Werewolf and NetZero: the interactions between operations, planning, investments and policies

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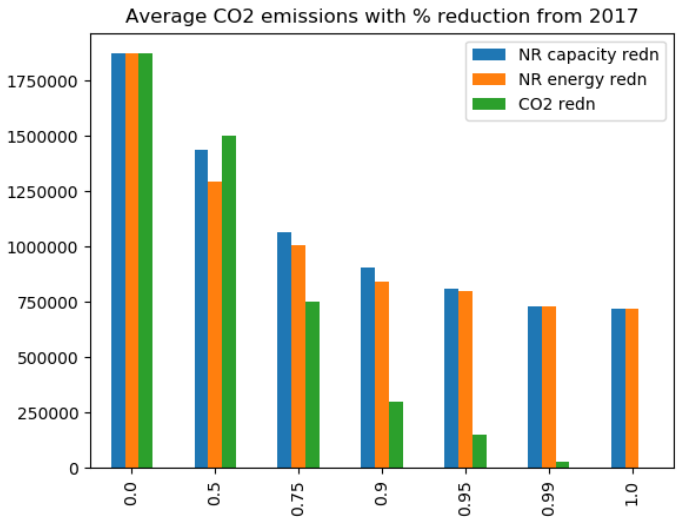
Jacinda's 2017 election deal

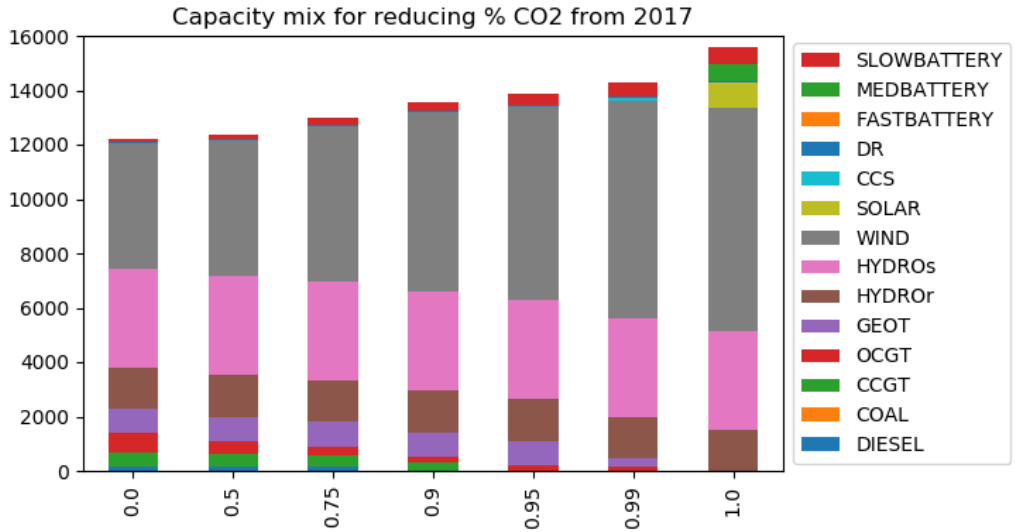
- Introduce a Zero Carbon Act and establish an independent Climate Commission.
- Request the Climate Commission to plan the transition to 100% renewable electricity by 2035 (which includes geothermal) in a normal hydrological year.
- Stimulate up to $1 billion of new investment in low carbon industries by 2020, kick-started by a Government-backed Green Investment fund of $100M.

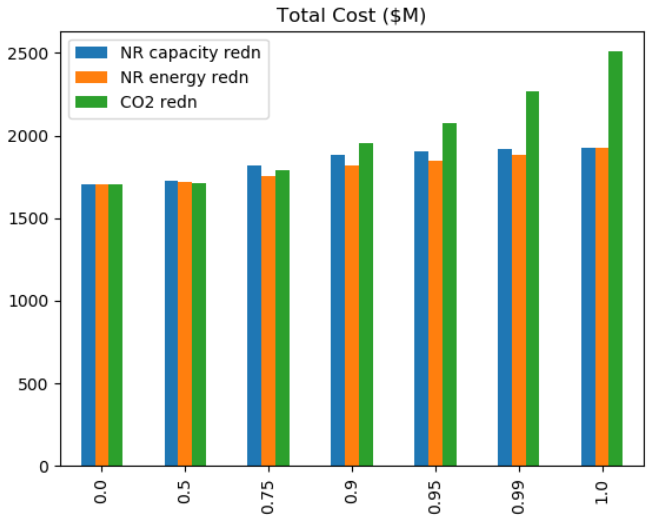
(Confidence and Supply Agreement between the New Zealand Labour Party and the Green Party of Aoteoroa)

Built model GEMSTONE that was used by New Zealand Climate Commission to help inform this policy

New Zealand (NetZero)

