DÁIL ÉIREANN

AN COMHCHOISTE UM CHOMHSHAOL AGUS GHNÍOMHÚ AR SON NA HAERÁIDE

JOINT COMMITTEE ON ENVIRONMENT AND CLIMATE ACTION

Dé Máirt, 11 Eanáir 2022

Tuesday, 11 January 2022

Tháinig an Comhchoiste le chéile ag 12.00 p.m.

The Joint Committee met at 12.00 p.m.

Comhaltaí a bhí i láthair / Members present:

Teachtaí Dála / Deputies	Seanadóirí / Senators
Richard Bruton,	Lynn Boylan,
Réada Cronin,	Timmy Dooley,
Cormac Devlin,	Alice-Mary Higgins,
Alan Farrell,	Pauline O'Reilly.
Darren O'Rourke,	
Christopher O'Sullivan,	
Bríd Smith,	
Jennifer Whitmore.	

Teachta / Deputy Brian Leddin sa Chathaoir / in the Chair.

Carbon Budgets: Discussion

Chairman: Happy new year to everybody. On behalf of the committee, I would like to welcome to the meeting the following members of the Climate Change Advisory Council's carbon budget committee: Professor Brian Ó Gallachóir, Ms Marie Donnelly, chair - she is very welcome back and we did not think that we would have her back so soon - Ms Patricia King, Professor Lisa Ryan, Professor Peter Thorne, Dr. Hannah Daly, Dr. Trevor Donnellan, Dr. Kevin Hanrahan and Dr. David Styles. I thank them for coming before us today.

The purpose of this meeting is to consider the carbon budgets. The carbon budget represents the total amount of emissions that may be emitted in the State during the five-year period measured, in tonnes of CO2 equivalent under the Climate Action and Low Carbon Development Acts, 2015 to 2021. Dáil Éireann may refer a carbon budget programme to a joint committee for consideration of the carbon budget and to provide a report in writing containing its recommendations to both Houses of the Oireachtas within two months from the date that it is presented to Dáil Éireann.

The carbon budget was referred to this committee on 7 December. We are required to report back to the Houses by 7 February. In order for the committee to consider the budgets we are holding a series of meetings this week. There will be a final session next Tuesday in which we will hear from all relevant stakeholders to inform our work. This is an important piece of work being undertaken by this committee, because it is the first in a series of carbon budgets to be agreed to ensure Ireland meet its ambitious target of being a carbon-neutral economy by 2050. This committee is taking this very seriously.

Before we begin, I will read the note on privilege. I would like to remind witnesses of the long-standing parliamentary practice that they should not criticise and make charges against any person or entity by name, or in such a way as to make him, her or it identifiable, or otherwise engage in speech that may be regarded as damaging to the good name of the person or entity. Therefore, if a witness's statement is potentially defamatory in relation to an identifiable person or entity, they will be directed to discontinue their remarks. It is imperative they comply with any such direction. For witnesses who are attending remotely from outside of the Leinster House campus, there are some limitations to parliamentary privilege. As such, they may not benefit from the same level of immunity from legal proceedings as a witness who is physically present on the campus does.

Members of the committee are reminded of the long-standing parliamentary practice to the effect that they should not comment on, criticise or make charges again a person outside of the Houses, or an official, either by name or in such a way as to make him or her identifiable. I would also like to remind members that they are only allowed to participate in this meeting if they are physically located on the Leinster House complex. In this regard, I ask all members, prior to making their contribution, that they would confirm that they are indeed on the grounds of the Leinster House campus.

I call Professor Ó Gallachóir to give his opening statement.

Professor Brian Ó Gallachóir: I would like to thank the committee for the opportunity to introduce the process underpinning the carbon budgets that were proposed by the Climate Change Advisory Council. I am professor of energy engineering at University College Cork, UCC. I am director of MaREI, the Science Foundation Ireland Research Centre for Energy,

Climate and Marine. I am the elected chair of the International Energy Agency, IEA, technology collaboration programme on energy systems modelling. I was one of 15 individuals invited to join council members on its carbon budgets committee, which was chaired by Ms Donnelly.

A number of other committee members are present to answer the committee's questions regarding the process and approaches that led to the formation of the proposed carbon budgets, namely Dr. Hannah Daly, UCC; Dr. David Styles, University of Limerick, UL; Dr. Trevor Donnellan and Dr. Kevin Hanrahan Teagasc; Professor Lisa Ryan, University College Dublin, UCD; Ms Patricia King, Irish Congress of Trade Unions, ICTU; Professor Peter Thorne, Maynooth University; along with Ms Marie Donnelly, who is chair of the Climate Change Advisory Council, as well as of the carbon budgets committee.

It was challenging for the council to assemble the necessary information and to propose carbon budgets in the timeframe required. Great credit is due to the secretariat in co-ordinating the meetings, analysis and engagements that supported the committee in its work. The committee would not have been able to produce these proposed carbon budgets had we not been able to draw on the modelling research capacity in energy and agricultural land use that was made available by UCC, Teagasc and UL. The continued and increased support for this research and analytical modelling capacity going forward is essential for informing national climate mitigation policy.

The most significant factor underpinning the proposed carbon budgets is the obligation under the Climate Action and Low Carbon Development (Amendment) Act 2021 to achieve a 51% reduction of greenhouse gas emissions by 2030, relative to 2018 levels. In addition, the committee also considered the implications for energy use and supply, for agricultural land use, alignment with EU policy and with the Paris Agreement and the economic and societal implications of the carbon budgets.

I am confident that the carbon budget proposed by the council represent the optimum balance between the various obligations we will require to consider under the Act. I have provided the committee with two diagrams. Figure 1 presents the proposed carbon budgets. Figure 2 illustrates an indicative future emissions trajectory that delivers the proposed carbon budgets. These are both from the council's carbon budget technical report.

On the background, the council agreed at its meeting on Friday, 5 March 2021 to establish a committee on carbon budgets to provide recommendations for carbon budget proposals prior to the council's final decision on the proposals to submit to Government.

In terms of the background, the council agreed at its meeting on Friday, 5 March to establish a committee on carbon budgets to provide recommendations for carbon budget proposals prior to the council's final decision on the proposals to submit to Government. The committee was tasked with drawing up carbon budgets, considering the criteria set out in legislation, namely, the Climate Action and Low Carbon Development Act 2015 and the Climate Action and Low Carbon Development (Amendment) Bill introduced in March 2021. Towards this end, the committee members met more than 15 times between March and September 2021. The approach adopted by the committee was to consider each obligation under the Act individually, drawing on analysis, modelling and expert engagement; to discuss the obligations in detail; to address information gaps; and to formulate a view of how each obligation impacted the carbon budgets. The approach is described in further detail in the background document submitted to the committee on 7 January and in the carbon budgets technical report.

The committee was able to draw on analysis in the form of modelling results, technical papers and presentations that were prepared for it on a range of topics relevant to the formation of the carbon budgets, namely, the implications of different sectoral emissions reduction pathways on the energy system, agriculture, land use and forestry; the alignment of proposed national carbon budgets with the EU 2030 Fit for 55 proposed emissions reduction targets for Ireland; economic, employment and distributional implications of carbon budgets, which also informed considerations of climate justice; the implications of the Paris Agreement on Ireland's carbon budgets; and the potential impacts of climate action on biodiversity.

Towards developing the proposed carbon budgets, the committee considered a range of scenarios with different mitigation efforts across the energy system and agriculture that were consistent with meeting the overall 51% emissions reduction target in line with the council's legislative mandate. In addition, the committee also considered a set of scenarios to explore the speed and scale of change required across the energy sector to meet the 51% mitigation target and to discover the potential costs associated with delivering the target at different speeds of reduction, that is, the impacts of seeking to achieve more ambitious earlier and later mitigation. In addition to the modelling, analysis and technical papers prepared for and by committee members, the committee also took into account the recently published Intergovernmental Panel on Climate Change, IPCC, AR6 Working Group 1 report, the latest Environmental Protection Agency, EPA, greenhouse gas emissions inventories and projections, the latest available information regarding mitigation technologies and costs, the potential for negative emissions, outreach with stakeholder Departments and agencies, and a workshop with international experts on the science of national mitigation efforts and gases and the 1.5oC target.

The ambition mandated by the legislation represents a significant step change beyond current climate mitigation policies and measures. This step change in ambition is reflected in the proposed carbon budgets and will require rapid and sustained economic, social and technological transformation across all sectors of the economy. The carbon budgets were developed and proposed during 2021, that is, in year one of the first carbon budget period. We are now in year two. I would encourage this committee to recommend that these carbon budgets be adopted and, further, to ensure the necessary urgency is directed at developing and implementing the policy supports and regulations to enable Ireland to remain within these carbon budgets.

Chairman: I thank Professor Ó Gallachóir for his opening statement. I will now invite members to indicate if they wish to ask questions. The meeting is confined to a maximum of three hours. To ensure all members get an opportunity to pose questions, I propose that each member be given two minutes to address their questions to the witnesses. Is that agreed? Agreed. If possible, I ask that members would indicate to which witness they are addressing their questions. We have more witnesses today than we usually would have. If any of the witnesses want to come in on a particular question, I ask that they use the raise hand function and I will call them in order. Professor Ó Gallachóir and Ms Donnelly might assist me if they think there are questions that might be referred to specific members of their committee.

As Deputy Bruton indicated first, I now invite him to put his questions.

Deputy Richard Bruton: I thank the witnesses for their time and for attending in such numbers. I would like to ask the simplest question first. What do the witnesses envisage being the biggest challenges in delivering this rapid transformation? I am interested in hearing their insight as to whether they are behavioural issues, people understanding and acting differently or developing technologies, market interventions, pricing and so on? What are the biggest challenges and how might that guide us?

Another thing that is coming up very hotfoot after we agree overall budgets is the issue of the balance across sectors and how to make trade-offs between adjustments that might be perceived as difficult in one sector versus those in other sectors. Again, I am interested in hearing how, having scanned all of the sectors together, the witnesses would guide the political people in balancing the trade-offs that clearly exist. I am aware there are bands, but within the bands there appears to be a big difference. For example, in agriculture, there is a 30% reduction and a 22% reduction. They imply very different sorts of impact, potentially.

