The Dual Impacts of Space Heating Electrification and Climate Change on Seasonal Peaking and Reliability of the Texas Power Grid

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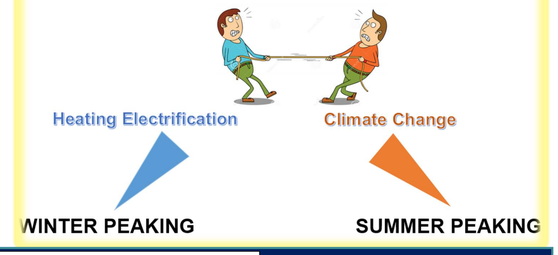


HEAT PUMPS FOR DECARBONIZATION VS. CLIMATE CHANGE

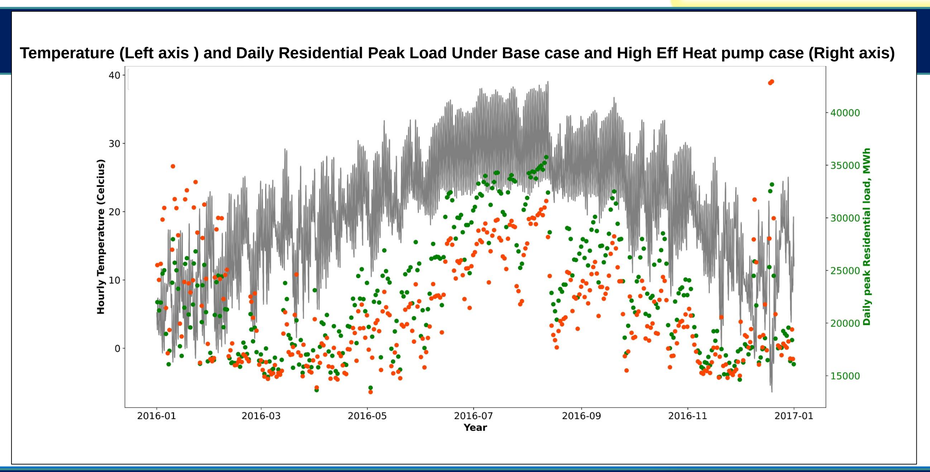
BACKGROUND:

The residential sector (heating/cooling) drives the timing of peak load events.

Electrification of residential heating could shift Texas from a summer to winter peaking system.

Conversely, climate change (changes in temp) could have the opposite effect.

Here, we assess the long term impacts of the 2 phenomena on seasonal peaking and grid reliability.



Reference:

White et.al. **Quantifying the impact of residential space heating electrification on the Texas electric grid**, *Applied Energy*

OBJECTIVES

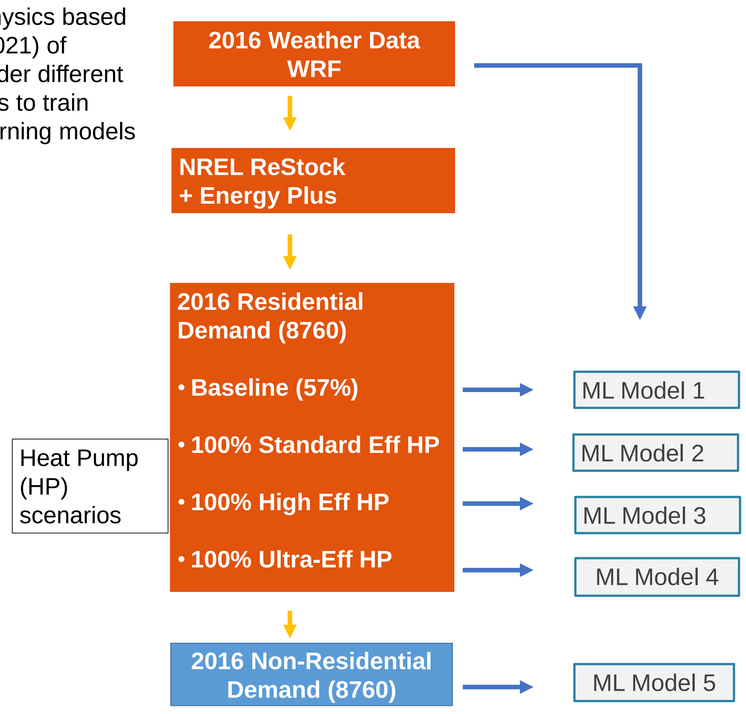
Understand impacts of simultaneous occurrence of heating electrification and future climate on:

- Peak demand and when it occurs
- Electricity Generation mix
- Reliability of the power grid
- Total load changes, etc.