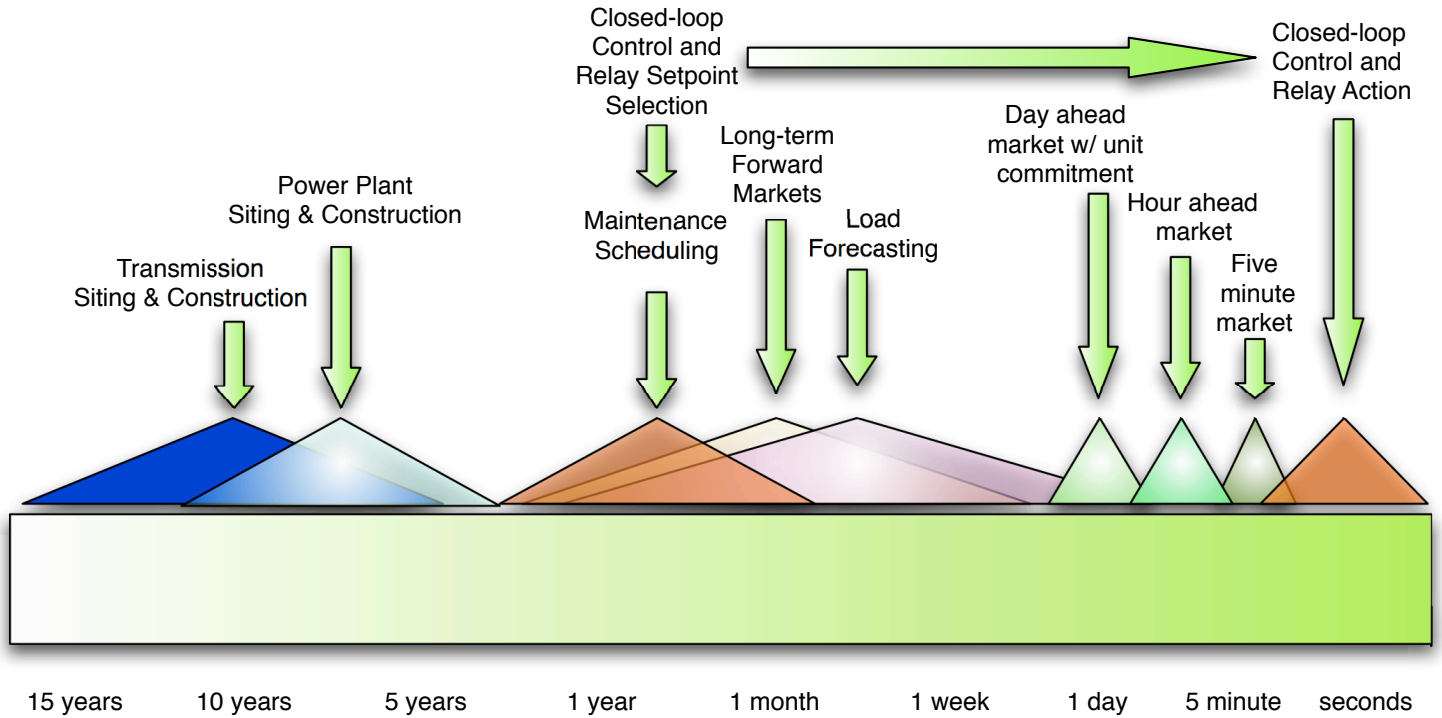






- Policies matter: affects reduction amounts and cost
- Portfolio of required technologies becomes complex as reduction increases
- Uncertainties and incentives key
- November 2019 climate act provides framework

Werewolf (Wisconsin Expansion of Renewable Electricity with Optimization under Long-term Forecasts)



- Design/policy decisions affecting operations/reliability and vice-versa
- Goal: to help policy and decision makers ...
  - to distinguish between objectives and actions;
  - to understand effects of uncertainty;
  - to understand effects of incentives;
  - to explore larger design space.

Simplified two-stage stochastic optimization model

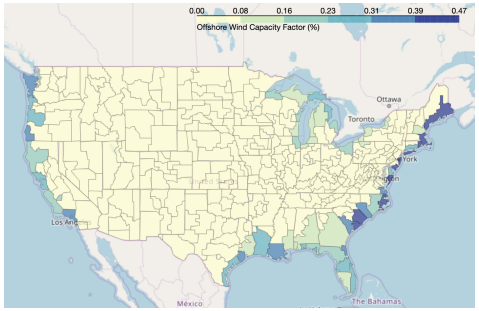
- Capacity decisions are z at cost $K(z)$
- Operating decisions: generation y at cost $C(y)$, loadshedding q at cost Vq.
- Scenarios (futures) ω, demand (load curve) is $d(\omega)$.
- Minimize capital cost plus expected operating cost:

