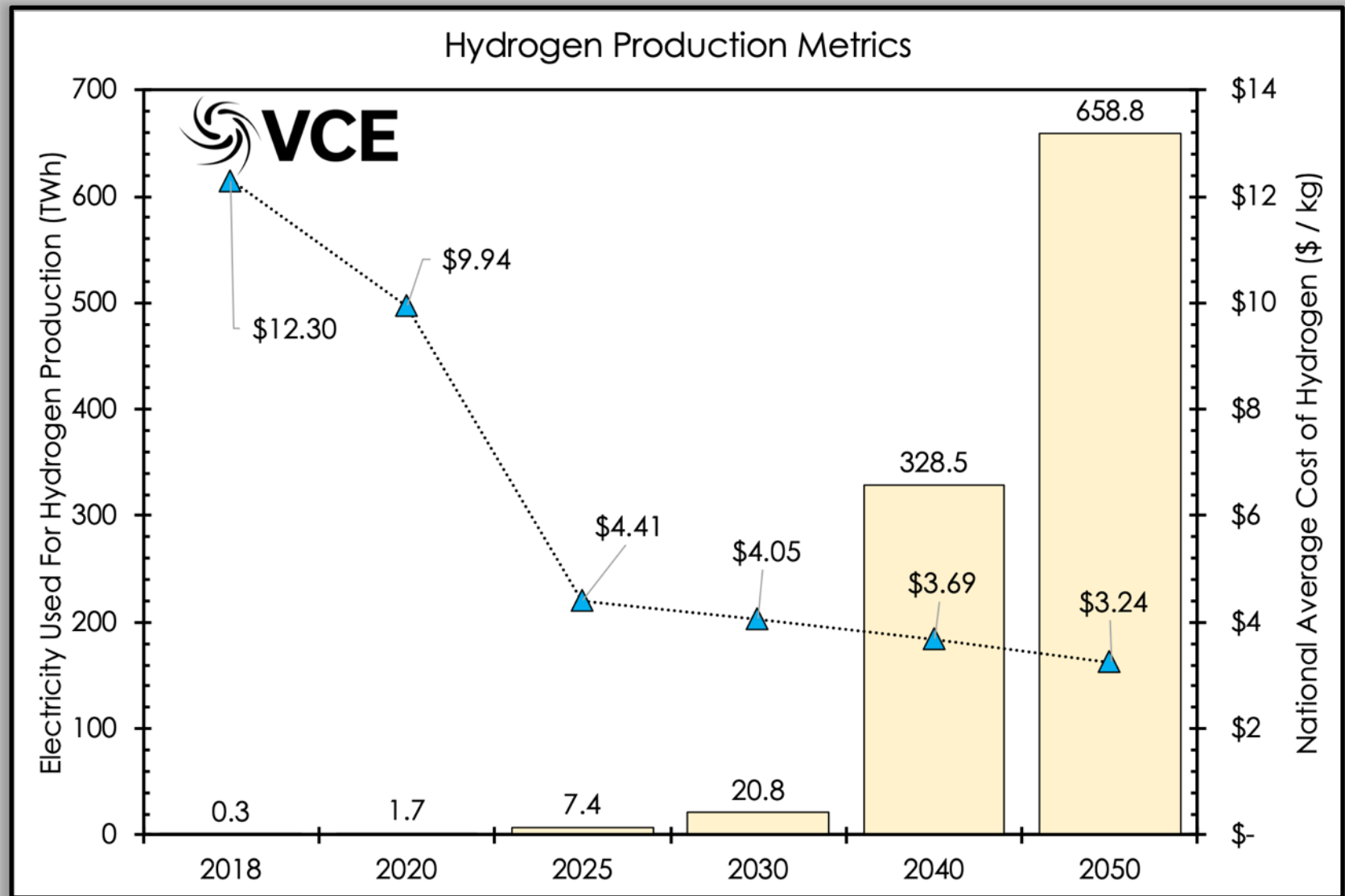


# Economic Dispatch





# Hydrogen Economy Enabled



# Thank You Questions?

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