How the TIMES Ireland Model (TIM) can be useful to the Committee

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How does TIM work?

The TIMES-Ireland Model is being developed at UCC to inform future possible decarbonisation pathways for the Irish energy system. We give it information on the Irish energy system as it is today, a set of constraints, including on emissions, and the best available projections for what the future technology and fuel options are upto 2050 and beyond. It then finds the lowest-cost transition over the coming decades that works within those constraints. Rather than offering a single prescriptive plan, the model helps structure our discussions of the trade-offs and uncertainties; and helps us develop meaningful, consistent narratives of energy transformation, while considering a huge range of possible futures.

Model Inputs (assumptions/variables)

Specifically, we give it a set of energy technologies (such as carbon capture & storage, heat pumps, wind turbines, hybrid cars) and fuels (such as electricity, fossil fuels, hydrogen and biofuels), and tell TIM how they all link together, and how much they could cost in the future. We tell it how large the energy service demands (such as car kilometres, home heating and data centres) of the present and the future are. We give it a set of constraints, including on how quickly things can get built, and what the level of future emissions should be in a target year, and/or how much CO_2 can be emitted in total within the each of the 5-year carbon budget periods.

Model Outputs

It then finds the lowest-cost pathway to re-architect and restructure Ireland's entire energy system, for electricity, transport, industry, residential and commercial, and novel fuels like hydrogen and bioenergy, to reduce emissions to meet the specified target. It accounts for all the linkages in the system; rather than transform it one piece at a time, it transforms the entire system over the modelled period, accounting for all the sector couplings and trade-offs, even between distant parts of the system.

It can report a vast number of summary statistics for each scenario, including investment and operating costs by year and sector; emissions trajectories; marginal abatement cost per year; changes to vehicle fleets; deployment of renewable electricity options such as wind and solar; imports and exports, and so on.

The model concerns itself solely with the physical apparatus and processes of the energy system: it does not tackle questions about who should pay, or what the macroeconomic implications are, or whether the implied behavioural changes and distributional impacts are fair, or what the electoral implications might be.

Uncertainties

Many of the inputs are highly uncertain and can have a large impact on the pathway TIM chooses. These include the cost of and date of availability of new low-carbon technologies, such as CCS and

electrically powered trucks, as well as the speed that these can be deployed; the sustainable feedstock of bioenergy; and whether future energy service demands will follow the same trend as in the past. We can deal with these uncertainties by studying alternative scenarios and being transparent about the underlying assumptions and outputs.

While TIM covers the entire energy system and future possible pathways in some level of detail, it cannot represent the full details, costs and constraints of specific pathways. For example, the infrastructure costs of the energy transition (such as the power and gas networks and EV charging stations), and land-use aspects are not considered. This requires iteration with experts and more detailed sectoral models to examine aspects of the system that TIM is not designed to handle; we use these to add additional constraints to TIM, to ensure that TIM is better placed to produce feasible outputs.

How can the Committee use TIM?

We can give TIM a set of scenarios to explore the speed and scale of change required across the energy sector required to meeting different mitigation targets, and to discover the potential costs associated with delivering these different approaches.

For modelling the 2030 target and intervening budgets, the key questions are going to be as follows:

- **How much effort is required from the energy sector, compared to the agricultural sector?** The less effort contributed by the agriculture sector, the more is required from the energy sector and vice versa. For every 10% shortfall from agriculture from the 51% target, the effort from the energy sector goes up by 5%. To illustrate: if agriculture is required to make 31% savings (20% below target), energy must make 61% savings (10% above the target).
- **Is carbon capture and storage commercially available and on what timescale?** It is a technology that has had its separate components piloted successfully, but is still a very immature technology, does not have an established global supply chain, and has very high uncertainty over costs; it does potentially offer very large opportunities for mitigation, particularly if combined with bioenergy.
- **How much bioenergy is available for use within Ireland?** This can be domestically produced or imported, but while their sustainability is contested, and can create competition for other uses of land, their availability to the model makes a solution far more achievable. The availability of these is a political decision, and is given as an input to the model which then constrains how much bioenergy can be used.
- **How much behaviour change can we call on to lower energy demand this decade?** Lower energy service demands in the future, which could be brought about by switching transport modes, a more circular economy and less energy wastage, makes meeting mitigation targets less costly. However, the barriers to meeting these changes are challenging to model.

In addition, there are dozens of questions with much smaller, but non-trivial impact on emissions between 2022 and 2030. With more time, many of these questions can be explored; however, given

the time constraints required in meeting the Council's June deadline and in the interests of testing the most impactful choices first, this briefing paper is confined to the four largest questions.

It is important to note that while TIM may find a technically feasible solution to a given scenario, social and political feasibility cannot be automatically assumed. And, as already noted, deeper sectoral analysis is needed to understand the full cost and distributional implications of pathways.

We will welcome the Committee's guidance on what summary outputs would be most useful to shed light on the differences between the modelled scenarios.