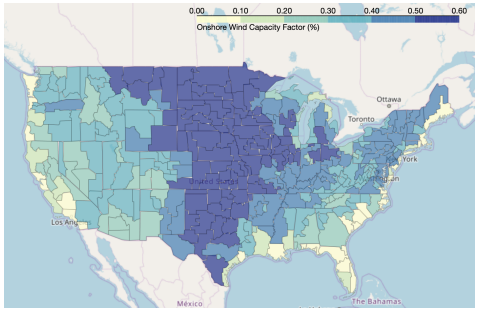
$$\begin{array}{lrcl} \min & K(z) & + & \mathbb{E}_\omega[C(y(\omega)) + Vq(\omega)] \\ \\ \text{s.t.} & y(\omega) & \leq & z \\ & y(\omega) + q(\omega) & \geq & d(\omega) \\ & (z, y, q) & \in & X \end{array}$$

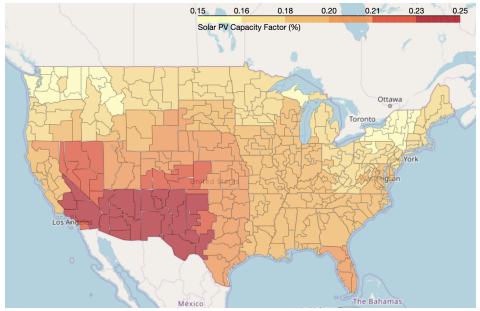
- WEREWOLF populated using data from Wisconsin: develop the model for MISO and look at Wisconsin policies in particular
- Data and structure facilitate any US regional model

The data

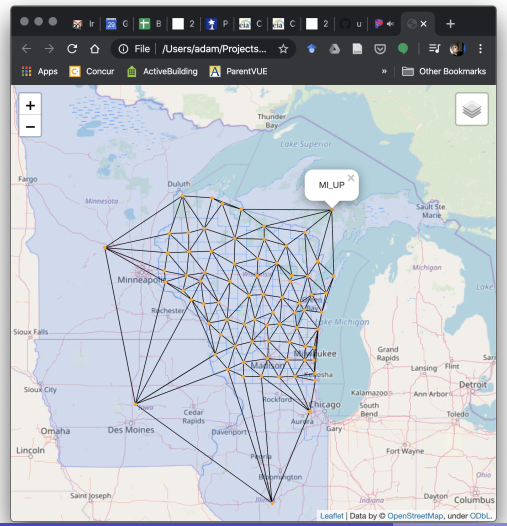
- WEREWOLF is data rich (EPA NEEDS/Integrated Planning Model, NREL ReEDS model data, NREL Annual Technology Baseline)

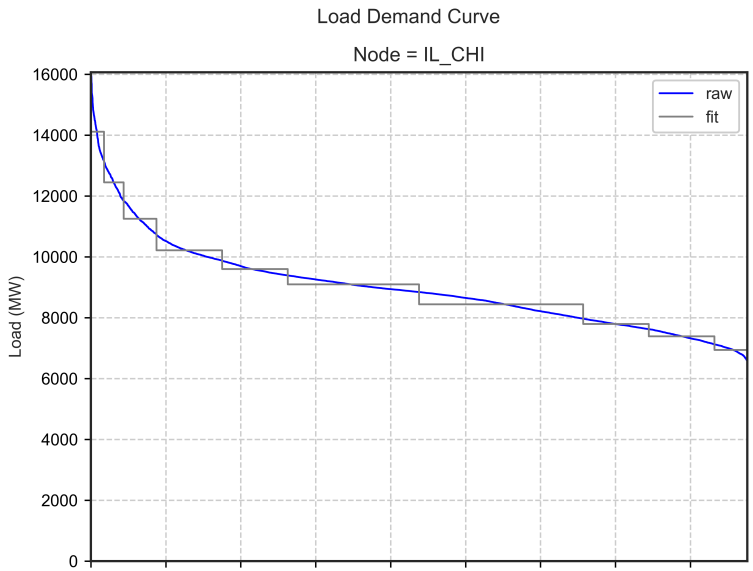






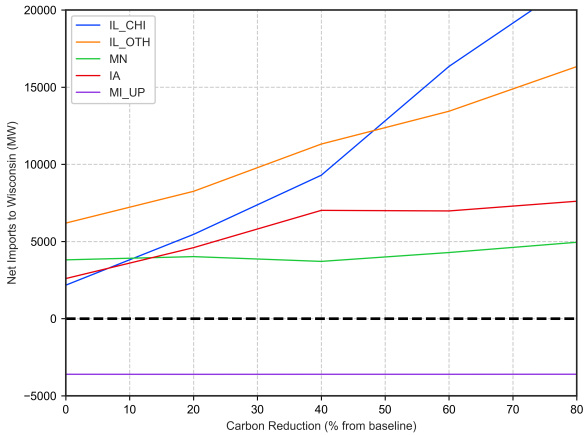
- Data is downscaled to county level - *user can customize regions as aggregations of these counties*
- Spatial impacts are captured in visualizations

