E3ME-FTT-GENIE: model description, update and results

Femke Nijsse, Unnada Chewpreecha, Jean-Francois Mercure, Hector Pollitt, Yeliz Simsek, Pim Vercoulen

ECONOMICS OF ENERGY INNOVATION AND SYSTEM TRANSITION

e3me cambridge econometrics

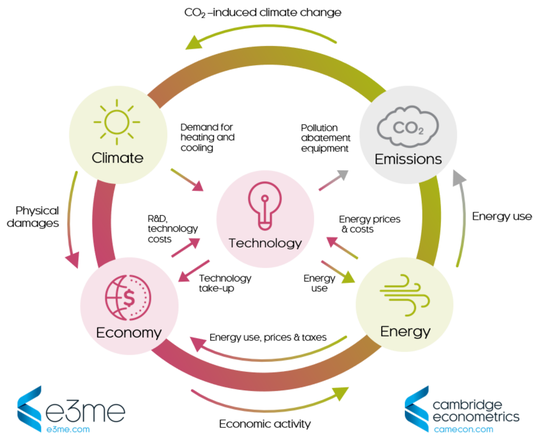
Introduction

Emissions have kept rising since the 2015 Paris Agreement, emissions Yet, rapid technological progress in clean technology is a reason for hope.

More strides are needed in heat, freight, and steel. Policy makers need models that capture policy instruments which can accelerate innovation and cost declines.

E3ME-FTT-GENIE (Mercure et al, 2018) is a model based on simulation instead of optimalisation. A key aspect of the model is path-dependency. There is empirical evidence that technological progress is shaped by policy. These mechanisms are included in the model.

Agents make decisions (with errors) and plan for uncertain outcomes (spare capacity), so it is not possible to optimise decision-making.



E3ME

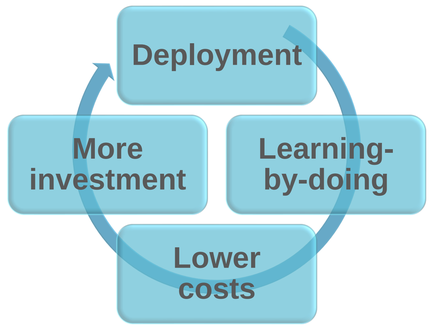
E3ME is the macroeconomic part of the model and contains 70 regions, including all EU members. Each EU member has 70 sectors, while other regions have 43. The sectors are linked with input-output tables; bilateral trade equations provide the linkage between regions.

Future Technology Transformations (FTT)

Sectors with expected transformational transition are captured by FTT submodels. These evolutionary models capture the S-curve which characterises innovation.

Five FTT submodels have been developed: Power, Heat, Transport, Freight and Steel. The submodels are calibrated with recent data on costs, learning and technology shares.

FTT:Power is disaggregated into 24 generation technologies. To ensure grid stability, we use a load-duration curve following Ueckert et al (2017). Energy storage costs are attributed to variable resources.



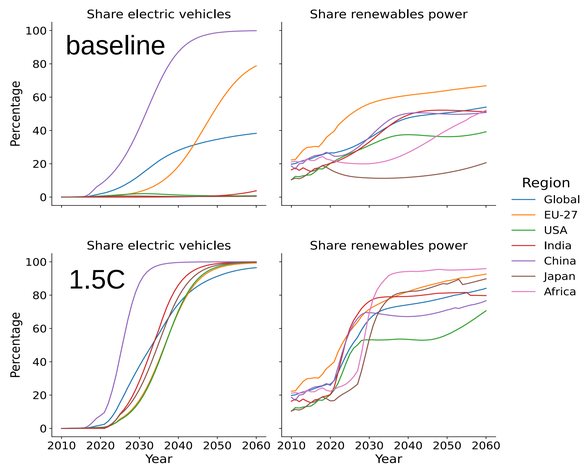
GENIE

The climate system is simulated with GENIE, a model of intermediate complexity. It is soft-coupled to the other two models: affected by greenhouse emissions, but not affecting the economy. The climate response is quantified by running the model repeatedly, using a set of varying physical parameters, so that the model provides a probabilistic temperature outcome.

Results + updates

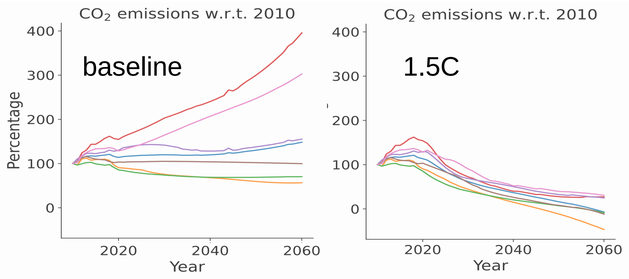
Using a wide set of policy interventions in energy efficiency, regulation and carbon pricing, a scenario consistent with 1.5 °C warming is constructed. Even in the baseline scenario, green technologies rapidly grow.

Kickstarts stimulate learning-by-doing in newer technologies, standards allow for improved efficiency and a carbon tax can level the playing field.



Key results:

- Solar takes off even more rapidly, dominating wind
- Job gains less significant due to dropping maintenance needs renewables



Conclusion

E3ME-FTT-GENIE provides a detailed description of the global energy system and economy. It explores the interaction of a wide variety of policy instruments, both monetary and regulatory. It produces detailed information about the economic and social impacts of said policies, and how they differ across the globe.

The model can simulate real-world policy options, going beyond forms of carbon pricing, and is therefore ideal for policy appraisal. Its bottom-up approach, simulating decisions by agents rather than envisioning a social planner, can form a blueprint for other IAMs.

Recommendations

- Bottom-up approach mimics reality closer than optimalisation
- Include a feedback between learning and deployment
- Don't arbitrarily curb learning curves
- Allow spare capacity and involuntary unemployment to model a just transition

Acknowledgements

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