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MEDEAS

MODELING THE RENEWABLE ENERGY TRANSITION IN EUROPE

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Guiding European Policy toward a low-carbon economy. Modelling sustainable Energy system Development under Environmental And Socioeconomic constraints

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Minutes

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Minutes of the Plenary session III: Modelling of behavioural aspects

Date: Tuesday 25 September, 16:00-17:30

Session Chairs: Davide Natalini and Kat Buchmann (MEDEAS project, Global Sustainability Institute, Anglia Ruskin University)

Panellists:

Nici Zimmermann (University College London)

Wander Jager (University College Groningen)

Martin Baumann (MEDEAS project, Austrian Energy Agency)

Davide Natalini made an introduction of the session and Kat Buchmann continued by stating that they come from the Global Sustainability Institute, Anglia Ruskin University. She talked about why modelling energy behaviours is important from a non-modelling perspective. As one of the few non-modellers in a modelling project, MEDEAS, there are different expertise, different world views. The session on modelling behaviours should focus on the value added of modelling in the field of energy and behaviour, but without speaking about specific behaviours or subsectors of energy consumption. Given the strong social science background at the Global Sustainability Institute, she proposed to take a step back and ask what is the general value added of modelling.

Looking at anthropology and historical studies on what the value added of modelling is, first of all modelling is a kind of experimentation, a testing, a simulation and it is basically a learning tool, similar to an experiment in the lab. Another value added is that many factors can be taken into account and modelling can help, but not automatically, with finding out more about causal relations. This is because a model can come close to modelling what is actually occurring and what will actually occur, but without getting the causal relations correct. Additionally, the most interesting aspect is a point by Margaret Morrison and Mary Morgan, two historians of economics, that models are seen as a mediator between theory and practice. Models are seen as diplomats who try to negotiate between two different fields, the field of soft and hard science and as an interface. These mediators often have a stronger voice and can lead to a stronger voice in policy. A mistake commonly made by policy makers is that models are seen as the truth. Due to that models can have a stronger influence because they also have a stronger visual and create

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a stronger reaction than text, which is another value added of modelling. Lastly, models can predict something in the future and substitute for missing data.

The second question she posed, but which will not be addressed in the session, was why behaviour is so important in energy. Generally, in energy there is the possibility to look at companies or at governments or at consumers and the stronger focus is on consumers, the demand side. This attention on people rises from three factors. Firstly, companies and governments are intertwined in the system, which is a hidden factor. Secondly, both companies and governments are interested in consumer behaviours; companies in order to maximise profit and governments in theory in order to make policies more sufficient and just. Lastly, a last factor of why there is a focus on behaviour is the potential shifts of how consumers participate in energy productions.

She presented the rest of the session and the speakers. The format of the session was a "this house believes debate", where speakers take very strong positions. The three modellers Nici Zimmermann, Wander Jager and Martin Baumann defended their specific modelling approach. Professor Wander Jager is an Associate Professor and Managing Director of the Groningen Center for Social Complexity Studies and his work is in the intersection between sociology, psychology and economics and he argued why agent based modelling is the way forward. Next was Nici Zimmermann, a lecturer in Systems Dynamic in University College London, where she undertakes research on housing, energy and wellbeing. She uses participatory methods and she argued for system dynamics modelling. Martin Baumann, senior expert in energy economics at the Austrian Energy Agency and partner in the MEDEAS project, develops and runs TIMES Austria and he spoke about linear optimization modelling and its benefits.

Wander Jager spoke about the city of Groningen and the city centre which is car free, presented a picture of the past and mentioned the decision made of the community in 1977 to ban cars from the city centre. This caused a heavy debate, similarly to other policies as well. This determined the cost of the redevelopment of the city and this made him realize that history could have been completely different and still cars would be in the centre of the city.

He mentioned that he likes to zoom in on the social efforts of people, of what is happening in those social dynamics and social structures at these moments of debate. This applies to many energy-related situations, for example, the start of an energy corporation or a decision of an island to go sustainable etc. He continued by saying that he is very keen on understanding those dynamics and he likes to use computer simulations, agent-based simulations where artificial operations are built. The challenge is how to make people in their variety as psychologically

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realistic as it is required for these models and for that the agent-based approach was developed and he focused on decision making, which is the heart of the artificial agent.

He continued by stating that repetition is the dominant way that people make decisions, it is the agent of habitual behaviour. People behave habitually because it is very efficient. Sometimes they listen to other people and imitate and enquire what someone else is doing to check whether it is an interesting option. Then there are some people who try to optimize, who try to come up with new solutions, who deviate from the norm and propose new directions. These kinds of behaviours can switch within an individual who can perform habitual behaviour for a long time and then may start to look around for other people.