Those are very basic questions. The issue of land use was not there before. Obviously, we have to deliver 51% in that additional arena. Do we have the policy tools required, or have they been worked up to the same degree as in the other areas? They are my first questions for the witnesses.

Chairman: Deputy Bruton did not specify if the questions are for any specific witness.

Deputy Richard Bruton: Professor Ó Gallachóir knows better than I who is best placed to answer the questions.

Professor Brian Ó Gallachóir: As suggested by the Chairman, I am happy to field questions. In terms of the challenges on the energy side, I will be drawing on Dr. Hannah Daly. On agriculture, I will leave it to Dr. Hanrahan and Dr. Donnellan to decide who would like to respond. I will ask Dr. Styles to respond on the land use question.

I would first like to talk about the process we undertook. We did explore the impact of different trajectories on different sectors. As members will know, our obligation did not extend to the sectoral emissions ceilings, which is a follow-on task to the task of agreeing the carbon budgets. In terms of informing the impacts, we explored the analysis. Deputy Bruton is correct in his comments on the balance question, namely, that different sectors have different challenges and different opportunities. It is very clear from the analysis we undertook, and this links in to the first part of the Deputy's question, that achieving the 51% target the Oireachtas has already agreed, very strongly, will require transformations across all sectors of society. It is very much a full and complete transformation. It is worth bearing in mind that that 51% ambition over a decade is the second highest ambition in the world in terms of climate action. The Oireachtas is to be commended on that ambition, but clearly that brings challenges across all sectors of society.

The Deputy asked whether the challenge is behavioural, market, technological or policy related. Again, it is system wide. We are talking about a complete transformation. If you look at the graph and the difference in the two trajectories in figure 2, you can see the difference between what is in the current policy mix and what is required in terms of this additional step change to achieve the carbon budgets required.

As for the implications of the 51% reduction on land use, the timing of this challenged us because the clarity came late in the committee's deliberations and proceedings. We were fortunate to have Dr. Styles's input from an early stage in the proceedings, so we had a good sense of the implications regarding land use.

I will leave it there. Dr. Daly might talk about her sense of the challenges on the energy side.

Dr. Hannah Daly: I am a lecturer in sustainable energy systems modelling at UCC. For this carbon budget committee process, I led the analysis of the implications of different carbon budgets on the energy system, that is, varying levels of decarbonisation of the energy system of

between 51% to 70% reductions in greenhouse gas emissions by 2030, and the implications of alternative technology pathways or demand reduction pathways.

The Deputy asked about the greatest challenge in delivering rapid transformation. It is important first to acknowledge the energy system underpins everything we do. Currently, about 88% of our energy comes from fossil fuels, which are the overall source of CO2 emissions. That figure of 88% needs to fall to below 50% by 2030 to meet any of the targets. We need a relentless, rapid shift away from consuming fossil fuels. It is important to move the narrative and discourse away from certain technology targets, such as a minimum renewable electricity target or a minimum electric vehicle, EV, target, to rapid reductions in the consumption of fossil fuel immediately. That is what the carbon budget framework requires. As an example, while electric car sales doubled last year, with an additional 4,000 EVs sold compared with the previous year, SUV sales grew by 11,000, or almost three times the number of additional electric car sales. Those SUVs entering the fleet are much less efficient and have a much larger carbon footprint. The focus needs to move away from meeting certain technology targets towards a relentless, immediate focus on reducing fossil fuel consumption. Because it permeates all aspects of society, there is no single solution. As Professor Ó Gallachóir described, it is about the societal, economic and political transformations which can achieve that.

A few aspects are critical in this transformation. It will be a surprise to nobody that renewable electricity is a cornerstone of meeting the decarbonisation targets. It is not that electricity is a large source of emissions – that is mainly heat and transport - but rather that the electricity system is needed to decarbonise the rest of the system. If we do not meet our targets to rapidly roll out renewables, mainly offshore wind and solar, all these targets will be at risk. At the same time, we need to move beyond renewable electricity to new solutions. The analysis we carried out, which included a low-energy demand scenario and a more progressive technology-solution scenario, indicates we need to consider solutions such as lowering energy demand where possible, carbon capture and storage, bioenergy and novel gases as quickly as possible.

The Deputy asked about the balance across sectors and how to assess those trade-offs. We can provide insights into what pathways are possible in the energy system in terms of how quickly the energy system can decarbonise, at what cost and with what technologies and demand reductions are required, but we cannot make that judgment as to what is the best because it becomes a question of how quickly people are accepting of a change in their demands and how quickly they can take up new technology solutions. The question as to the appropriate balance across sectors is really one for policy to decide.

I will leave the question on land use to my colleagues.

Dr. Kevin Hanrahan: I thank committee members for the opportunity to talk to them. I am the head of the rural economy development programme at Teagasc and an economist working in this area. Like Dr. Daly, I do not think it is within our remit to make that judgment about where the fairness of the sectoral balance lies.

The work we did as part of the carbon budgets committee in 2021 looked at many different pathways, as Dr. Daly mentioned, for the energy system. We did the same or equivalent for the agricultural sector, looking at different reduction end points and pathways to those end points for agriculture, and examined what the set of actions identified in the Teagasc marginal abatement cost curve analysis would allow the sector to achieve in the context of reduction efforts. It was clear from that analysis that the lower end of the range chosen by the political system for agriculture could be feasible without large changes in activity levels.

However, at the upper end of that range or beyond, at about 30%, given the set of technologies we have to hand and those that are likely to come on stream over that period, we will need to see changes in activity levels. The analysis we carried out as part of our work for the committee, outlined in the technical note of the carbon budgets committee, sets out some of the economic consequences for the agricultural sector and the food-processing sector and for employment in those sectors and the wider economy of different scenarios we considered, from a 20% reduction target all the way to a 51% *pro rata* allocation for the agricultural sector.

My colleague Dr. Styles from UL will talk about the forestry contribution. We did some work on the land use, again based on work that is going on at Teagasc. Of course, there are opportunities for the rewetting of carbon-rich soils in particular, which could deliver significant mitigation, but there is nothing of the order of 51%. An awful lot more activity-level change would be required to meet that reduction target by 2030.

Chairman: I thank Dr. Hanrahan. I suspect Deputy Bruton's questions have now been answered. Is he happy with the responses?

Deputy Richard Bruton: Yes, I am. They raise many other questions but I am conscious that my contribution is limited to two minutes.

Chairman: Yes, and I gave plenty of latitude to our guests. We will see how we go over the remaining time. I hope we might time for a second or even third round of questions.

Deputy Jennifer Whitmore: I thank our guests for their attendance and their work. This is a very complex area and I believe their work has been leading the way internationally. Not many countries have been through this process, and our guests have had rely on a great deal of information, data and processes that were developed before carbon budgets were even considered.

I will focus on the modelling, given that in the task our guests were set, their fundamental role was to develop the budgets using that modelling. It is a building block for the report and their recommendations. I acknowledge the area of modelling is very difficult and the fact that, internationally, not much work has been done on this makes it even more complex. There appear to be three primary models, on energy, agriculture and forestry. Have those models, or the assumptions that went into them, been peer reviewed or do our guests intend for them to be? I ask the same question about the data, given a model is only as robust as the data it uses. I do not know whether time would have allowed them to be peer reviewed but is that the intent? Do other countries use our guests' models? I note that the TIMES-Ireland model, TIM, is used internationally. Is the agriculture model used internationally?

I noted that the scenarios used for the agriculture sector were suggested by the Department of Agriculture, Food and the Marine. Was that a standard process? Did the relevant Department select the scenarios that were used for the energy model? Did the Department of Agriculture, Food and the Marine have any other input into the formulation of these models and the data that were used during this process?

I know that when our guests were doing the modelling for the energy systems, they looked for pathways and examined what it would mean if there were X numbers of cars, and what would be the cost to the Government or whoever would be subsidising or funding it. Did our guests do any modelling on the herd? I know they did different pathways and suggested that if we took the requirement for reductions under scenario C, it would result in a reduction in

production of X amount. Did they model how to achieve the reductions? When we are talking about the herd, many people talk about a cull. However, there are other ways to reduce the herd which could be started now by, for example, reducing insemination or impregnation of cattle. Did our guests model that out to see how long it would take to get to the different scenarios they outlined in their analysis?

Professor Brian Ó Gallachóir: I will defer to others. I might allow Dr. Styles to answer first on the forestry side because he did not get an opportunity to speak previously. Dr. Daly may then come in on the energy question and Dr. Hanrahan can answer on agriculture. One of my roles is to chair an International Energy Agency technology collaboration programme on energy systems modelling. It dates back to the early 1970s and it is the international body which has developed the TIM, the energy system model that is used and has been widely peer reviewed internationally. I will leave it to Dr. Daly to answer further on that. Perhaps Dr. Styles can come in first, followed by Dr. Daly and Dr. Hanrahan.

Dr. David Styles: I thank the Chair for the opportunity to present here today. I am a lecturer in environmental engineering at the University of Limerick. We did some work on the land use sector for the carbon budget committee. With respect to Deputy Bruton's previous question, I would like to clarify that we did a little bit of work that looked at land use and it was very clear that the 51% target for land use by 2030 is exceedingly difficult to achieve, to say the least. One of the reasons for that is that land use comprises both the big emission source from organic soils, which are drains for agricultural production, and peat extraction. There is approximately 10 million tonnes of CO2 from those annually. We also have a sink in the land use sector, which is unique. We have the removal of carbon dioxide and forestry growth. That offsets 5.5 million to 6 million tonnes of CO2 if one accounts for the wood going into wood products, which continue to store carbon.

One of the problems is that because of very low planting rates recently, that sink is projected to decline dramatically over the next decade. Almost a doubling of emissions in the land use sector is projected by 2030, while we are aiming for a 51% reduction. That is a massive challenge in the land use sector that illustrates the degree of activity change we might need.