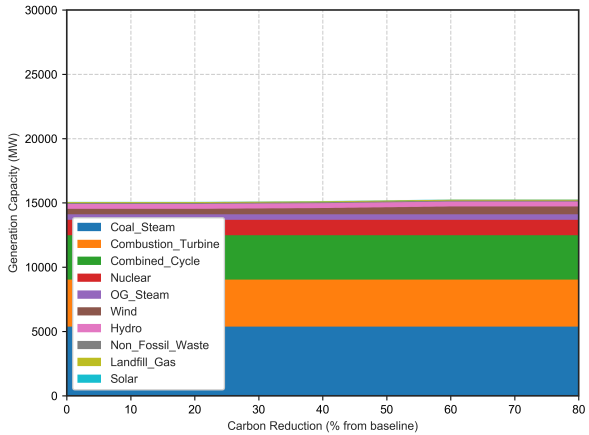


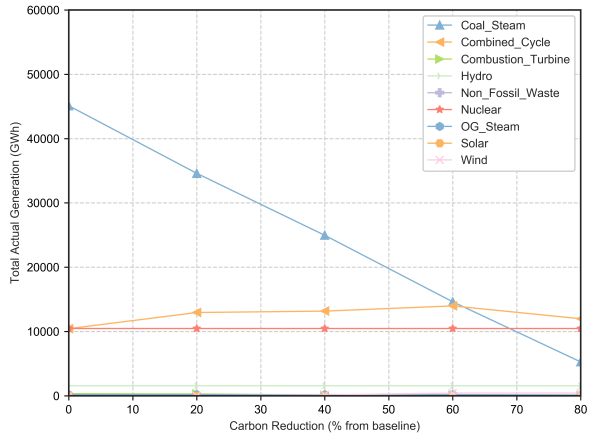


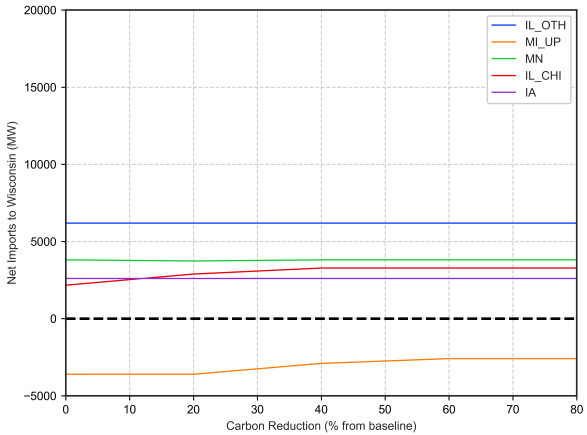
Carbon reductions (increasing or flat imports)

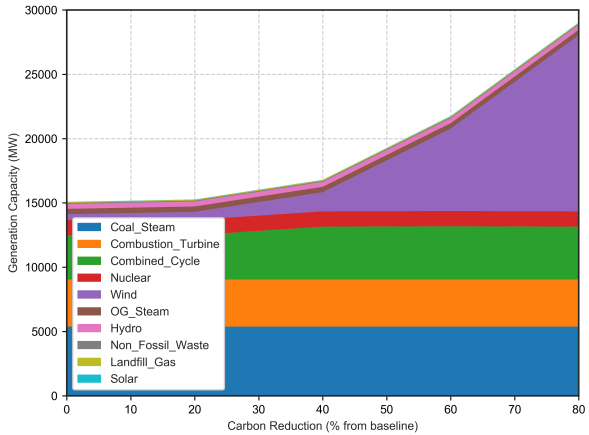
- Demand in 2030 is a data input, what generation portfolio needed for this new demand under increasing carbon reduction requirement
- Imports, capacity mix (no plant shutdowns), generation