He presented an example of how this plays out in a real situation in the model. There is an artificial society, where each dot represents a consumer who has the option to choose between green, red and blue products. In the model there are sliders which allow changing the price, the service and quality of the product. While they are equal and the model runs, most of the agents stand with the same product. By adding some normative influence, clustering is immerging, clusters of groups of agents who consume the same. The products are equal, but due to social influence the blue products are in a better position, while the green ones are in a bad position. By lowering the price of green products and improving their service level and their quality, still even though the green product is the best, it remains in a very bad position. In this model it requires a lot of effort to conquer the market.

These are the processes they are interested in exploring, how these dynamics work. In the new SMARTIES project, they apply this methodology to ten cases of cities and islands and explore how social dynamics affect the diffusion of new energy technologies and how we can stimulate together with communities these processes of change. Because if there are opportunities that are clearly better they are not automatically dominating in the market, so solutions are required. Agent-based modeling is a tool that hopefully helps towards that direction.

Nici Zimmermann continued and presented system dynamics modelling. She stated that system dynamics is a socio-technical method, which from the beginning is focused on people that are making decisions. It works at a strategic, as well as a policy level, and it helps in policy design. It is a high level methodology. She started with an example which they are also using in a project with two Chinese, two African and two European organisations and this was developed by the city of B…., but it also applies to the city of London. It is about active journeys that people take, in particular cycling to work for example, instead of taking the bus or the car. If there are a lot of

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active planners this increases the cycling or the walking accidents and she demonstrated how this is presented in a system dynamics model.

She presented a very high level simplified causal sketch of the system dynamics model. It is a causal model, so active journeys may cause accidents, the more active journeys the more accidents. This causes people to react, so the accidents reduce the numbers of active journeys. This creates a balance because as the system is pressed in one direction then it counteracts. Over time more infrastructure will prevent accidents. Accidents are not only represented by the number of journeys, but also by the infrastructure, which creates a second balance and feedback, so accidents are balanced out. There is infrastructure that affects not only accidents, but also behaviour. This creates a feedback around which the infrastructure around cycling; walking also increases the number of active journeys, so there is a reinforcing impact. A small example of how the system dynamics model works. Of course there are many other influences and factors.

Dynamics are modelled over the time and there is no interest in static problems, but in how things evolve. Things are non-linear and interdependent problems are characterized by information feedback, it is not only the physical flow of things, it is also information. More importantly it takes an endogenous perspective, putting the decision maker into the model and looking at the feedback relations and the feedback behaviour that emerges over time. The explanatory power comes from the way the model structures influences, behaviours, perspective, it also comes from having people participate in the modelling process, as well as in the validation process. The point is to realize how things happen and viewing things from more perspectives. The modelling of behaviour tries to be realistic and model decisions as they happen and it uses all kinds of information. Also, the ideas are firstly put on paper, where that are seen and discussed about.

She showed an example of a model developed together with some stakeholders from policy. The model can be accessible online and it has modelling sessions with policy makers, with industry people, with the community people. They developed a model, one for policy analysis and another one for the participants to “play” with and understand. Participants were given the ability to invest money in three different things, the energy efficiency of housing, more communal space, for example parks or libraries, and monitoring of the industry. Some participants were mostly interested in energy efficiency and invested all their money there; others had a more balanced view. This way they could find out whether there were unintended consequences and how the system behaved according to the assumptions they made. This demonstrated how system dynamics work in a participatory way with stakeholders and capture

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their decision making and their behaviour, but also bring them closer to change decisions and behaviour.

Martin Baumann started by saying that he was glad to speak about something that he rarely gets the chance to discuss, energy modelling and social behaviour. He comes from the Austrian Energy Agency. The fact that he doesn't come from academia gives him the opportunity to think about this issue from a different perspective. Therefore, he did not present projects or results, but thoughts about modelling and social behaviour from the point of view of linear optimization modelling, what he has been occupied on in the past fifteen years.

Firstly, he posed a basic question, why are we modelling. He answered the question by saying that there are a lot of different reasons for doing so, such as resource depletion, the analysis of markets and capacities, development of prices, strategic planning and capacity extension and in our time greenhouse gases. Especially regarding greenhouse gases, the use of energy is very important to solving this problem.

Taking another step back, he posed another question, why we are using energy. He answered that it is due to the services people get as energy users, such as food preparation and biomass for fire in the past and nowadays for all kinds of activities, such as heating, communication, transportation etc. Regarding where social behaviour enters in all these, the answer is everywhere, because social behaviour is about choice and choice is important. He made an analogy with jumping out of an airplane, where someone is making a choice because they can either stay in or jump out. Once someone jumps out they are falling and that is no social behaviour, but natural laws, as it is done by gravity. So there is a difference between social behaviour and natural laws. With the services people want to consume they are making choices in two ways. For one, they choose the amount of service they want to consume, that could be transportation, living space, entertainment. The second thing is they choose the technology they apply to get these services, whether they want light by candles or light bulbs etc. Therefore modelling energy is all about choice and as a result all about social behaviour.

