

The Impact of Uncertainty in National Energy Planning

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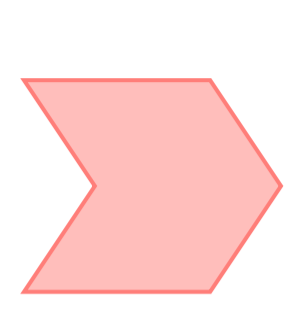
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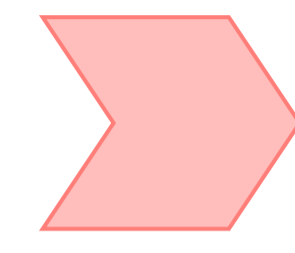


MOTIVATION & GOALS

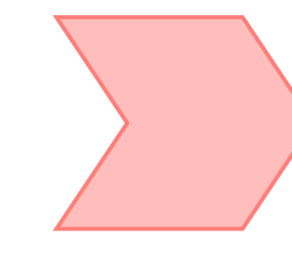


Strategic Energy Planning

Large-scale: urban/national energy systems
Long time horizon: 20-50 years
Errors in **forecasts**

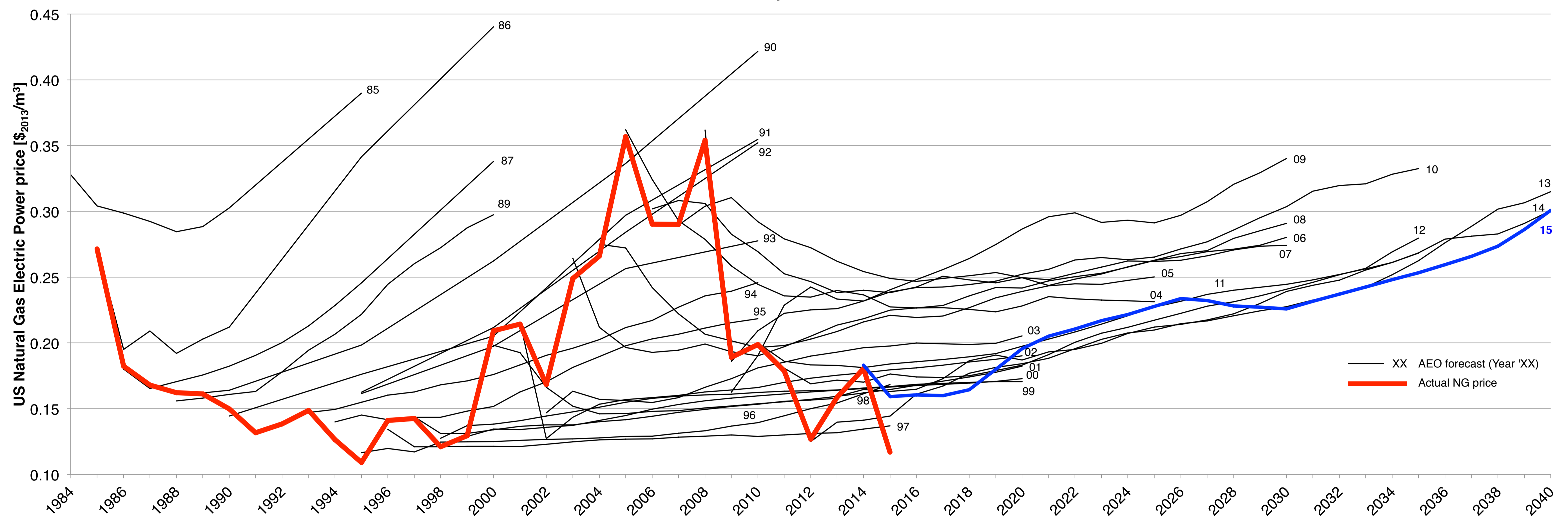


Large-scale energy model



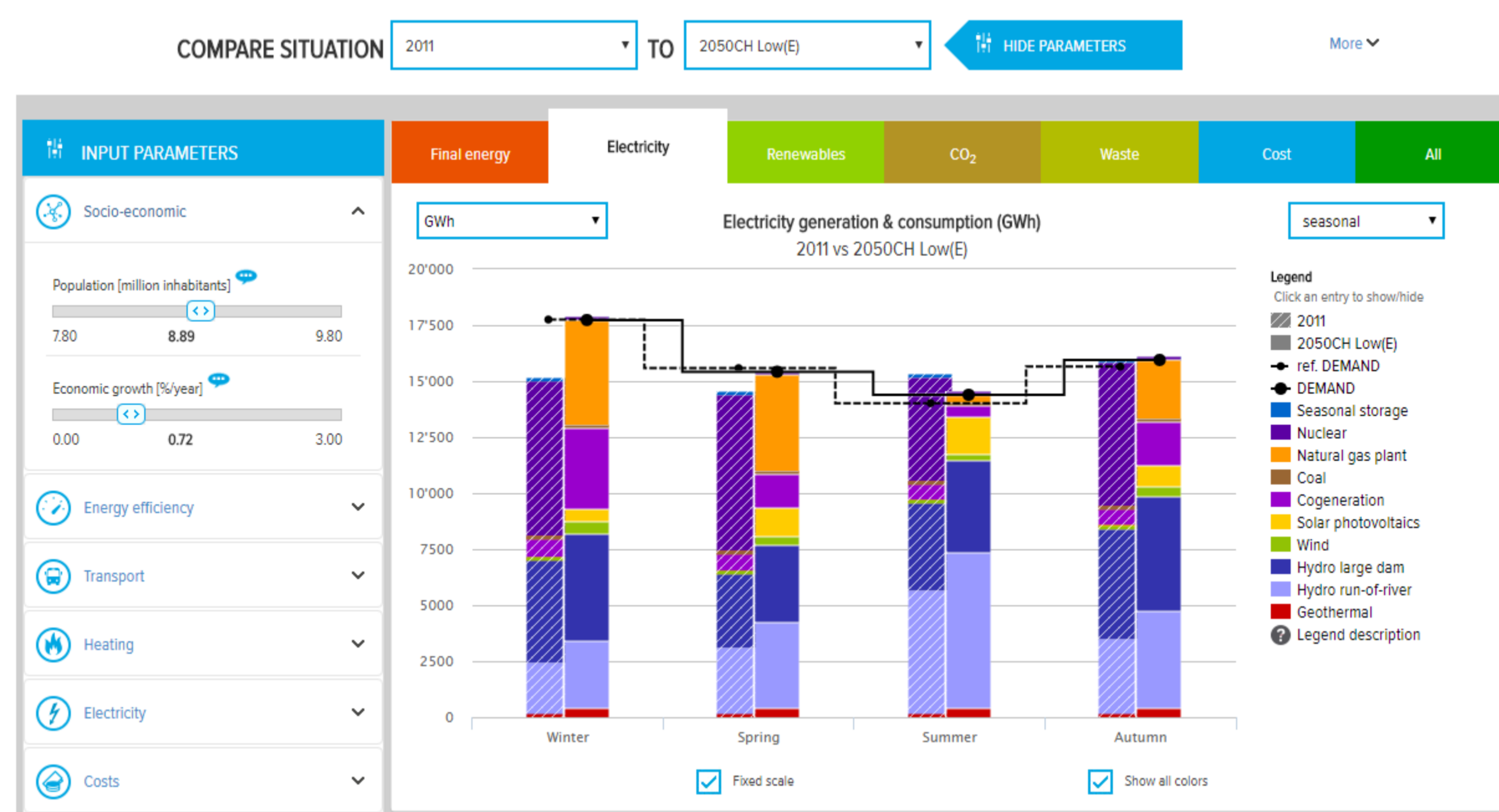
**Global sensitivity analysis
And
Optimization under
uncertainty**