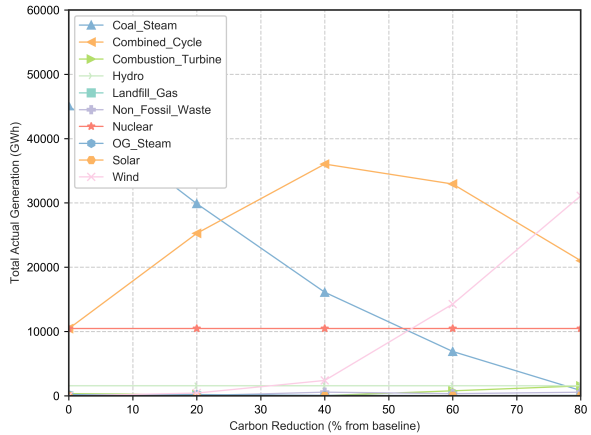






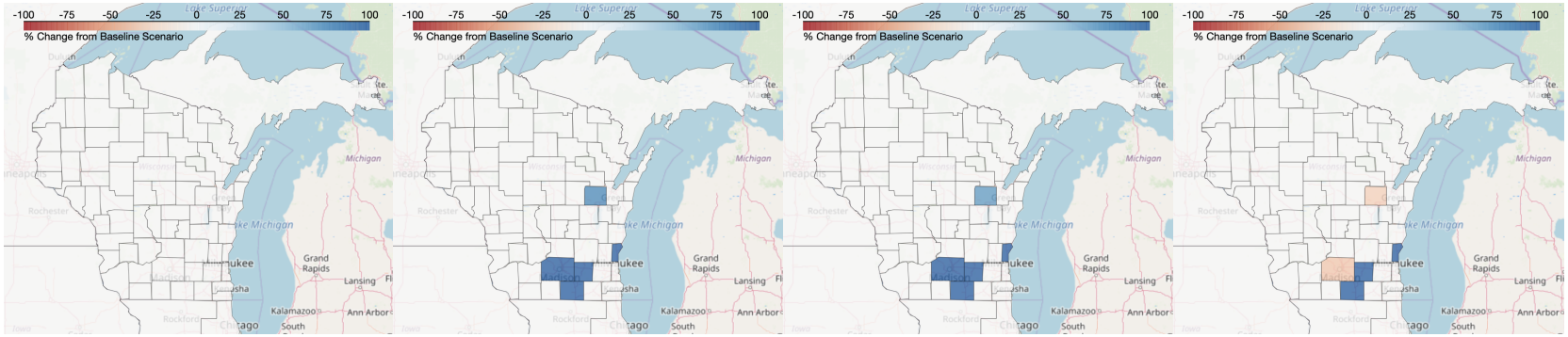




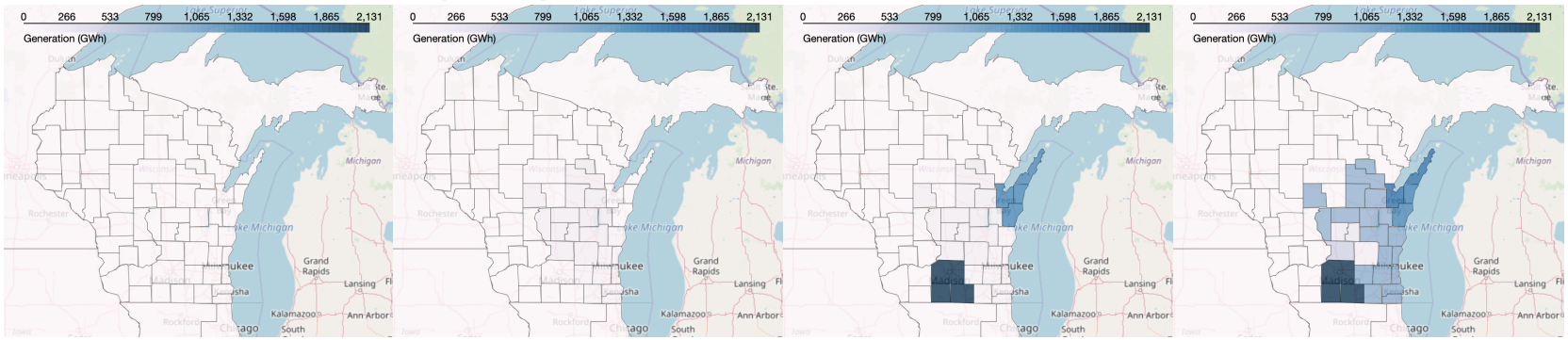


Carbon reductions – No Plant Shutdowns

Combined Cycle (natgas) ramps up and then down while...

