WEREWOLF in London: Minding the Gap with User-Friendly Energy Optimization Tools Informing Policy Makers through the Energy Transition

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Energy Evaluation Europe 2021 Virtual Conference
15 March 2021
GEMSTONE model was used to inform New Zealand’s Zero Carbon Act

- Zero Carbon Act and new Climate Commission
- Transition to 100% renewable electricity by 2035
- Stimulate new investment

- 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 for adoption
WEREWOLF (Wisconsin Expansion of Renewable Electricity with Optimization under Long-term Forecasts) informs policy...quickly

- Design/policy decisions affect 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, with quick turnaround
WEREWOLF uses up to date industry-leading data sources

- (EPA NEEDS/Integrated Planning Model, NREL ReEDS data, NREL Annual Technology Baseline) can be updated regularly as needed
- Data is downscaled to county level - user can customize regions as aggregations of these counties
- Spatial impacts are captured in visualizations
WEREWOLF uses open source code available on github

- Transparency - open source code is on github
- Data is adapted from EPA NEEDS/Integrated Planning Model, NREL ReEDS model data, NREL Annual Technology Baseline and other sources
- After data initialization, each run takes \(\approx 5\) mins to generate the following results
- Show effects of strategies driving towards 100\% carbon free energy by 2050, coal plant closures, rapid deployment of renewables, increase in electric vehicle (EV) uptake, for example
- Demand in 2030 is a data input, what generation portfolio needed for this new demand?
- Model and app exercised with utility executives and state regulators (Wisconsin Public Utility Institute, Public Service Commission of Wisconsin, and WI Office of Sustainability and Clean Energy)
WEREWOLF model outputs: Renewable increases (wind and solar) for 0%, 40%, 80% carbon reduction policy scenarios in State of Wisconsin, USA
WEREWOLF: User-friendly configuration using interactive GAMS MIRO app
No Carbon Goals: overall system costs are minimized, without a carbon constraint
Carbon Goals: 60% reduction on in-state carbon emissions by 2030
Nuclear (low-carbon) used when deep carbon reductions are necessary
Coal steam generators are shut down, supplanted by renewables
Storage to arbitrage across time slices
Caps on investment are modifiable
Impact of Electric Vehicle Deployment on Generator Investments

❖ Model widespread adoption of light duty electric vehicles (EVs)
❖ Additional 180,000 MWh demand per year
❖ Storage investment needed
❖ No significant CO2 reduction
❖ Additional demand and/or imposing carbon goals necessary for more dramatic effects
How can WEREWOLF add value to your next energy decision?

- Models can and should inform policy
- Models demonstrate effects and costs of constraints
- Investment is coupled to reliability
- Run high level scenarios in close to real-time – quick and interactive
- We are interested to get feedback from utility and policy experts about how this model/app would be useful in your utility and regulatory planning and evaluation efforts
- One-on-one demonstrations of model, suggestions of possible policy interventions
- Contact at: ferris@cs.wisc.edu or see https://werewolf.discovery.wisc.edu
WEREWOLF: two-stage stochastic optimization model (simplified)

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

\[
\min K(z) + E_\omega[C(y(\omega)) + Vq(\omega)]
\]

\[
\text{s.t. } y(\omega) \leq z \\
y(\omega) + q(\omega) \geq d(\omega) \\
(z, y, q) \in X
\]

- 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 or EU model