Historical U.S. AEO Natural Gas for Electricity Production Price Forecast vs Actual Price^{[1][5]}



SWISS ENERGYScope

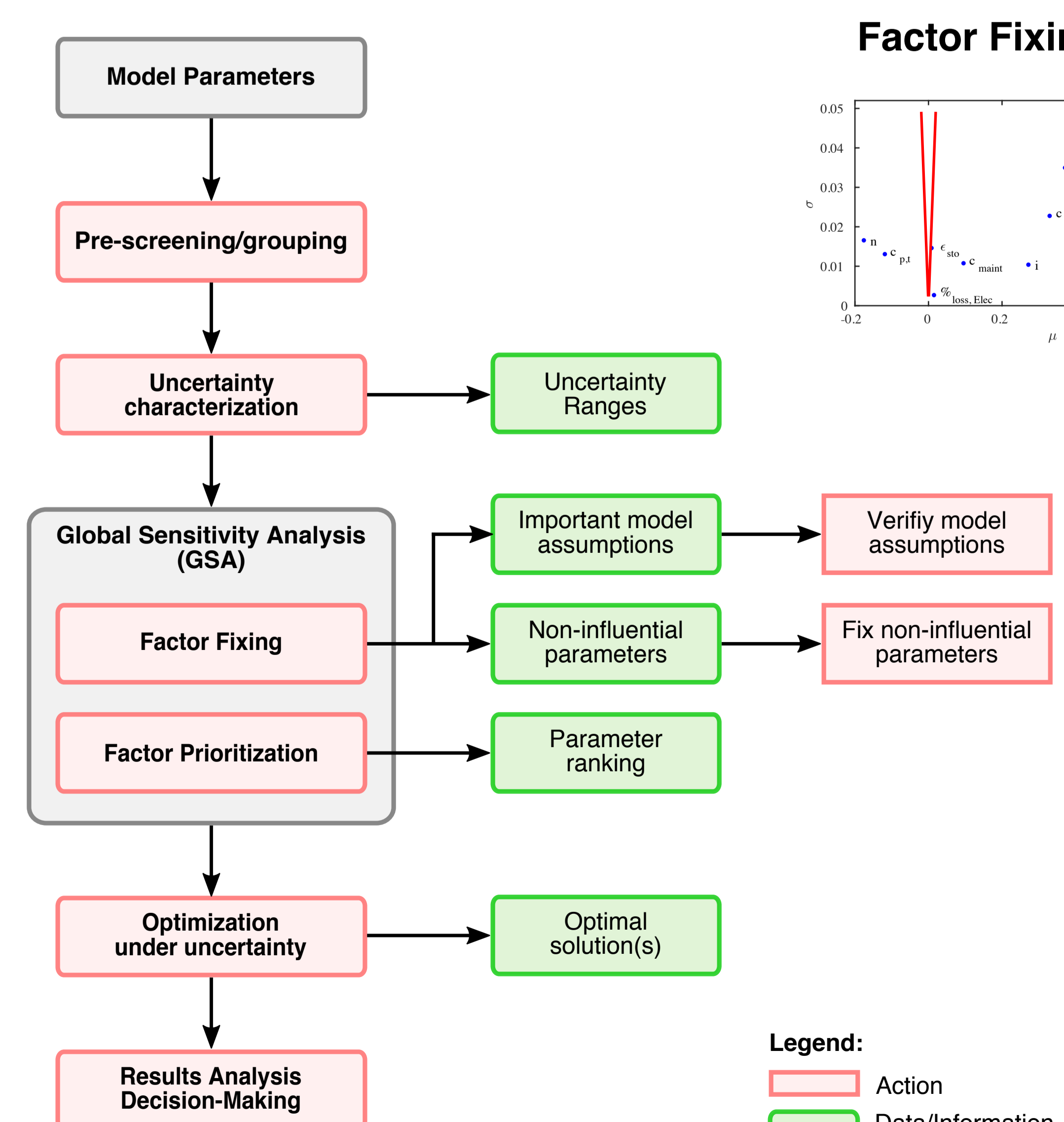
Energy Calculator ^[2]



