Exploring a Simulation Model of Canadian Energy Policy

Success and Failure Conditions, Robust Policies, and a New Modelling Paradigm

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We have an open source and validated energy policy simulation model for Canada!



We explored the behavior of the Energy Policy Simulator:

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Nachhoalt

- 184 input parameters
- 600,000 runs
- Global Sensitivity Analysis
- Scenario Discovery

We connected the Vensim-based EPS to Python using the *ema-workbench* package.



Us vs. Youth Policy Design Competition Winner



GHG Emissions

Total Change in \$ Costs to Society

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GHG Emissions

Total Change in \$ Costs to Society

Global Sensitivity Analysis

1. Callenand

outlays wi heutral carbon tat Many outcomes of interest share CO2e Emissions, 2017-2050 cole Emissions, 2050 sensitive parameters. Some are consumer cash Flow Industry Cash Flow unexpected. GOV Cash FLOW Lives Saved outlays Additional EV Subsidy Percentage[passenger,LDVs] Additional Fuel Tax Rate by Fuel[electricity] -Annual Additional Capacity Retired due to Early Retirement Policy[nuclear es] -Carbon Tax[industry sector] ------Carbon Tax[transportation sector] Percentage Improvement in Egpt Efficiency Standards above BAU[other industries] -Percentage Increase in Transmission Capacity vs BAU -RnD Building Capital Cost Perc Reduction[envelope] -RnD Electricity Fuel Use Perc Reduction[biomass es] -RnD Industry Fuel Use Perc Reduction[other industries] ------RnD Transportation Capital Cost Perc Reduction[battery electric vehicle] -RnD Transportation Capital Cost Perc Reduction[gasoline vehicle] -----Subsidy for Elec Production by Fuel[biomass es] -



Scenario Discovery





1) industrial carbon tax,



- 1) industrial carbon tax,
- 2) transmission capacity, and



- 1) industrial carbon tax,
- 2) transmission capacity, and
- 3) building insulation innovation.



The point.

• Why so much carbon tax?

• Validation?

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Some parameter combinations produce integration errors!



Relevance to Policy Analysis

- Exploratory modelling adds value!
 - Important Policies
 - Model Issues and Behaviours
- Not useful for net-zero

Future Work

Us

Update EPS for net zeroCompare to other models

Us and EMI?

 More advanced exploratory techniques

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Model speed survey

Main Conclusions

1) EPS model

- Industrial carbon tax influential
- Found errors
- 2) Canadian energy policy
 - Found quantitative bounds on essential policy components
 - \$270/tCO2e industrial carbon tax
 - not too much new transmission
 - invest in building insulation
 - Most policy components are unimportant for overall success

Questions?



Thanks to the Energy Modelling Initiative: https://emi-ime.ca/



Global Sensitivity Analysis Co-Relations







Future Uncertainty Work

- Hard to validate numbers without other models to compare to
 - We ran SD on cases where lives saved was negative and found results that are compatible with common logic
 - Ensemble comparison
- Robust Decision-Making
 - Optimize policies for robustness
 - Dynamic policy pathways