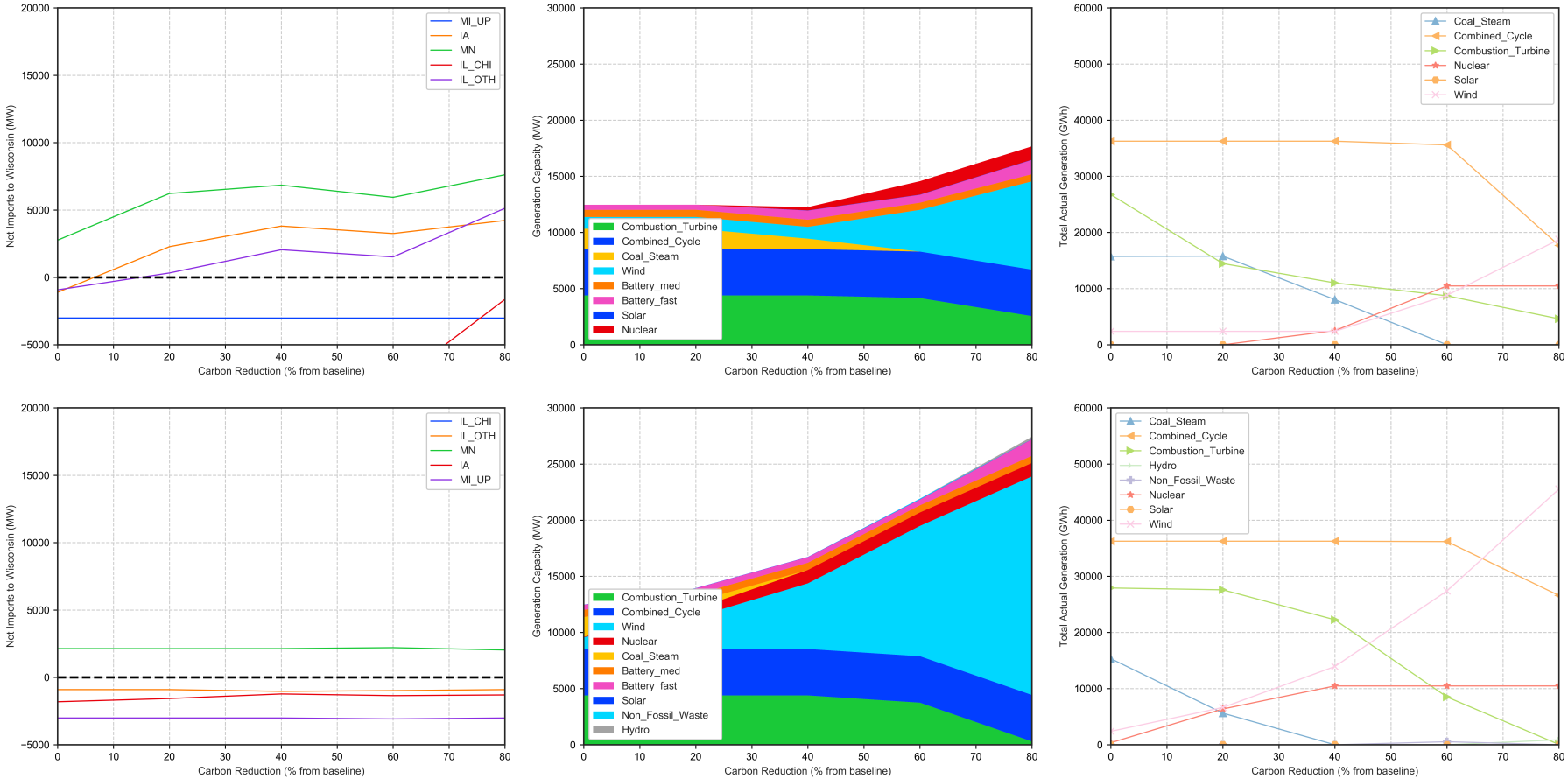


Onshore wind ramps up.



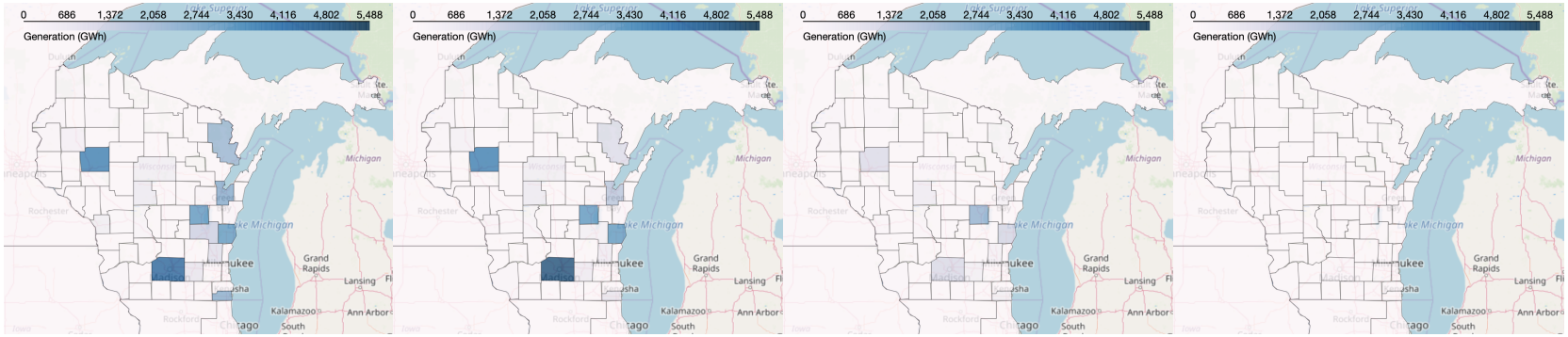
Carbon reductions (increasing or flat imports)

- Reductions in coal, increase in gas
- Imports, capacity mix (shutdowns allowed), generation