Dr. Hanrahan alluded to the fact that we can rewet organic soils and that is an important thing we are going to have to do to reduce emissions. That can be done in a more timely fashion and once we rewet those soils, we can curtail emissions. However, the forestry side takes a while to ramp up so we have limited planting rates and a build-up of the carbon offset that we achieve for any given area that is planted with forest. Those two things together mean it will take some time to build up the offset we need in the land sector to offset emissions from other parts of the land sector, agriculture and other parts of the economy in time. The 2030 targets, for that reason, are extremely difficult and almost impossible, one could argue, for the land sector.

There has been a lot of focus on the longer term offsets and strategy that might be needed for the land sector. When we think about activity change and, for example, planting areas with forest, it is not just the 2030 targets but also the 2050-and-beyond climate neutrality target that we need to think about. Because of the long lead-in time, although some of those activities might not contribute as much to the carbon budget as we might hope, they will certainly contribute to future carbon budgets in 2040, 2050 and beyond.

The activities linked with this mean there is a big land demand for some of these things. Up to 1 million ha could be required, long term, for rewetting and forest planting to achieve

significant offsets. That obviously begins to compete with agriculture. These are political decisions. As Dr. Hanrahan and Dr. Daly said, this is not something for us to decide. However, we note there will be real trade-offs although there may also be new income streams from this diversification. We know we need to use bio-based materials in other sectors to decarbonise those sectors for energy generation, including renewable building materials, etc. There are opportunities here to build new sectors and bio-based economy activity derived from this change in land use. That was a reply to Deputy Bruton's previous question on the scale of the challenge in respect of land use change.

Deputy Whitmore asked about modelling and peer review. The forestry side of the model that we use, the general overview for a back-casting approach of livestock intensification, GOBLIN, model, was reviewed in previous work that was undertaken and we simply took that part of the model that was published in the *Journal of Environmental Management*. We took that part of the forestry model and incorporated it into our bigger land use model. The bigger land use model, GOBLIN, is currently in the final stages of peer review in *Geoscientific Model Development*, an international journal. We have got quite positive feedback and we hope the model will be fully peer reviewed within the next few months. That is a specific response to Deputy Whitmore's question.

Dr. Hannah Daly: I thank the Deputy. I could stay with the committee all day to talk on the topic of modelling. I am delighted to talk about it. The Deputy asked about open source modelling, which I will get to. I will first take a step back. The way I see modelling is not as a way to produce a set of answers or a single pathway or set of solutions. It is a process which helps to inform decision-making. I see it a little like producing a map. If we were all at the bottom of a challenging mountain and wanted to figure out the best way to get to the top, there is a potentially infinite number of ways we could do that but some are better than others. The best way depends on our relative skills and the knowledge we have about the pathway forward. It is an iterative process. As we gain more information about what lies ahead, we update our best information, preferences and so on. That is where I want to start. Models do not give any single answer and they are a simplification of reality. However, they are essential for group decision-making and plotting the best way forward.

My area of expertise is energy systems models and that was how we contributed to this process. We used the recently developed TIM to produce a range of different scenarios which would meet different levels of decarbonisation for the energy system, with different assumptions about demand and technology. It builds from a long history of energy systems modelling at University College Cork, led by Professor Ó Gallachóir, and it was a big group effort. There are a number of PhD students and postdoctoral researchers in the group who made critical contributions. The model is currently undergoing peer review. Peer review alone is only one important step. In this world where models are informing policy, it is important not only for the models to be peer reviewed but for them to be open and transparent. We have already published the model in its entirety and made it freely available, including publishing a web application where one can explore the various different scenarios that we developed for the carbon budget committee, the implications for investment, the marginal abatement cost and dozens of different outputs. One can also query the inputs. As well as for transparency and trust in the process of science and forming this policy process, it is very important to give capacity to national policy-making and academic analysis. The model is under review at the moment. At various stages during the development of the scenarios and the model, we brought it to different experts to get the best data and best assumptions.

One thing I would like to say about the scenarios that we undertook is that the model is called an energy system optimisation model. Given a set of inputs about technology availability, the speed at which technology can change and what fuel prices and demands will be, it outputs the optimum energy system in terms of cost optimisation. At the scale and speed of decarbonisation that these carbon budgets require, the solution is far more led by our assumptions on technology transition than on cost optimisation. It is really about how quickly things can change that determines what is the best solution. For example, someone else could take the model, turn on a bunch of different technology assumptions, assuming that there is breakthrough in something, and it could give a completely different solution. However, it is not about the answer; it about the process.

Dr. Kevin Hanrahan: On the peer review process, the model itself, generally, is not peer reviewed, but the papers that write up the results that are generated with the model have been peer reviewed. The modelling process was also reviewed as part of the review of the EPA's projections generation infrastructure because the model is used to provide the agricultural activity projections that underpin the agency's projections of emissions from the sector. In addition, it is always under development and it has been used for more than 20 years in different iterations to inform agricultural policy here and at a European Union level. Models with which it is integrated are also used in the US to inform Congress's considerations of economic policy.

In contrast to the TIM, it is not an optimisation model; it is a structural econometric model. It is parameterised econometrically using economic theory, combined with Irish data. All of the data that are used in the model are published by the CSO or EUROSTAT. The projections of agricultural activity levels that we use to create the numbers in terms of greenhouse gases are using the numbers used by the EPA in the creation of the greenhouse gas inventories for agriculture. There is nothing hidden in the data that is used. There are thousands of parameters in these models. Generally, there are cascading effects all through them. We have a different approach to transparency to Dr. Daly. Our results are out there. The data that we use are all publicly available CSO and EUROSTAT data and European Commission, Department Agriculture, Food and the Marine or CSO prices. The parameters are not publicly available. That was a decision that we could make. It would be a challenge for a member of the public or another scientific peer to use or change them in an intelligent way.

On understanding the scenarios, I think what the Deputy asked in her question about the role of the Department of Agriculture, Food and the Marine is to misunderstand the Department's role. We were doing work in this space for the Department. We were a State agency reporting to the Department in advance of the formation of the carbon budgets committee. We had begun to run scenarios looking at different paths to potential sectoral targets in advance of this committee being formed. The context was the climate change and biodiversity resolution being passed by the Dáil. There was a commitment in the programme for Government for a significant reduction in emissions by 51%. We started to do analysis for the Department and to run scenarios. That work became a subset of the work that we went on to do during the past year for the carbon budgets committee. It is not that the Department was determining the scenarios. Those scenarios were determined within the carbon budgets committee, but there was an intersection between the work we have been doing for the Department and the work that the committee set for us to do in parallel with the work detailed in the table on the energy-agriculture allocation split in the briefing note .

On how we modelled things in agriculture, in terms of, for example, not inseminating cows, that would be a pretty inefficient way to go about it, because there are all the greenhouse gas

emissions from the cows that are still alive, but none of the milk or meat that they create if they are inseminated. We did not do that. What we have done in the model is we have introduced implicit taxes to change the economic incentive that farmers have to breed and put those cows into calf, whether they are dairy or beef cows, or ewes into lamb. Those assumptions about the implicit taxes are what drive the behaviour of the economic agents in our model. Our model is an economic model. It is a pretty standard partial equilibrium model that produces a response to economic signals. If we reduce the incentive to farm these type of activities, they will reduce. We basically reduce the incentive to farm dairy or beef, and in fact, all these type of bovine agricultural activities, progressively to get a larger reduction in agricultural activity levels and a larger reduction in the emissions from agriculture associated with those activity levels. It is not about assuming that farmers will just keep cows, expend money, create greenhouse gases and not have any output. What happens in the model, and what we think would be most likely to happen in reality, is that farmers will cull those cows if the economic incentives are there for them to do so. In a simple sense, that is what drives the behaviour we have seen across the scenarios we have run for the carbon budgets committee.

Deputy Jennifer Whitmore: I thank Dr. Hanrahan. Does that mean that Teagasc has a figure for each of those scenarios of what it would cost? It is really important that if any demands are put on those in the industry, they are recompensed for it. Are those figures available?

Dr. Kevin Hanrahan: We have figures for the value of the output foregone. Lower levels of output and outward expenditure are also involved. That is partially offsetting. We also have projections for the loss of value added or what is known, in the jargon, as operating surplus, which is the contribution of the sector to GDP. The figures on that are all there, as are figures for the tonnes of milk and beef. We have also done analysis on the impact of the output value changes on downstream activities in the wider economy, particularly looking at employment in the food industry, which is driven by the number of units and the volume changes that are going through the factories. We have done all that and that is included in the papers that are available on the council's website.

Deputy Christopher O'Sullivan: I thank all the members of the council for attending. Like Deputy Whitmore, I also thank them, on behalf of everybody, for the unbelievable work that they have done in getting us to this point. Quite simply, we would not be here without them. They deserve a lot of credit. I also appreciate that they have come here to respond to questions and concerns that we may have or clarifications that we are seeking.

My first question is for Professor Ó Gallachóir or any of the witnesses who wish to respond, because it is quite a general question. One of the criticisms, as soon as the proposed budgets were announced, was the fact that the target for first five-year period is the 4.8% reduction, which increases for the second five-year period. There were some suggestions that this was somewhat of a cop-out or left the heavy lifting for later on. I do not agree with that assessment. I would like to give the Climate Change Advisory Council an opportunity to back up the rationale and make it as clear as possible as to why there is a smaller reduction in emissions for that first five-year period. I imagine it is down to the fact that technologies are still being developed and that we must do this in a fair and equitable way. That is the first question.

There are so many questions in areas we could delve into around this. I hope to come in for a second round but I hope to hear more about transport and particularly the 42% to 50% range selected for transport. I have often heard the Minister, Deputy Eamon Ryan, describe that as one of the most challenging ranges. I would not mind an assessment of how we are doing on that. Perhaps the rate of change to electric vehicles is not as fast as possible but there is a very

notable increase in the number of electric vehicles on the road. I note Dr. Daly's comments that there are just as many, if not more, SUVs entering the market at present. Will the witnesses provide an assessment of how we are doing, particularly with regard to investment in active travel and public transport? A quick comment on that would be great. I will leave it there for now because, as we said, there are so many questions that could be asked.