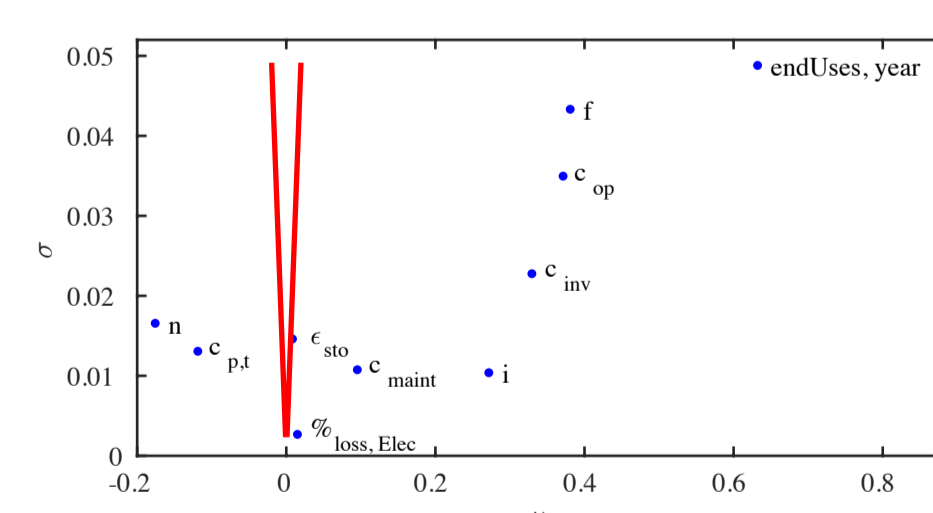
Large-scale Energy Modelling Framework

- View the current energy situation in Switzerland.
- Explore the energy scenarios for Switzerland developed by the Swiss Confederation for 2035 and 2050.
- Create your own energy scenario using simple cursors: > 30 parameters to tune.
- Visualize the implications of your choices for Switzerland: 6 performance indicators.
- Monthly resolution: 12 periods
- All sectors included (heating, electricity and transport).
- Seasonal storage
- Excel^[3] and MILP^[4] versions
- Life Cycle Assessment (LCA)