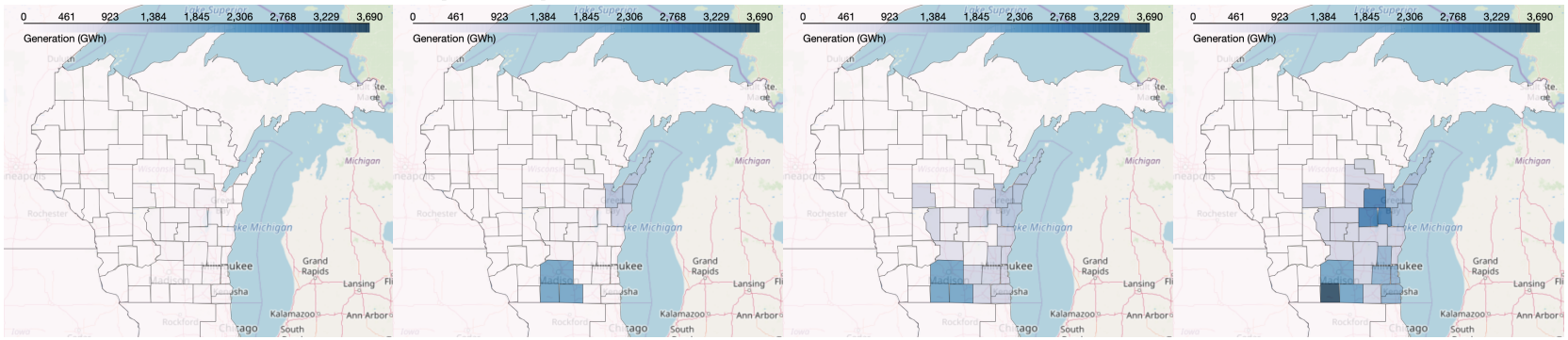


Carbon reductions – Shutdowns Allowed

Combustion Turbine (natgas) ramps down while...

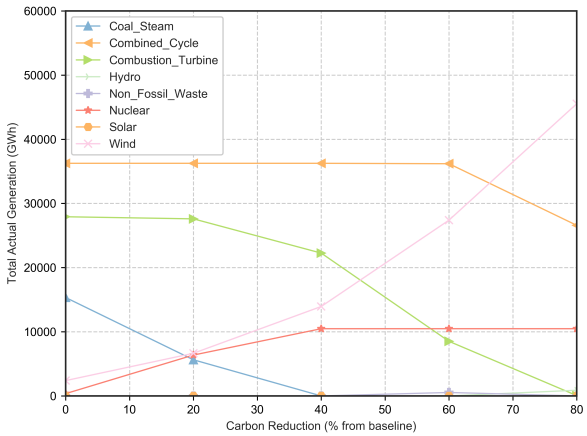


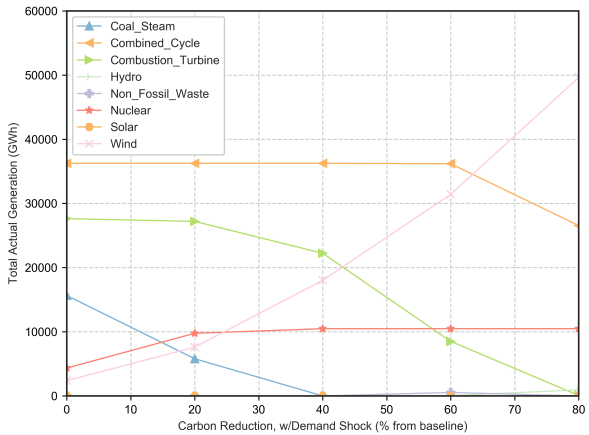
Onshore wind ramps up.

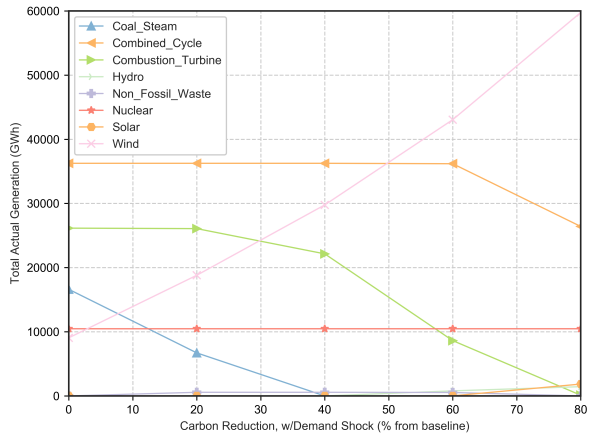


Increased demand – Shutdowns Allowed

- 5% and 20% increase in demand for WI only (beyond the growth factor for 2030)
- Wind still dominates the low carbon fuel, but the demand shock incentivizes nuclear to come in back in earlier ($> 20\%$)