Professor Brian Ó Gallachóir: I am happy to take that and I thank the Deputy for the question. There are many different possible routes between where were are now and 2030 to achieve the overall 51% emissions reduction targets. Some of them result in more emissions and some result in fewer emissions. Effectively, we looked in the analysis at all the obligations we were asked to consider. In addition to elements like compliance with the Paris Agreement, we have seen how some conflicts have already arisen with impacts on the economy, employment, competitiveness and climate justice. We also considered where we are now, as I mentioned in the opening statement. We did the analysis in 2021 and it was quite clear at that point where emissions were heading for 2021. It is now 2022 and there is a balance between the desire to mitigate and reduce emissions very quickly and the requirement for policy mechanisms to be introduced, societal dialogue and the transition taking place in a just way.

There are many factors behind what will push things in one direction or another. The reason we picked the trajectory we did and those budgets was a basis in considering all those different elements. I agree that some people have argued this is a cop-out and we should have more emissions reduction at an earlier stage. I repeat that this is the second most ambitious emissions reduction target in the world. I challenge anyone to demonstrate how we might achieve lower emissions and reduce carbon more in the first period, given where we are now and all of what is required to mobilise across society.

As was mentioned again and again, this is a societal transformation. We are not talking about tweaking or a limited emissions reduction. We are heading onto a pathway to significant emissions reductions. It may be a slightly more personal opinion, but we must also bear in mind that if we set a carbon budget in the first five years that is not achievable, it could be a very damaging process for the whole trajectory. We are aiming to get to net zero by 2050. We are aiming to significantly reduce our emissions.

We have had emissions reduction in the period 2005 to 2020 but at approximately 18% overall in terms of greenhouse gas emissions reduction, it is nowhere near what will be required in what is proposed. What is proposed is very ambitious and it could, of course, be more ambitious. The committee was conscious of its obligations in taking into account all the different obligations, some of which would push us in one direction or another. I am certainly very comfortable that what we have arrived at is the optimum. I do not know if the committee members dealing with the carbon budget have other comments.

To clarify, most of us are not on the Climate Change Advisory Council. We were brought in for the carbon budget committee.

Chairman: I thank Professor Ó Gallachóir. I repeat that if witnesses feel they can add to points made, they can raise their hands and I will bring them in. There was a question from Deputy O'Sullivan on transport so does somebody wish to take that one?

Dr. Hannah Daly: I thank the Deputy for the question. Transport the largest energy consumer and it is approximately equal to heat in terms of emissions from the energy system. To reach abatement levels of more than 51% for the transport sector requires that the electric ve-

hicle target is met but also that there be a range of other solutions as well, mainly focusing on demand reduction, including elements like walking, cycling, improved public transport and, where possible, reducing trip lengths where necessary. That relates to more compact development, home working and such ideas.

The Deputy asked about transport decarbonisation ranges as proposed by the climate action plan. I should clarify that the climate action plan is a Government-led process rather than an output of the Climate Change Advisory Council. We did not recommend any particular sectoral carbon budgets or trajectories but in the modelling we did, we saw very different optimal ranges for different sectors depending on the level of abatement in the energy system. It depends on the level of decarbonisation in the agriculture system, for example. If the target for agriculture is to decarbonise by 30%, the energy system is required to do 61% to 65% by 2030. Every additional level of abatement required in the energy system gets progressively more challenging as we take the low-hanging fruit and go up the theoretical margin of abatement cost. It will require faster or more rapid adaptation.

In some of the more extreme scenarios, for example, with demand shifts and with greater than 60% abatement in the energy system required, there is the model selecting massive scrappage schemes for later in the 2020s required to make the target. It would take all the cars being sold now out of the system earlier and that amounts to much wasted capital. Approximately 55% of new cars sold last year were SUVs, and that rate is growing. It is more about reducing fossil fuel consumption as soon as possible rather than hitting a particular target for clean technology in 2030.

Deputy Christopher O'Sullivan: I thank both the witnesses for those very detailed answers.

Deputy Alan Farrell: I hope everybody can hear me okay. I am in Leinster House. I extend my thanks and appreciation to the members of the council and those who served on the sub-committee. As others have said, their work is really valuable and we would not be here without them. They had particular time constraints. It is really appreciated. I have three questions on energy systems, land use and transport, with an interrelated question on planning in terms of density.

I listened carefully to Dr. Daly's response to Deputy Bruton on how quickly people will accept change in terms of the broader questions that have been posed. One of the biggest questions I have on our ability to reach our targets for greenhouse gas emission reductions and wean ourselves off fossil fuels appropriately is how achievable some of the targets are with regard to some parts of the energy sector, particularly when it comes to the geopolitics of the gas supplies to this country, which are limited domestic supplies. There is a broader question as to whether the wind energy sector is capable of ramping up to the level we require and whether the Government and Oireachtas are doing enough to facilitate that, noting certain Bills that are before the House.

On land use, Dr. Hanrahan mentioned the sort of activity level changes that are required in the context of forestry and afforestation and the problems that exist. It occurs to me that while we have made great strides in improving our afforestation levels in recent years, we seem to have just stopped in the past three or four years. I am baffled. Perhaps it is a lack of information on my part. I am baffled that we seem to be stuck in the mire in terms of afforestation and what we need to do to improve that sector. I would be pleased to hear any insights or remarks Dr. Hanrahan may have on that issue.

While it is a micro issue, peat extraction has arisen in recent months. It is frustrating because we have done the right thing in stopping peat extraction for energy purposes. We are heavily engaged in bog restoration, yet we are importing peat for certain sectors that do not require it and for other sectors that will not survive without it. Having read up on this issue a little, it appears that some of the sectors, particularly horticulture, would be self-sufficient with a small amount of peat extraction in conjunction with the regrowth and restoration of bogs. If there is a view among members and witnesses today, I would appreciate hearing it.

I completely agree with Deputy O'Sullivan's remarks about the transport sector. I will not repeat them. Investment in alternatives is where we need to be. I thank Dr. Daly for her remark about journey reductions and heavy investment in public transport. Related to that is the work of the Oireachtas and whether we and, indeed, the local authorities are doing enough in the area of compact development, building upwards and taking a strategic overview of our major cities and towns. We are not doing enough. We are blocking high-rise development even though it is environmentally sound and will, from a transport perspective, take people off the roads and out of cars and put them into public transport to access employment nodes, which are often in and around where they need to live. That is the way of the future. I believe I see some heads nodding. We all agree on this, yet we have high-rise development being objected to and planning permission being declined by the same planning authorities that authorised the heights proposed for particular locations. Issues like that frustrate me because we are going backwards. Sprawl continues and we are still building two-bedroom semi-detached houses in the suburbs and all the rest of it.

Chairman: I thank Deputy Farrell.

Deputy Alan Farrell: I will finish now. If a view could be provided to the committee, I believe it would be beneficial to us as we go forward. I thank the Chairman and apologise for being a bit long-winded.

Chairman: That is no problem. I thank Deputy Farrell. I suggest the witnesses may be reluctant to answer some of those questions as they are policy related. I will leave it to them to decide.

Professor Brian Ó Gallachóir: I thank Deputy Farrell very much for the questions. He highlighted some of the real challenges that are ahead in delivering the carbon budgets. As the Chairman outlined, some of these are policy questions and beyond the remit of the committee's work. I will give some reflections and ask Dr. Daly if she wishes to answer the energy question. Dr. Hanrahan and Dr. Styles can respond on afforestation.

This is more of a reflection than an answer to the question on the wind energy sector being capable of ramping up. We might look at what we have achieved in the last 15 years in the electricity sector. Between 2005 and 2020, electricity demand grew by approximately 18%, while the emissions associated with electricity generation decreased by 46%.

We have done something phenomenal in this country in terms of the rapid development, deployment and integration of wind energy into our power system. I remember the conversations before 2005 when the targets were being set and the same types of questions were arising on whether wind could be ramped up. The evidence has shown that when the policy is clear, there is a good integration between that policy, the signs around what is required and the engineering to deliver it and there is also a public appetite, we can achieve great things.

Perhaps Dr. Daly can address the energy question and Dr. Hanrahan and Dr. Styles can respond on land use. I am not sure if the peat extraction comment required an answer. As I said, I think it reflects some of the challenges but others may want to answer that one as well.

Dr. Hannah Daly: I thank Professor Ó Gallachóir and Deputy Farrell for the question. I will give an overview of the pathway forward for the electricity system. The Deputy mentioned gas and the difficulties with geopolitics. I will not get into geopolitics but I will outline the rationale for the need for additional gas capacity in the short term. First, gas-fired electricity generation has approximately half of the CO2 emissions of coal and even less than that of peat. The first need for additional gas in the system is to replace coal, oil and peat as quickly as possible. It is also a very flexible source of generation to balance intermittent renewables. Our electricity demand is set to grow very rapidly with the growing economy, the electrification of heat and transport and the growth of large energy users such as data centres. While there is a short-term need for additional gas capacity, there is also a need to move to a zero-carbon electricity system as quickly as possible. That requires interconnection, storage in the form of batteries and, most likely, a green hydrogen economy and flexibility in demand. While we are building the electricity system, we need to make it in such a way as to be zero carbon as quickly as possible, which will likely be in the 2030s, to meet our net zero target.

The Deputy asked if the wind energy sector is capable of ramping up. It is not within my remit to comment on that. I will say that a cornerstone of the carbon budget programme is for the wind energy sector to ramp up. If that does not happen, it will be very problematic for meeting targets.