Heat Pump Type	COOLING EFF. (SEER)	HEATING EFF. (HSPF)
	REF: DOE required Min : 14	REF: DOE required Min : 8.8
Standard Eff.	15.0	8.5
High Eff	22.0	10.0
Ultra High Eff	29.3	14.0

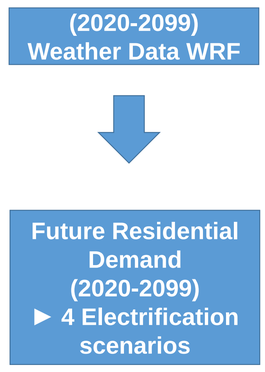
OUR WORKFLOW

1 We use output from physics based models (White et al. 2021) of residential demand under different electrification scenarios to train predictive machine learning models

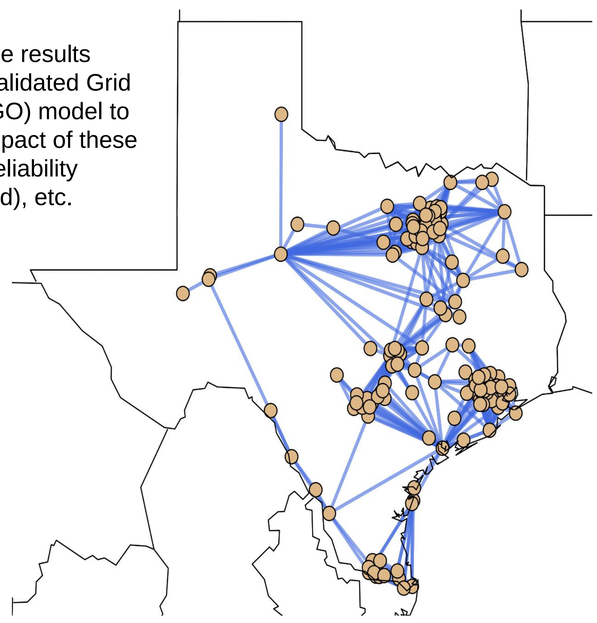


*ML: Machine Learning

2 Then we use the ML models to predict residential demand under different electrification scenarios with future population weighted weather data incorporating thermodynamic global warming (TGW)