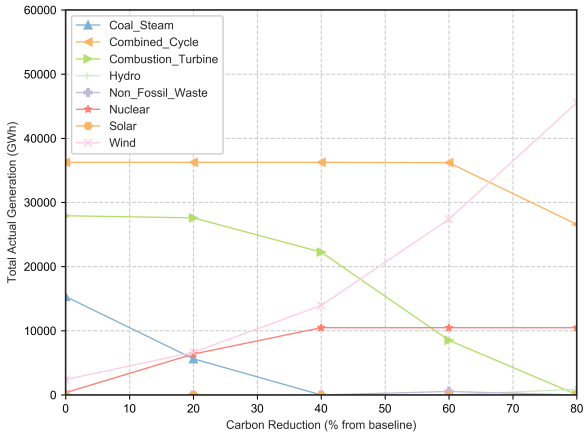


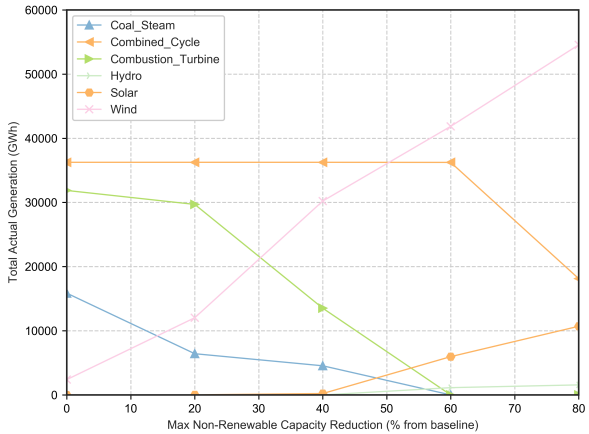


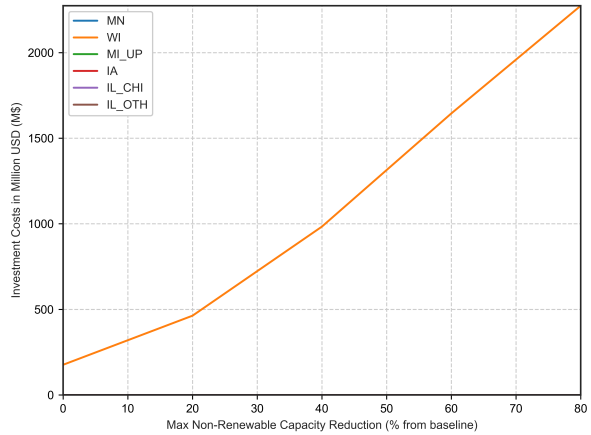


Limit non-renewable capacity

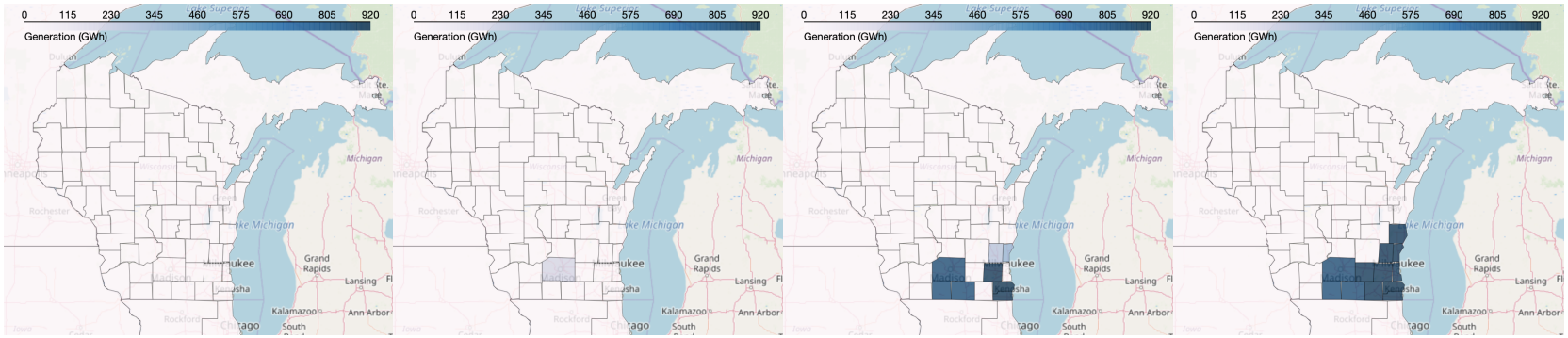
Expansion of combustion turbines for 2030, but then they ramp down as nonrenewable capacity allowed shrinks, cost increase significant







Solar deployment ramps up is specific locations...



How can we help?

- Models can inform policy
- Models can show effects and costs of constraints
- Investment is coupled to reliability
- The model is currently being refined, and we are interested to get feedback from utility and policy experts about how this model would be useful in your utility and regulatory planning efforts (by April-May)
- One-on-one demonstrations of model, suggestions of possible policy interventions
- Contact at: ferris@cs.wisc.edu