When modelling social behaviour there is one obstacle that makes it hard to do so, social behaviour is not optimal to one specific value and that makes it difficult. For example, when someone wants to buy a new car, there are many kinds available, so they have to make a choice about several aspects: what size, is it family car, sports car, the fuel, the range, safety. So in this example, social behaviour or choice has no optimal solution. This is just for choosing a car, because someone could choose to walk or cycle or use public transport or not go there at all. So the energy system cannot be modelled without taking into account social behaviour.

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He continued by saying that he comes from linear optimization modelling and linear optimization models are really simple. This is the very nature of modelling, because modelling is mostly about simplification. If someone wants to have the one on one model of reality they need to look outside their window, but it is hard to learn something from that. Due to the fact that not much can be learnt due to the complexity, people simplify the system, reduce the complexity, and try to study the interactions and by this process they learn. The equations used eventually are just numbers, but the important parts are the study of the simplifications and the interactions. Linear optimization models are very good examples of this. Due to their simplicity the question is how social behaviour can be modelled, a process which is needed in order to have the impact of the social behaviour in the consumption of energy, how can it be endogenous in our linear optimization models. He states that this cannot be done.

Social behaviour is not optimal, so that is out of the scope. But when working on the energy system, linear optimization models are the right tool if people ask the right questions. Factors from social behaviour are taken into account on energy consumption and are included into the model and the values of these parameters are taken from several outside sources. For instance, demand for living space depends on the household income, on the price of apartments, on the family size, on whether someone wants to live in the city or a rural area. So average values are used and the sources can be historic developments, expert elicitations and other models that focus on decision making. In linear optimization they model the impact of decisions, not the decisions themselves. He concluded by saying that it is important for someone to choose the appropriate tool for their questions.

Davide Natalini started the debate by asking about accuracy. Scientists want more accuracy and add more characteristics in the models, but one of the main characteristics of the models is simplification, so there is some sort of trade off and his question to the panelists was to discuss about where the balance is. Wander Jager answered by giving the example of a community, where some people have a more important role in a public debate than other people, such as relatively to education or status or overall. He pointed that a reputable person of society may have a more important role compared to someone who on the contrary is considered “weird”. Even though they both have the same idea, it will not be faced similarly. This requires quite detailed information, so it is really hard to include it in the models.

Nici Zimmermann commented that in systems dynamics the focus is on things that are really important and can make a difference and a lot of difficult questions are around that. As someone tries to model a problem, this affects their level of aggregation and determines to what extend they include things or not. They start with the simplest representation and then they complicate

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things and it is not a decision made in advance, but in the process. Also, the stakeholders can be asked because the models need to make sense to them.

Martin Baumann commented that the focus should be on the question the models are looking at and modellers have to be aware whether the models are complex enough to point in the right direction without going too far. Because at some point there are not enough data, so modellers start disaggregating, make additional assumptions and by that introduce additional uncertainties, so they have more numbers without added value due to uncertainties. So overall, it is better to make assumptions and be aware of the uncertainty instead of introducing artificial equations and simulate something, but with rough guesses.

Wander Jager commented that empirical reality is one manifestation of multiple possibilities, so it is very dangerous to focus on replicating this one thing. Martin Baumann agreed and commented that when modelling social systems modellers are in a non-linear area. In energy modelling linearity has two advantages, short time frames and quality inertia, because the user relies on technology which means they rely on capacity, appliances and that causes inertia which means they can switch fast and that is the advantage of linear optimization.

Nici Zimmermann commented that the issue lies on the purpose of the modellers, whether they want to understand the robustness of policies or want to make a point for it, a case where a lot of accuracy is required. But if someone intends to model behaviours they have uncertainty, but the point is to interpret the numbers. Wander Jager remarked that agent-based models are a relatively unstable system, so when someone does not know what is going to happen and they want to steer the system to one or the other direction, agent-based modelling offers a very interesting tool.

Martin Baumann noted that it is similar in energy modelling where longer time frames to 2050 or 2100 are taken into consideration and modellers should be aware that they are not in a stable situation anymore, things will change dramatically and models have inertia due to the relationships that they build in them. So there is the requirement for better scenarios, which are the starting point. When going further to a more extreme future, modellers should think more about the scenarios and they need input from other people. One idea would be to have an energy scenario workshop of what the future will be like in 2050 and have some outsiders to the topic, for example science fiction writers. Their creativity could be added to the modellers' sense of plausibility.