I will reflect briefly on the Deputy's question on whether the planning system is doing enough. Again, I cannot comment specifically on individual projects. There are, however, very many win-wins in the area of dense development at the urban level but we should not forget villages and towns either. It is currently very difficult for people to build a house on the periphery of a village to allow them to walk or cycle to do their daily activities. We modelled a low-energy demand scenario, which is a broad picture of the situation if we moved to this more integrated planning approach where people live in denser neighbourhoods and buildings are smaller and much more efficient. It makes the transition far cheaper and far more feasible and requires less dramatic technology change for a given level of decarbonisation, which is important to note.

Chairman: I thank Dr. Daly. Does Dr. Hanrahan wish to respond?

Dr. Kevin Hanrahan: Yes. I thank Deputy Farrell for the questions. The question about relatively low levels of afforestation is a very contested one, both politically and economically. As an economist, the evidence suggests that the relative returns from planting forests are not sufficiently large compared with other agricultural uses of land to drive high levels of afforestation. However, it is also clear from the research that lots of other factors are important in influencing landowners' decisions on whether to afforest their land. Despite the relatively generous subsidies to afforest land, the levels of afforestation are still very low relative to where they have been in the past. The level of subsidy is no lower now than in the past so there is a nut there to be cracked. That nut will need to be cracked if we are to get to the kinds of targets that my colleague, Dr. Styles, will talk about in a moment.

I agree with the Deputy that the volume of peat extraction that would be required to provide a medium for the Irish horticultural industry would be relatively small as compared with the volumes of peat that were extracted and mostly exported historically and in the recent past.

Teagasc is in the process of hiring a new research officer on a permanent basis who will be looking at alternative growing mediums for the horticultural sector. I am sure the committee understands that it is not easy to find a medium that is as good as the peat resource which, unfortunately, involves lots of carbon dioxide emissions as part of the harvesting process. Teagasc is actively trying to figure out how the industry can develop without the use of peat but that is a long-term goal. It is probably possible to extract minimal amounts for the domestic horticultural market which could potentially be more than offset by re-wetting bogs and getting some sequestration going in Irish wetlands.

I am sure Dr. Styles wishes to respond too.

Dr. David Styles: The forestry issue is extremely challenging. Dr. Hanrahan has already outlined some of the barriers. There is resistance to long-term land use change, with farmers reluctant to commit land to forestry which can never then be changed back to other agricultural uses. It is a big commitment. There are also huge issues around licensing, from what I understand. There are difficulties with the speed of, and level of administration associated with, obtaining a licence, not to mention the work involved in both establishing and cutting a forest. Those are very real barriers. If the economics were stronger, maybe we could overcome some of those barriers but at the moment they are not.

A lot of the work we have done, both in Ireland for the carbon budget committee but also in the UK, shows the future value. If we are very forward-looking and think about where we need to be in 30 years' time, namely, climate neutral, we are going to need a lot of wood for various things, buildings for example. We could be using cross-laminated timber and glulam which are capable of producing buildings that are ten to 15 storeys high but we do not have that processing capacity in Ireland right now. This is where we get to the transformative nature of the challenge, to which Professor Ó Gallachóir alluded. We are not going to get to where we need to be without huge, systemic changes. The insight we have gained from the work we have done tells us that we also need to think about integrating changes across systems. This is also relevant for the energy sector because a large amount of the wood that is harvested from commercial forestry will not go into high-value uses. Approximately 30% to 40% of it will go into products which can be used in construction but the off-cuts, dust residues and so on can go in to energy production. There is a possibility of providing some of that baseload energy in the future from wood via cascading value chains at the end of life.

The way to think about forestry is to think about how it contributes to the future economy, sustainable buildings and sustainable energy. We could be linking some of that wood energy with carbon capture in the future to have a permanent, negative emissions technology. That biogenic carbon does not need to get back to the atmosphere if we lock it up in buildings for 50 years or we burn it and then capture the carbon again. It is an indefinite sink of carbon dioxide in that sense. Those are the kinds of transformations we need if we are ever to achieve climate neutrality in the long term. This is a mix of insight from research we have done and personal opinion on some pathways that we might need to pursue to get to long-term net zero.

A final point on this relates to the carbon credit values. Professor John FitzGerald is not here today but he has looked at some of the value of offsets in the future from forestry. We could be talking about billions of euro per year in the value of offsets once we start valuing carbon dioxide emissions at hundreds of euro per tonne, which is what is projected ten or 20 years into the future. There is very real value there in terms of the value of avoided emissions and offsetting which could be realised. The difficulty is that this is something we anticipate in the future. The question is how we translate that into money in farmers' pockets now to actually change

behaviour on the ground. That is where the big, fundamental challenge lies at the moment.

Senator Alice-Mary Higgins: I thank all of our witnesses for attending. I have lots of questions but will leave some of them for the second round. I want to focus on two core issues. The first is the core considerations in the development of the carbon budgets and specifically the question of climate justice. To be frank, I was a little disappointed with the climate justice aspect, which there is an obligation to consider. In the technical document, there is very limited consideration of it. The most recent briefing document we received states that "an appropriate contribution" to the Paris Agreement is an appropriate response to international climate justice and yet, in the technical report on carbon budgets, the advisory council says that it is not the job of the council to determine what Ireland's contribution should be to the global effort. The document states:

> Any such determination has implicit or explicit implications around climate justice, historical responsibility, equity and equality. It is not the job of the Council or the Carbon Budget Committee to make such value judgements.

However, considering equity is one of the obligations under the law. Indeed, considering the issue of equity is core and considering climate justice is one of the key obligations under the Act, I am particularly concerned about a set of assumptions that seem to have been made in relation to the question of fair share and so forth. Article 4.1 of the Paris Agreement refers explicitly to the fact that the 1.5°C limit has to be achieved in a manner consistent with equity. It also refers to common but differentiated responsibilities. There was really good input from Mr. Price and Mr. Smith, who put forward very good ideas on how to approach equity and deciding what a fair share would be. Mr. Smith set out six different scenarios in terms of how we can approach that but none of those scenarios seems to have been taken on board. Instead, there is this new proposed Paris test, which the technical document says is the approach being taken. This approach is to consider what the temperature outcome would be if every country in the world had the same starting point as Ireland and reduced emissions at the same speed and by the same amount. That is just factually not true and I am really worried about a factual mistruth being part of the modelling. Again, how much weighting we want to give to historical responsibility, to respective capacity or to the cumulative of the future is a political decision but the facts-----

Chairman: Thank you, Senator Higgins.

Senator Alice-Mary Higgins: If I could just have-----

Chairman: I will let the Senator come back in but she is way beyond her two minutes.

Senator Alice-Mary Higgins: I would specifically like an answer to that question because I am concerned about the climate justice issue. It is important not just from a climate justice perspective but because it throws off the modelling. For example-----

Chairman: I will let Senator Higgins come back in. I call Professor Ó Gallachóir.

Senator Alice-Mary Higgins: It would not be consistent with the ultimate objective if the modelling is wrong.

Professor Brian Ó Gallachóir: I thank the Senator. As she mentioned, we were fortunate to have contributions from Paul Price and Andrew Smith, who did a top-down analysis to explore what the Paris Agreement says Ireland's contribution should be and how to incorporate that into our carbon budgets. In parallel, we carried out a bottom-up exercise where we tried to

explore the implications of different sectoral pathways on Ireland. For example, we looked at what the implications would be if we took different approaches in respect of energy and agriculture. There are two key elements on the equity side. One, which the Senator touched on, relates to our fair share and our contribution internationally. There is also the national aspect with the just transition element of this. Both of those are part of the equity remit or discussion and we took them into account. In addition, as the Senator can appreciate, we had many obligations that we were asked to consider by the legislation and we took our role in doing that seriously. What we end up with is, effectively, a balancing, and climate justice was part of that. We added on to that contribution what the Paris Agreement might mean for Ireland. We also considered our historical emissions and the different implications of the projections associated with the bottom-up scenarios. I will ask Ms King to talk about some of the national aspects with regard to the just transition-----

Senator Alice-Mary Higgins: We have limited time and others will want to come in. I am not actually asking about the just transition. I am very interested in that area but I am concerned specifically about the assumption in the modelling of our compliance with the Paris Agreement. There are a lot of important policy and sectoral points but I am talking about the assumptions that have gone into the modelling.

Professor Brian Ó Gallachóir: I thank the Senator for that clarification. When it comes to equity, I think of both. I think I have answered this question already but I will summarise again, and others may come in as well. With regard to the Paris Agreement alignment analysis, we had a top-down analysis from Andrew Smith and Paul Price looking at the global carbon budget. There is a wide range within that looking at different dimensions to Ireland's fair share because, as the Senator noted, Ireland's fair share is very broad. We can look at historical emissions because there is literature and an international process associated with this. When we were looking at the modelling, we looked at the different scenarios of emission reduction pathways for Ireland. It is not that the models made any interpretation about the Paris Agreement. These were two parallel pieces of analysis. One was by its nature top-down as it was looking at a global carbon budget and trying to estimate what might be reasonable for Ireland in that context. At the same time, we did a bottom-up analysis to understand the implications of different pathways, which we were required to do under the Act. We took on board both those analyses. We also considered the Paris test in the report. That was one part of that analysis of the Paris Agreement. We thought it was interesting to explore what the temperature contributions would be of the different pathways we were considering with regard to the different sectoral emission shares. What we arrived at with the final carbon budget was effectively a collective view on the optimum, based on all the different considerations we were obliged to take into account.

Chairman: I thank the Professor and Senator Higgins. We will have time for a second round so Senator Higgins should stay with us. I call Deputy O'Rourke.

Deputy Darren O'Rourke: I thank the witnesses for all their work and for attending the meeting today. I have a number of questions but I may ask some of them in later rounds. I want to focus on the issue of the models. First, I would like to know about the information gaps, the data sets and the input variables. What gaps were there when the witnesses started their work and what gaps or weaknesses in information remain? I have a similar question about the models themselves. This is pioneering work and we are all very grateful for it. It is hugely important because what comes out the back end of it has a real significance and impact on policy and people's lives. I ask the witnesses for some critical reflection on the models we are using. There are three, as I understand it, as well as various submissions from other parties. What are

the strengths of the models and what are their limitations or weaknesses? Those might relate specifically to the models or the information going into them. I also have a question about the future. Do the witnesses envisage that we will end up with a unified model, or will we continue with the focus on energy, agriculture and land use?