GLOBAL SENSITIVITY ANALYSIS & OPTIMIZATION UNDER UNCERTAINTY



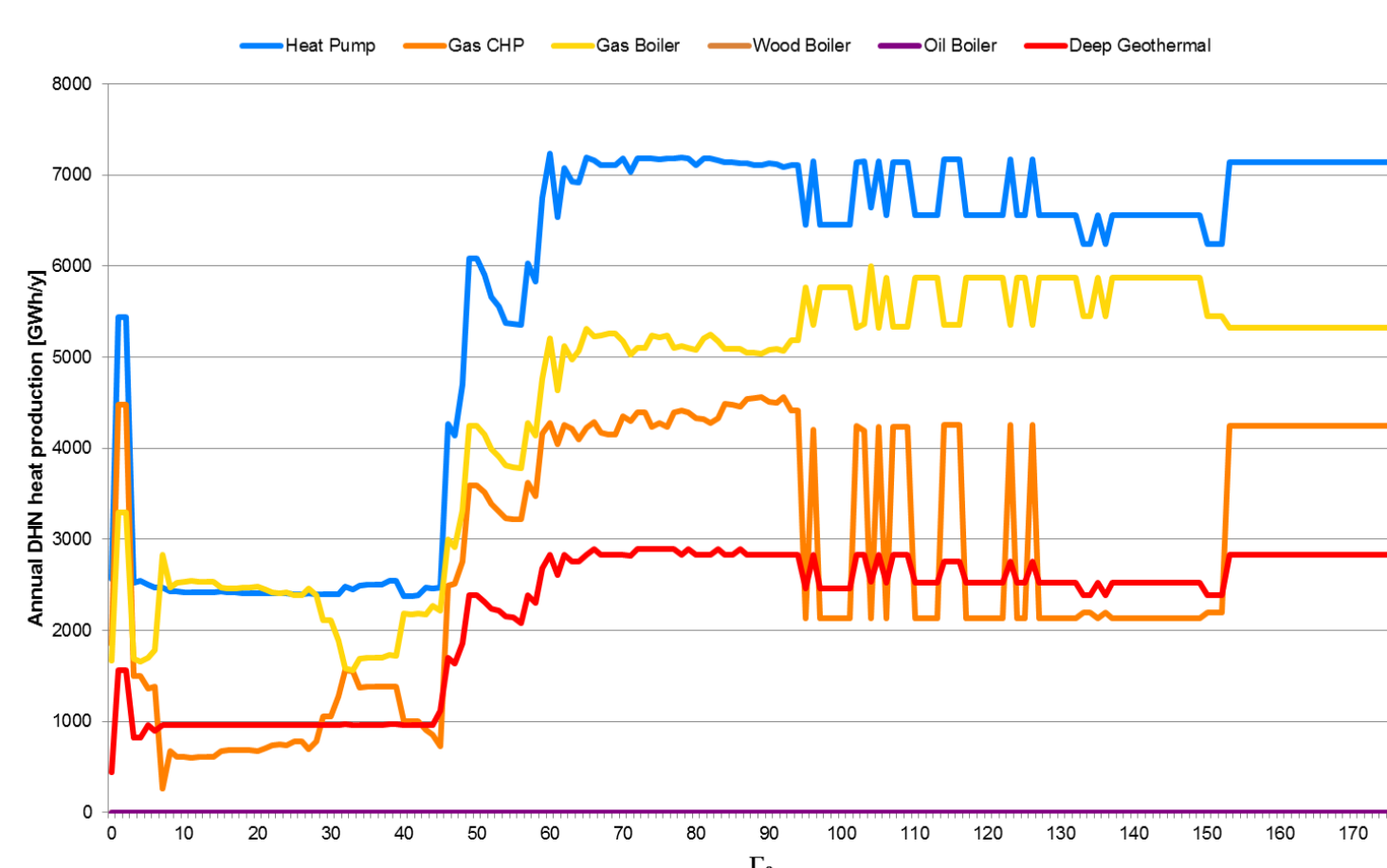
Factor Fixing



- Morris method: $\pm 20\%$ variation for all the parameters.
- Parameters outside the V are influential.

Optimization Under Uncertainty

- Robust optimization: + 40 % on c_{op} (per each resource and period), + 20 % on c_{inv} (per each technology).
- The bigger Γ_0 , the bigger the level of protection against worse case.



CONCLUSIONS

- Excel/MILP framework to for large-scale energy system modeling \rightarrow Application to CH
- Methodology to assess impact uncertainty on strategic energy planning
- Preliminary results

Future work:

- Complete classification of uncertainty in energy planning
- Methodology for optimization under uncertainty

References

- [1] U.S. EIA - Energy Information Administration.
- [2] www.energyscope.ch
- [3] V. Codina Gironès et al., Strategic energy planning for large-scale energy systems: A modelling framework to aid decision-making. Energy, 2015.
- [4] S. Moret et al., Strategic Energy Planning under Uncertainty: a Mixed-Integer Linear Programming Modeling Framework for Large-Scale Energy Systems. Proceedings of the 26th European Symposium on Computer Aided Process Engineering, 2016.
- [5] S. Moret et al., Uncertainty Classification for Strategic Energy Planning, SIAM Conference on Uncertainty Quantification, EPFL, 2016.