Modeling for Insight Using Tools for Energy Model Optimization and Analysis (Temoa)

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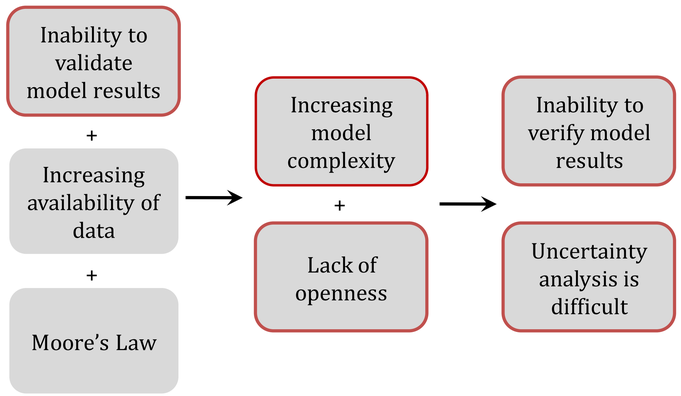
Motivation

Energy economy optimization (EEO) models employ formal search techniques to explore the future decision space over several decades in order to deliver policy-relevant insights.

Such models have been used to produce **high visibility analysis** that informs energy and environmental policy at scales ranging from local to global.

However, there are **several problems** associated with the development and application of such models:



We are building **Tools for Energy Model Optimization and Analysis** (Temoa) to address these concerns.

Our approach involves :

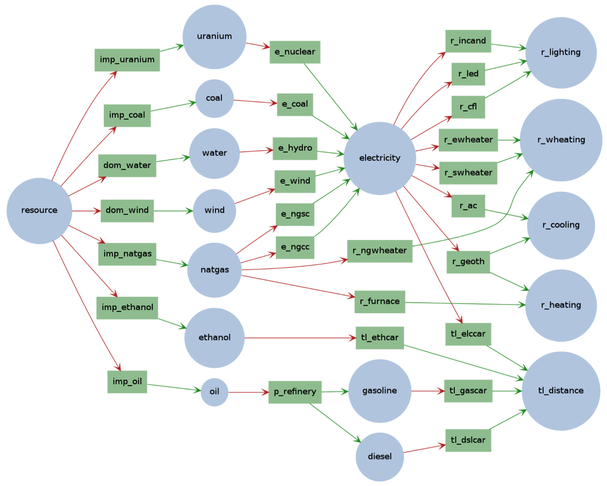
Making model-based analysis replicable with **public access to source code and data**

Building the Temoa framework to operate in a **high performance computing (HPC)** environment to enable rigorous uncertainty analysis.

Framework

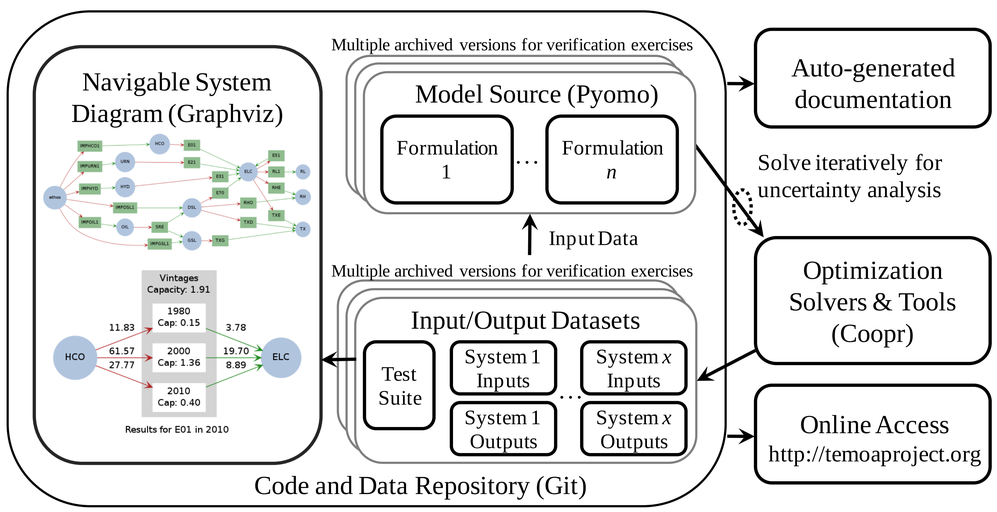
The core component of Temoa is an **open source EEO** model that:

- Utilizes **engineering / economic** parameters to represent energy technologies
- **Links energy technologies** together via commodity flows
- **Minimizes the cost** of energy supply
- Explores the decision space over a **multi-decade horizon**



The Temoa model is embedded in a larger framework, which utilizes an **open source software stack**:

- Built against Sandia's Python Optimization Modeling Objects (**Pyomo**), which enables algebraic model formulation
- Utilizes Sandia's **Coopr** package to link the model to solvers
- Employs **Git** to publicly archive source code and data
- Incorporates **Graphviz** to generate energy system network maps



Website: http://temoaproject.org

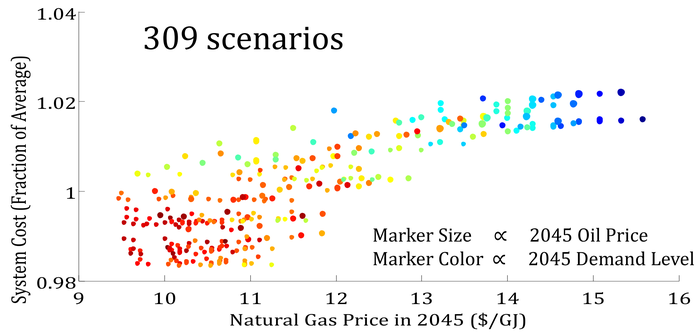
Analysis

Approaches to uncertainty analysis

- Quantify the effect of key inputs on outputs (**Monte Carlo simulation**)
- Develop hedging strategies that account for future uncertainty (**stochastic optimization**)
- Test the robustness of the hedging strategy (**modeling-to-generate alternatives**)

Sample application

- Treat crude oil, natural gas, and energy demand as stochastic parameters
- Calculate conditional probabilities based on historical 5-year moving averages, 1969-2010
- Build and run stochastic formulation using Sandia's Python-based Stochastic Programming (**PySP**)



Future Work

- Application to examine U.S. climate policy
- Relational database schema for I/O data
- Modeling-to-generate-alternatives
- Parallel implementation of PySP

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