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Davide Natalini asked the audience whether there are any questions. The first question was about the last conference of social sciences related to energy modelling where there were complaints that in social science people tend to use the narratives from economics. As citizens and not consumers and people can choose among social practices, not among products and they can change the option base. According to the questioner, the presentation was very interesting, but there is hegemony of economics and this is wrong, when for instance people study sustainability and use narratives that claim that there is no sustainability in the first place. So he asked for a comment by the social scientists.

Nici Zimmermann answered that agent-based modelling and system dynamics try to model people as they act and decisions as they happen. Then they try to put inertia into the model, they try to put how people are influenced into the model. In a project for a government department into the UK they were interested to the take up of energy efficiency retrofit measures by home owners, they modelled word of mouth effects and neighbourghood effects, they wanted the financial value of things, but also the non-financial value and that made the difference.

Wander Jager added that one of the main challenges on modelling behaviours is to address the different needs that people have and needs have different dynamics. Modelling behaviour is very complicated, usually trying to address it as simple as possible there are three basic needs, one is focusing on food or income or safe place, one on social needs, whether someone feels comfortable around people, do they have the possibility of building up a social status, can they express their identity and the final is individual beliefs.

Wander Jager commented on the next questions that what is of interest to policy makers is to realize that in a social system people respond very late because they perform habitual behaviour and there may be norms in the system. If someone looks at these dynamics from a psychological point of view it is clearer what has happened in comparison to looking at these from an individual optimized status.

Martin Baumann commented about hybrid models and how some years ago they used agent-based models while modelling households and system dynamics models while modelling the economy and a linear optimization model in order to model energy, electricity and heat production. This approach worked and it was interesting. Nici Zimmermann pointed that she is also a great fan of coupling the models. Just one thing is that they do not need to be coupled only in a technological and a technical sense, but also there can be discussion about their assumptions and their philosophy. Wander Jager commented that the coupling of models easily

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results in a model that is not understandable anymore; a good model someone should be able to run it on their mind because that is the ultimate understanding of knowing what someone is talking about. Nici Zimmermann emphasized that models should be explanatory.

A member of the audience asked a question about doing more reasoning behind the models instead of focusing on getting the reductions anticipated. Nici Zimmermann agreed and said that it is about understanding something better, not about predicting. Martin Baumann said that it is mostly a communication issue as by having mostly nearly an unlimited number of decimal digits and by writing a number, accuracy cannot be ensured. There should be awareness that modellers are making scenarios and assumptions. It would be exorbitant if these scenarios were named prognoses. Wander Jager remarked that the time is changing and policy makers are becoming aware that they are dealing with a complex system which deals sometimes with unpredictable non-linear processes and that models cannot always be trusted.

Kat Buchmann stated a quote that “Models are policy tools for the weak that otherwise would not make us listen to them”. Another member of the audience asked about the reasons why every model is not open source or transparent. Martin Baumann answered that as he does not come from academia, they get projects for which they are paid for, so their model is their intellectual property and they publish their scenarios and this also explains why their model is a black box. They are using the TIMES model generator, which is written in GAMS, the source code is completely open, the methodology behind it is transparent as much as possible. Wander Jager commented that models should be open source, an opinion that was applauded by the audience. Nici Zimmermann commented that if someone wants to publish a paper in the system dynamics review, they have to send the model with it, unless they have other good reasons not to, so it more and more open source. Wander Jager commented that people are more easily convinced when they see numbers and emphasized that in communication with policy makers the focus should be on what exactly are the processes behind the models and explain what is happening instead of just showing numbers even though policy makers are usually interested in numbers.

Martin Baumann commented that once someone has a model which is open source, it can be used and manipulated by others and if several people do that the credibility of the model is ruined. Because if a model is completely open source the modellers has no control of the numbers people get in. Therefore, he understands why people whose tools are being used might worry about them being misused or discredited by people with bad intentions. Wander Jager added that he would like to have a discussion with people with bad intentions about what is in

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the model. Martin Baumann commented that there is no possibility to discuss this because these people are only interested in showing their results without discussing their assumptions.

To the next questions Martin Baumann answered that the people who misuse the models are actually play a different game compared to the model creators and Nici Zimmermann commented that modellers become much more vulnerable when they open up their model to everybody, but the percentage that misuses the models is small, so there are some disadvantages, but there are also advantages, such as model improvement. Regarding optimization, she answered that an answer is working with multi-criteria decision analysis. System dynamics models the structure so it is about not only model extrapolation, but radical changes so that the system structure over time creates this change. Wander Jager responded that optimization is hard, first of all regarding the time scale involved and the focus and he added that there are different optimal solutions and different systems that each may have different goals and as such there may be internal conflicts between systems. So he considers that there is not an optimal to be found in human behaviour.

Davide Natalini closed the session by thanking all the speakers and the people who asked the questions.

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