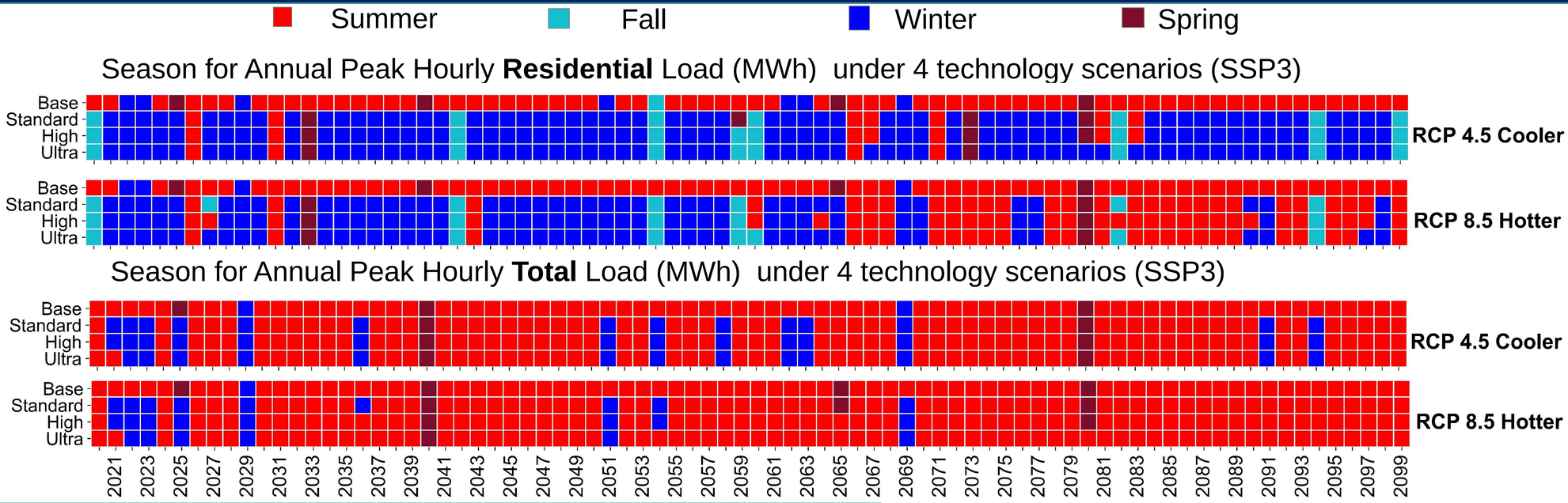


3 We push these results through our validated Grid Operations (GO) model to assess the impact of these changes on reliability (unserved load), etc.



GRID OPERATIONS MODEL (GO ERCOT)

RESULTS: HEAT PUMP ADOPTION MAY CAUSE SEASONAL PEAKING SHIFTS

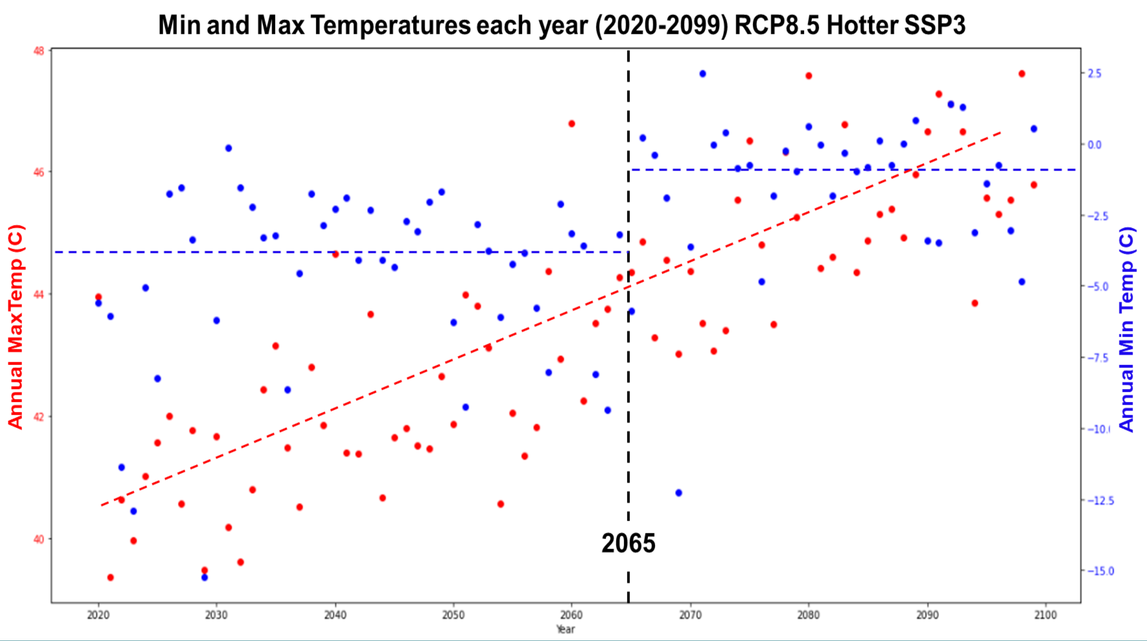


KEY TAKEAWAYS & NEXT STEPS

- Overall peaking outcomes depend on:
  - a) Focus (residential vs. total load)
  - b) HP efficiency (Standard, High, Ultra-High efficient)
  - c) Climate warming intensity
- Energy efficient heat pumps will help reduce impacts of climate change and annual total load.
- Depending on climate change severity, it overpowers effects of heating electrification to make residential load summer peaking by around mid century.
- Significant increments in winter peak loads under HPs, which could affect reliability, necessitate adequate integrated resource planning.
- HP use overall reduces loss of load events, cause infrequent but significant winter loss of load

NEXT STEPS:

- What parts of the grid are likely to be most affected by massive loss of load events and why.



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