Professor Brian Ó Gallachóir: These are great questions. Again, I will defer to Dr. Daly, Dr. Hanrahan and Dr. Styles on the individual models. With regard to my own initial reflections on the information gaps, we had not modelled this level of deep decarbonisation before across sectors. That was a key information gap at the start of the process, which we were able to shed some light on at the end of the process. While we worked intensively in those six months, we were not starting from scratch. We were building on years of modelling capability and capacity that we were able to draw on. That is extremely important and speaks to the Deputy's point about the future. As much of this work is invisible to the policy system until we come to a situation like this one, it is important that these models are resourced on a continuous basis. There are gaps and challenges. One of the key broad gaps is on the societal side. We are quite good on the technology and the economics but the societal dimension of the transformation we are talking about is the biggest gap, in my view, although others may disagree. The Deputy asked about the strengths and limitations of each of the three models. The reason there are three models is that they are focusing on very specific things and sectors with their own dynamics, inputs and outputs. My personal view is that, although I do not know if a unified model is the right approach, we need to have some kind of bringing together of modelling capacity such as we have had in this six-month period. That has been very valuable. In this period, we have been able to show how far we can go in these sectors, but on an individual basis. There are a lot of interactions in the area of land use with regard to, for example, bioenergy on the energy side and on the agriculture side. There are a lot of interactions and a lot we could build on. What we managed to do in the six months was phenomenal. Many of the committee members have commented on it and I believe we have made a valuable contribution. We have done something solid. Modelling is never finished; it always goes on. Thinking about the Deputy's last question, that critical reflection is very important in considering the developments required to progress this work under each of the models and in taking into account more fully some of the things we were not able to take into account. There is also the question of the interaction between the different sectors. I thank the Deputy for the question. I will hand over to Dr. Daly, Dr. Hanrahan and Dr. Styles on the individual models.

Dr. Hannah Daly: I echo much of what Professor Ó Gallachóir has said about the need for continued support and capacity. While there were a number of data gaps, there is a real bottleneck with regard to our capacity to feed into this process. Through this process, we are training PhD students in both modelling and communications. Processes like this can be improved by making national datasets as freely available and open as possible so that we can build from the data and modelling of other groups and replicate and update that work as things change. Adopting a principle of making data as open as possible would really assist with this process.

Modelling itself is just one part of this process. Other parts include defining the question, creating the model, producing the results and engaging in this iterative engagement between the policy system, stakeholders and scientists. Ideally, this process should be as iterative and strong as possible so that we can gain insights. We can see what kind of scenario is feasible within the world of models but we cannot make judgments about the scale of change that is feasible politically or societally. That is really important.

I agree with Professor Ó Gallachóir that the representation of society and demands should

be improved and the distributional impacts of these energy scenarios considered because our models do not assess who pays, what type of finance is used and what the impacts of that are. It is also very important to look at the co-benefits such as the reduction in air pollution that results from climate mitigation measures and the potential to develop good-quality jobs. Correspondingly, it is also important to look at where jobs will be lost. Integrating the wider sustainable development goals into these models will be a priority in future.

Another big priority for the energy system model is equipping it to look at net zero to beyond 2030. We have shifted the model greatly to focus on the next decade and on how quickly the system can change. We want to move the focus beyond 2030. For example, we want to examine how ambitious we can be for the third carbon budget period. There are to be reductions in emissions of more than 8% annually in the second carbon budget period. Can that be sustained or even grown? Can we bring forward the date at which we will achieve net zero as the urgency of climate mitigation becomes more apparent in the coming decades?

I will say a final word on the integration of models. As we move towards 2050 and net zero, the interactions between the food system, land system and energy system will become much more apparent. There will be synergies. Dr. Styles alluded to some of these, for example, using wood for bioenergy as well as for construction, where it will replace cement. There will be lots of different systemic interactions but that will create competition for agriculture. There will be trade-offs. For example, re-wetting land will reduce the capacity to afforest it and to produce food. I would not necessarily like to have one fully integrated model but representing these interlinkages between energy, food and land in the context of carbon neutrality will be the main priority.

Dr. Kevin Hanrahan: I thank the Deputy for his really insightful and sharp questions. To pull on the ball from Dr. Daly with regard to the unified model, the models are representations of reality but all models are wrong, although some are useful. The demand from users of our analysis is that the models capture the complexities of the issues at hand. Our stakeholders want to know what happens to the numbers of cows and sheep, how much oats are grown and so on. When the models are asked to capture that level of complexity, unifying them is an almost impossible task. An energy system model might run on a time step of hours or minutes. It is really a massive task and I am not sure unifying them would yield benefits commensurate with the amount of work that would be needed to do so. That is my own perspective.

On the gaps, the work of the committee and the feedback from fellow members has pointed to a gap that we are going to work to fill. We have to think of how to do so. I am referring to the idea that some of the changes we considered would lead to losses of output from agriculture. Some of the land resources in question could be used to produce other things but those other things often involve doing things that have never been done before or never been done before at scale. How can that be represented in a model? That is something we need to tackle. To give an example, the quantity of Irish agricultural land used to grow horticultural products is minute. It has not been very large since before the Famine. How do we develop parameters for a model of a reality that has not existed in modern history? That is a big challenge. We need to think about how to fill that gap.

The bigger gap - and this speaks to the concern about the ability of the models we have used in this work to consider wider societal issues - is really the absence of a unified macroeconomic models analysis that could tell us something more about the distributional implications across high-skilled and low-skilled employment, rural and urban areas and different strata. This would also involve different ways of thinking about society and different industries. I know the ESRI

did work for the committee but its involvement in the process came so late in the day that its work was not able to form a fundamental pillar of the technical report. Given the scale of the societal change we are considering, it behoves Ireland's socioeconomic and analytic community to be much more involved in this question because it involves changing the bedrock of an awful lot of things we need to think about.

There in one other point of difference. When thinking about agriculture specifically, because we are so export-oriented, in constructing models we need to think about what is happening in the rest of the world in terms of agricultural markets, agricultural policy and, down the road, climate change policy with regard to how it affects other industries in competing countries and demand for the type of products we produce in Ireland. That is a very important consideration and one of the reasons it is so difficult to move to a 50-year time horizon because that involves making enormous assumptions about what agricultural policy will look like between now and then. That will predetermine the path you travel on to a great extent. I am not an expert in forecasting how policy will develop but the role of policymakers domestically and at the European and global levels is endogenous. It affects all of this stuff and we need to think about how we reflect that in our work.

Chairman: I thank Dr. Hanrahan. Did Dr. Styles want to come in on this as well?

Dr. David Styles: I do not have a huge amount to add because it has all been articulated clearly so far.

Specifically with regard to the modelling in the land sector, we used a model which draws upon recent models we developed in the past to use for agricultural emissions for different land management and for forestry. There were some significant emissions gaps because we very much looked forward to a 2050 perspective and took the so-called "backcasting" approach. We tried to imagine what the future could look like irrespective of what it looks like now and what are the possibility of the future in terms of land use combinations that are compatible with net zero, and we worked back from that. UCC has done a bit of work on this. Because of the transformative nature of what we are looking at, my personal view is such modelling is quite useful. It does not give you any kind of right answers or predictions *per se* but it shows you what is possible within the constraints of what we know we need to do to get to net zero. It is quite a useful approach and my view would be we need to encourage modelling to be perspective so that we look at future trajectories and we are not confined to extrapolations from the past, which is perhaps a danger of relying heavily on models which had been developed hitherto - often they are prioritised using data that we have had in current systems and when we are talking about transformation those systems are no longer relevant. That is a fundamental challenge. There is no easy way around it.

I fully agree with what Dr. Hanrahan and Dr. Daly have said about unified models - it would be difficult to ever achieve that - but there is great potential for coupling models and to make sure that outputs from one model are designed in a way to be compatible with data one puts through another model. The best way of making that happen is for large-scale long-term strategic research investment that encourages collaboration across institutions and research groups because that is the way that these things happen.

I would make a minor point perhaps, to finish off. It is something that we are conscious of with our backcasting approach and what could be compatible with climate neutrality in the future. The big uncertainty there from our perspective is the degree of decoupling that is possible from animal emission intensity, which could be highly sensitive to future technologies around

methane abatement in cattle, etc. Things like that are very difficult to forecast and we will depend on these models being iteratively updated through time to ever come to any conclusion on that. That is one of the ways we cannot really predict the future. We will have to keep updating these models with revised parameters as the technology develops and you will never have a finished model. As Professor Ó Gallachóir has alluded to, it is an ongoing progress. That is just a little bit of insight from my side.

Chairman: I thank Dr. Styles. Next on the list is Senator Pauline O'Reilly.

Senator Pauline O'Reilly: I thank the Chair. First, I thank all the witnesses for their work. The response from the public, from the media and, indeed, politicians, was positive overall, which goes to show how valued and respected the witnesses are as a council.

Sticking with the modelling for a minute, we are not experts in modelling but it seems that one of the challenges for policymakers is that it becomes a quite contested space once you get into policy and away from the science. That is the bit that we struggle with. The modelling, based on the technology that is available, is hugely important but is there a place there to do something? Dr. Styles spoke about this as an iterative process but, even at a closer level, to have some collaboration on an ongoing basis between policymakers and either those on the council or those in science generally to assist with policymaking seems to be the challenge that we face, not only on the cold hard science of how we get to a point through the technology that may be available. Policies might drive in two different directions. Can we model it to look at both directions and see which is the best outcome or which is most achievable?

The second point that I will raise is on health consequences. The reason I raise this is that the council speaks about it in the carbon budgets in its report even though it is not specifically listed but I think that this is because it has an economic consequence. I believe that this is something that could really drive change. If we are to look at what the consequences are for healthcare, that is something that can make people want to make the change because it directly impacts on them. If there is some more that the council has to give us, such as some of the costs around healthcare that the council has looked at in the report, that would be welcome.

