Accelerating the energy transition

Master thesis topics in Energy Systems Analysis

The world is moving towards relying more and more on sustainable energy technologies. However, to limit the threats associated with climate change, a much faster transition is necessary than what we see nowadays. The question is how can we speed up the transition, e.g. to use more wind and solar energy for electricity production, the faster introduction of more efficient equipment, the scale-up of electric cars and hydrogen?

Many studies have been published that show how sustainable energy systems may look like in the longer term, but in these projects the focus will be on the short to medium term, e.g. up to 2030. This timeframe is especially relevant as the next round of climate negotiations will focus on more ambitious commitments for that year.

1. Limits to technology deployment

How fast can technologies, like solar or wind energy, or electric vehicles be scaled up? Deployment rates depend on certain technical characteristics, but also on political choices. So, the topic can be treated from different perspectives.

See also this blog. A similar approach may be relevant for other technologies (e.g. EVs or heat pumps) as well. A first inventory (but static) was done in this master thesis.

2. The role of companies, cities etc. in climate change mitigation

Not only national governments, but also other actors, both from the public sector (cities, municipalities, provinces) and the private sector (companies and sector organisations) can play an important role in reducing greenhouse gas emissions. This role was formally acknowledged in the Paris Agreement of 2015. And indeed, thousands of cities and companies have committed themselves to reduce their greenhouse gas emissions, switch to sustainable energy, etc.

The question is now: to what extent do all these parties deliver? What impact do they have on the energy transition? And what are the reasons for failure and success?

For a 2015 overview of commitmenst, see this UNEP report. There are more recent assessments, e.g. this one. For concrete inititatives, please check the Science-Based Targets initiative, RE100, C40, there are a lot more!

3. Global modelling of energy demand options

The demand of the energy system is critical in reducing greenhouse gas emissions. Many options are available to reduce the need for fossil fuels, like energy efficiency, new conversion technologies (heat pumps, electric cars), new processes (e.g. circularity), and new fuels (e.g. bio-energy, hydrogen). All these options are interacting with each other, and it is difficult to say upfront what role they will play.

Within a global model framework, the energy consumption is modelled by country and per sector. The MSc project would consist of both modelling (in Python) and analysis of the role that various options can play. A first version of the model can be found in the master thesis by Pieter van Exter. The most detailed modelling so far is probably the Energy Technology Perspectives report of the IEA (and a lot more for individual sectors buildings, transport and industry).

Special topic:

- Renewable energy potentials in Indonesia. Indonesia is a country very rich in virtually all resources, but what can renewable energy contribute to that? In a cooperation project with Indonesia, we want to do GIS-based analysis of renewable energy potentials, notably for solar and wind energy.

Suitable master programmes are: Sustainable Energy Technology, Industrial Ecology, Complex Systems Engineering and Management. For more information, please contact Kornelis Blok, k.blok@tudelft.nl, tel. 015-278 9284.