Modelling complexity in the energy transition

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Modelling complexity in the energy transition

- By Emile Chappin in Modeling
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'The pieces are moving'
J.R.R. Tolkien

Over the years, it has become clearer and clearer: the energy transition is taking shape. Research on the energy transition also evolves. In the TPM Energy Transition Lab, we aim to take an interdisciplinary approach to expand our knowledge on 'what works' and 'what doesn't', when it comes to the coming decades in the energy transition. We bring smart people together, each with their own perspective and expertise to see where transition insights are complementary or clash. We started sketching a map of the energy transition, with 'simulation modelling' as our pencils.

Simulating complexity

Simulating the complexity of the energy transition may help to unravel many of the challenges and trade-offs. Modelling forces you to think extremely systematically: if you translate something into computer code you have to be very clear and specific about it or it will either not compute or make no sense. This is often a painful process: to crystallize your ideas, decide what you leave behind and what you take on board. Ideally, you do not get lost. Or if you do, hopefully in the end you get out of your modelling crisis (read more in this blog or listen to me explaining it below).

Escaping the modelling crisis

Simple rules create complex patterns

If you do it right, modelling is elegant and you can see the complexity unfold before your eyes. The process of developing and using models can be a real inspiration. I see merit in the systematicness of all modelling methods; I have a specific appreciation for a specific modelling method with which I model so-called 'agents' that represent individual entities. Why? Well, for example, you start understanding how it is only *simple rules* which can explain complicated patterns… for example how groups of birds flock together. Can you come up with simple rules for individual birds that would describe the patterns you see below? And can you translate those into computer code?

Beautiful patterns of flocking birds

How to look at the world

This made me look at the world differently. I started connecting 'how systems evolve' to 'how individuals behave' (and what governs that behavior): how economic crises emerge out of the behavior of banks governed by 'the rules of the system', how traffic jams emerge out of how individual cars drive, and how hard it is to translate global climate policy goals into regional/local action. By developing and studying many simulation models, I started to be able to switch perspectives, getting accustomed to think how changes in the behavior of individuals may have a rippling effect on the system. And where opportunities lie to shape the developments of the system as a whole.

Policy for the energy transition

For the energy transition, a key challenge is how to develop effective policy. This is a complicated question: lots of things matter for what makes policies effective. What technologies and system cost and how financing is arranged, complexities due to the multi-stakeholder nature of energy systems, all kinds of physical interdependencies between technological systems, and behavioral aspects of people, business and governments (see http://emlab.tudelft.nl/yfactor/ for an introduction to such factors and this scientific article). And how do the many policies interact? And what if different countries have different strategies?

Phasing out support for renewables

In a recent paper, Marc Melliger and I show how easy it is to be misled by a policy success. Wind and solar energy are becoming competitive; governments may see this as a signal to take away policy support. We explored through many simulated scenarios the possible downsides to such policy changes in the Netherlands and Germany. Taking the perspective of the behavior of individual firms, we simulated how investors in electricity generators may react to ongoing and changing market developments and policy. We used empirically observed investment preferences and state-of-the-art agent-based simulations and analyzed resulting system patterns. And we find it is risky to take away support – it may make us miss our wind and solar targets – so we ought to hold on to it: better be safe than sorry! Read more in this blog or this scientific article)

Join us

As I started out with, we try to sketch a map of the energy transition by simulating its complexities. We hope to understand better how the transition may unfold and how we can avoid unnecessary mistakes. We aim to add more and more color, integrating perspectives and disciplines researching the transition. Reach out if you want to know more and join us for the ride!

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behavior change, complexity, emergent behavior, energy policy, energy transition, system change