Finally, there is a small reference to the circular economy in the agriculture section. I wonder if there are other opportunities or what the council sees the opportunities being for the circular economy because, as it will be aware, another large part of our work towards the end of last year was on the circular economy. The kind of regulations that we can put in place for companies, for instance, could drive change. If we have the scientific evidence to show that a circular economy can drive down emissions, that would be really helpful.

Professor Brian Ó Gallachóir: I thank the Senator. They are great questions. The first one is close to my heart. The need for integration generally of science and policy and the policy system is a fundamental one. We have seen the benefits of that over the past 18 months with the Covid response but it applies equally to responding to the climate emergency. The committee itself, and how it is structured and being able to invite ourselves and others in, is part of that process but it can go much deeper. Certainly, in what we do for the climate action team in the Department of the Environment, Climate and Communications, we provide a modelling service to inform the Department's need. As part of that, we also have a specific branch of that work focusing on what we call building absorptive capacity in the policy system, that is, working with Departments to try to help them understand the outcomes of the models and what they mean. It is that bridge between, as the Senator said, the science and the policy decision. Our expertise is in the science around this, while that of the committee, the Departments and the Civil Service

is in the policy system but that bridging is hugely important.

Increasingly, with our researchers we introduce more and more training in the communication of the research. That is another part of it. There is an obligation here on the research side of the house to communicate better, to be more open and to engage more with the policy system.

One of the challenges we found on the policy system side is that they tend to be stretched in terms of the time and capacity they have to engage with the research community. That is a requirement there. Another mechanism by which this can be done is through secondments. For example, we have one member of a Department who works with us two days a week. We have a great deal of experience of students and researchers spending a day a week in industry in different companies but, equally, we could make that available as an option to Departments as well. Another example would be a car stock model that Dr. Daly developed some years ago where we handed it over to the Department of Transport and that helped the Department to inform decisions on policy considerations for it on electric vehicle roll-out. There are many examples on bridging this gap. The Covid experience has shown us the value of it. What we need is the mechanisms to put in place.

In terms of the health consequences, the Senator talked about the economic aspect but there is also a just transition aspect to this. If you consider where, particularly in concentrated urban areas, much solid fuel residential heating takes place, some of that is happening because the people cannot afford the investment required to change their heating system and you have this consequential health impact. Approximately 1,300 people a year die from air pollution from residential solid fuel burning and, therefore, there are linkages between health and the energy system. Equally, as for the responses as we decarbonise and remove other emissions, that has positive health and just transition implications as part of the economic consequences the Senator mentioned.

As for the circular economy, we did not have too much time, as she correctly said, to focus on that topic. Clearly, however, within the principles of the circular economy and the development of circular economy approaches there are efficiencies, demand reduction and consumption reduction, which are huge potential benefits in respect of emissions reductions. One thing to bear in mind, though, is that sometimes, while there can be a lot of co-benefits, there can also be trade-offs between some of these different goals.

I am not sure if any of the other members wish to come in on those points. I see Dr. Hanrahan's hand up.

Dr. Kevin Hanrahan: This line of questioning is really welcome in the context of the demand for analysis that informs policy. Some of us would say we model not policy or the policymaking process *per se* but the consequences of policy options that the political process will develop. There is a chicken-and-egg issue here. I will speak about the economic research we in Teagasc have done. We are a State agency so we work a lot of the time on quality analysis with the Department of Agriculture, Food and the Marine. That is where our work in this area started. We work quite closely with that Department but we are quite clear about the economic space. We do not propose policies to the policymakers; we analyse the policies they develop that are informed by the research we do. We are not in the business - certainly, we do not see ourselves in the business - of writing what we should do. We try to be a bit more positive in our approach by saying these are the different options policymakers could choose and these are the consequences of option A, option B and option C. That is what we try to do in this work in respect of the scenarios we have looked at.

I agree with Professor Ó Gallachóir that there is an important role in educating policymakers and people involved in the political process such as Oireachtas Members, lobbyists, etc., to understand the role of modelling, how far down the road it can get you and the gaps we addressed in the last round of questions, which the model sometimes cannot answer at all but which are still pretty important. I am an economist, but there are more ways to look at a problem than through the lens of economics, and not all the answers come out of economists' mouths.

The circular economy is an active area of research within Teagasc. As for the modelling, we are still grappling with the definition of "circular economy" and where the circular economy starts. We need collectively to draw the map as to what is and is not in the circular economy. An awful lot of the agriculture and food industry is already circular, but research ongoing in Teagasc has identified that there are things that could be valorised to a greater extent within the existing agrifood sector that could have benefits not only in environmental efficiency but also economically in the form of greater value added or income earned in the economy. That is something in which we are involved.

Chairman: I see that Ms King and Professor Ryan are indicating.

Ms Patricia King: The point that was raised about the modelling and the policymaking is important. Taking the topic of just transition, there is no precise modelling that will give the answers, but the discussions on and the considerations of both the budget committee and the council went along the lines that we know that there will be job losses and job creation. The budget committee provided quite a lot of work on that, and my colleague, Professor Ryan, will, I am sure, contribute on that. Our task was to make sure that, from the point of view of policy advice to the Government, we would say to the Government that to ensure we have a just transition and manage the job replacement and the job displacement that will occur, its policies should include a massive overhaul of the training and skills development infrastructure in the country in order that we can have timely interventions and offer workers whose jobs are gone or going, preferably at the stage at which the job is going rather than gone, timely reskilling and retraining intervention to enable that worker to becomes equipped to be a good employment option and has good alternative job options. We should not repeat some of the examples we have had. The Bord na Móna scenario, for instance, was not timely and there were job losses and not necessarily job replacement for displaced workers. We should get into a space where we can have that infrastructure ready and available for workers to upskill and retrain. We will hit some challenges. For instance, people talk about the availability of skilled labour to produce retrofitting. We have other exigencies in policies the Government is pursuing on housing and so on. In the advice the council gave the Minister in that regard, which the committee will have read, we say this is the policy advice on the infrastructure that needs to be put in place to meet these challenges. Professor Ryan will talk more in-depth about the actual projects that were done in UCD and other places to advise the council on that.

Professor Lisa Ryan: I am a professor in energy economics. I am not a member of the Climate Change Advisory Council. I was brought in as an expert on the committee on carbon budgets. I would like to clap because some of these questions are extremely welcome, as Dr. Hanrahan and Professor Ó Gallachóir have said, in clarifying that it is very important that policy is informed by modelling and research. I totally agree with that. The carbon budget work we have done has formed the envelope of those carbon emissions that would form what Ireland needs to do to get to 2030. After that, it will be much more detailed. It is for the Department and the Minister to decide the individual policies that will then need to be implemented as part of the climate action plan, for example, to achieve those carbon budgets. We need models. I

totally agree that one of the gaps, certainly in the big technology models, is society. Given the nature of models, it is very difficult to model everything. As the basis for this carbon budget work, therefore, we have had three main models that have best addressed the questions to which we were asked to respond. Society and economics formed less of a focus initially but, as we try to decide what these policies are and how we can implement them, we get into much more detail, such as distributive impacts across society. Then it is very important we have societal models. By their nature, they are often different kinds of models. They may be formed by surveys getting into the level of the individual. There will be winners and losers, as we all know, in this climate transition. It is about how we best protect the most vulnerable. However, that is not the question for here and now.

As part of the work on the carbon budgets, from a top-down perspective, in UCD we were asked to look at what expenditure is related to the different scenarios and where current employment is in Ireland. It was just a question of matching up and looking at where that current employment is, what kind of capital budgets will be required and whether there will be jobs involved in different sectors. We can see that employment will be created in many sectors. The question, following on from all this work, will be, as Ms King rightly said, how we can make sure, despite the fact that there will be job losses, that people will be helped to make that transition. That will be the next step. It is a very important question for society if we want to bring people along with us. Without people coming along with us, we definitely will not achieve any kind of transition. The way I see it, at least, is that the next step is the policy implementation of the council and its review. It is all very well to set targets but now the really detailed work needs to begin as well on the implementation.

Chairman: I thank Professor Ryan, the other witnesses and Senator Pauline O'Reilly. Before we go into a second round, I will ask some questions. Senator O'Reilly got in ahead of me and kick-started an interesting discussion on the gap between policy and the work the advisory council is doing in setting the trajectory. I suggest there is possibly a second bridge between policy and politics. Politicians, lamentably, run a mile from very difficult discussions. We cannot have climate mitigation unless we have very difficult discussions and make very hard and unpopular decisions which we have to own. If that first bridge is not built, we cannot build the second bridge.

We are not there yet in joining up with the work of the Climate Change Advisory Council. There is a significant gap in respect of the pressure that needs to be on politicians and the information at their disposal. While acknowledging that the advisory council has a limited remit, I do not think it could have done the modelling it did without playing around with different policy instruments. That needs to be out in the open and communicated. Otherwise politicians will run a mile and we will not get the climate action we need. I am not speaking about any member of this committee. They are all very committed. Outside of this committee, I would certainly suggest there is not the pressure that is needed. That is going to result in us failing to stick to this trajectory. As Professor Ó Gallachóir said, what is being set out is incredibly ambitious but we have no choice in this. I would be interesting in Professor Ó Gallachóir's or Dr. Donnellan's comments on the significant gap between the work the council is doing and what the politicians need to do.

I have a question for Dr. Hanrahan. I was interested in what he said about the model Teagasc is working with. It is very much an economic model. I would love to play around with it. Does the biodiversity challenge form part of the model? It is a great concern. We could make great strides in agriculture in mitigating carbon emissions but we could so while further devastating

biodiversity. Does or should Teagasc's model go there? Does it need to be developed further?

Professor Brian Ó Gallachóir: I will not speak on behalf of the Climate Change Advisory Council. I will defer to Ms Donnelly on that. I will give some of my own reflections on the question of these gaps. I agree with the Chairman that there is a gap between analysis and policy and another between policy and politics. The analysis-policy gap needs to be addressed first. It is interesting in terms of some of the broader work we do at the MaREI centre with Government Departments and politicians. The politicians and civil servants have different roles, interests and competencies. It is a fascinating area. My main comment would be that we need more of this interaction. The siloing of things is detrimental.

I agree that, more broadly, the penny has not dropped on what is required to achieve the ambition the Oireachtas has agreed on. I would add, however, that the other key element is wider society. As well as the policy system and the politicians, engagement with wider society is a significant requirement for achieving the ambitious transition we are discussing. The Citizens' Assembly was a landmark pioneering example of what can be done in that regard. There is research on different types of dialogue processes. It is not that these processes result in changes of mind. We are all in this together and there is this challenge. It is a question of how we grapple with it.

This links back to my earlier point about the gaps in the modelling. One aspect of the societal dimension is the modelling but the other is the engagement. That is the bit that I love. I will not digress too much on this. One example I draw to the committee's attention is a project in the Dingle Peninsula. I encourage the committee to visit it if possible. It is an example of how research, industry and civil society actors can come together to embark on transition. It started as a project to see how far things could go with technology adoption but it evolved into a much broader study of sustainability. If the committee cannot visit, I encourage it to invite some of the people involved to address members. That is a digression, however. I will pass on to Ms Donnelly.

Chairman: I did not quite catch that. The professor is suggesting we take a visit to where?

Professor Brian Ó Gallachóir: To the Dingle Peninsula 2030 project, a rural energy transition project on the Dingle Peninsula. It is an example of how industry, community development organisations and the research community have come together to support a community embarking on transition.

Chairman: Thank you for that. Dr. Hanrahan is next.

Dr. Kevin Hanrahan: I will provide a little more detail about the FAPRI-Ireland model. It is an aspatial partial equilibrium model and because ecological issues and the biodiversity challenges are definitely not aspatial, it is very difficult to have an ecological or biodiversity dimension to the FAPRI-Ireland model. Needless to say, Teagasc is active in this space. I will ask my colleague, Mr. Donnellan, to explain what we are doing to collect the information we would need before we would start to think about modelling this.

Mr. Trevor Donnellan: I am head of economics at the national farm survey at Teagasc. Biodiversity is very much on our radar and agenda. We have begun measuring what we call habitat biodiversity with a view to developing an index of habitat biodiversity for farms in Ireland. One of the weaknesses historically of biodiversity data in Ireland is that they have tended to be collected in an *ad hoc* way so we have information on biodiversity in particular pockets

of the country at particular points in time. It is not a good means of being able to talk about what biodiversity looks like at a national level on an ongoing basis to measure changes that are happening in the aggregate. It is something we are beginning to do. Historically, measuring biodiversity would have been a very expensive business because it would have involved sending people with expertise out to farms to see what was going on at those farms. Now, using remote sensing technologies this is becoming more affordable. Using an approach with the eye in the sky, which we have tested, has shown to be highly accurate in the case of habitat biodiversity. We will now have a capacity to show the different habitats that exist on different farm types in Ireland. This opens up opportunities to look at the relationship between those habitats, the types of activities happening on those farms and the farmers that are operating those farms That is part of the wider dataset in the Teagasc national farm survey. It is at the top of our list in progressing this issue. Once we have the data we can begin to model how these things might change over time.

Chairman: I thank Mr. Donnellan.

Senator Alice-Mary Higgins: My first follow up point is very important with regard to that Paris Agreement test being developed and used in the development of the budgets. I wish to be clear about the Paris test and the assumptions in it. I am not just concerned about it because it is climate unjust, for example it assumes that Malawi, which has 0.3 tonnes of carbon per person, has the same responsibilities, capacities and path as Ireland, which has 8 tonnes per person. It is not the injustice that I am only concerned about. I am very concerned that two factually inaccurate assumptions, namely that every country in the world has the same starting point and that they will reduce emissions at the same speed and amount, are being used for the scientific modelling. That is my ultimate concern. The section in which the Paris Agreement test as developed, is being used in section 4.213 of the technical document, which compares the temperature impact of the carbon budgets with the 1.5° goal. That is the core of the whole thing. Are we going to do enough to get global temperatures down to 1.5° if there is an area forming in which we need really hard science scientific input and not assumptions that we know are not true? That is used to develop table 4.4, and then table 4.4 is used as the basis for the council saying that they have complied with the legislative of criteria of 1.5°. I am very concerned about that. There is a lot of other amazing work that has gone in. I have seen inputs and there are a lot of great facts and evidence out there. I must, however, strongly indicate my concern about this Paris test. I do not believe-----

Chairman: The Senator's question is clear.

Senator Alice-Mary Higgins: My final point on this is that I am happy to have this in writing, because I know that people have already responded.

My other point is a simple factual straight question. I raised this issue previously with Ms Donnelly when she spoke to us. My concern is that the climate action plan seems to suggest that many of the actions relating to forestry specifically might bear fruit in the post-2030 period but in order to incentivise activity provision could be made to account for the committed emissions savings in a shorter timeframe. I was very concerned about that and I looked at the letter sent by the council. This is something that the council had sent. Even though new trees would only have most of their sequestration potential after the period of 2030, in order to incentivise activity provision could be made in regulation to account for the committed removal in a shorter timeframe. I want to be very clear about this. One of the previous inputs that gave me some assurance today said that future forests planted now will not contribute to these carbon budgets but future budgets. Is there any suggestion with regard to the trees planted now that their future

removals after 2030 would be counted in the 51% and the specific tonnage targets that we have for each of the next five year budgets? Perhaps I could get a clear answer on that.

Chairman: I thank Senator Higgins. Was Dr. Hanrahan indicating to come in on that? No. I call on Professor Ó Gallachóir.

Professor Brian Ó Gallachóir: I will ask Ms Donnelly to come in on that also. We have discussed the Paris test but the Senator is asking for something quite precise and perhaps it would be better done in writing.

On the other point, about the climate action plan, the carbon budgets committee did not have a specific focus on the climate action plan but Ms Donnelly may like to add to that. Essentially, we focused on the legislation remit around the carbon budgets rather than the policy instruments to deliver those.

Senator Alice-Mary Higgins: I am specifically asking, in relation to the carbon budgets, if the forests planted during this budgetary period would be counted within this budgetary period or would they only be counted when the sequestration has actually occurred?

Chairman: Is the Senator asking if that suggestion came from the Climate Change Advisory Council?

Senator Alice-Mary Higgins: I know it did. I have read the document whereby it was mentioned, but part of that document also talks about other incentives, which I would certainly support. I just want to know if it is part of the calculations.

Ms Marie Donnelly: I have been following with great interest the discussions until now and indeed I want to come in on a few points. I was making a list for later.

Specifically, I would like to come back to Senator Higgins on the two issues that she has raised. On the Paris Agreement question and that part of the document, I will be very honest with the committee. That part of the document is very technical. Personally, I found it very difficult to follow it and to understand it. The key issue that we as a council insisted upon was that we would meet the temperature objectives and goals required of Ireland out of the Paris Agreement. In other words, we took the 1.5° temperature as an obligation on Ireland to achieve as part of our contribution to a global action for climate change. Members will see from the very beginning paragraph of that section, we took the view that we had to contribute at least to that. Therefore, with each of the scenarios we looked at we asked if these will keep us below 1.5°? Forget where we start from and forget everybody else, will these keep Ireland's contribution below 1.5°? I will caution with one small point. With regard to those graphs, the numbers that are degrees to the power of ten must be read a little bit carefully because they are not actually temperature degrees. They are not degrees of 1°, 1.5 °,2° or whatever the case might be. It is actually degree changes. We asked the scientists to forget where we are starting from and to forget everybody else. The question we asked was "Will the budgets we are proposing keep Ireland's contribution to the 1.5° of Paris?" The answer to that was "Yes, with one exception." That was the extreme instance where the energy scenario went to 69%. All of the other budgets keep us to the 1.5°. That was the key issue. As the committee is aware, the Paris Agreement is about more than temperatures. There is also social justice, food supplies, and equity across all of the communities globally. There are many aspects to the Paris Agreement but this is the one we felt that we really must focus on and was a litmus test by which Ireland would verify in this carbon budget that it would not exceed the 1.5°. That was the analysis we put in at that stage.

The second point was a letter that was sent by the council to the Department on foot of a query from the Minister. The Senator will recall the discussions that took place in the Oireachtas on the last-minute changes to get clarification regarding the removals, and the decision that was ultimately put into the legislation that there would be regulations adopted. The Department sought the advice of the committee in terms of the regulations that would be adopted prior to the budget being recommended by the council. We sent a letter of reply. I believe I said when I was speaking before this committee on the previous occasion that the discussion that took place during all of August last year came as something of a shock because I, and I fear many people like myself, had not realised that our forest sink was degrading and likely to disappear between now and 2030. We will, therefore, find ourselves in an extremely difficult position not just for 2030 but indeed if we project out to 2050, as Dr. Styles has been talking about, where if we do not have sufficient forest and forest sink we would not be able to achieve a net-zero position by 2050. That was the situation we were confronted with in August. We looked at it and said that biophysical processes are what they are. Even if we planted half of Ireland today, we would still not have the emissions sink in place by 2030 because it takes 15 or 20 years for the tree to grow and start to absorb. We were in a position where, frankly, there was absolutely nothing we could do on the day.

We have two choices then. We say that we are sorry we are in a hole and let us keep digging or we say that we are in a hole and we have to start to address the problem. We said to the Department that it needs to build in incentives for afforestation roll-out across the country and if that means looking at some sort of a carbon credit system that would incentivise afforestation, the technology calculations from a scientific perspective would allow that to be done. However, it was absolutely fundamental that we did not double count. It is like what we are saying in the legislation that we have a carbon budget 1 and a carbon budget 2 and we can effectively carry over from one budget to another. If we exceed the target in the first budget then it makes it easier for the second one and, unfortunately, *vice versa*, if we do not achieve it the first budget, it actually gets carried over to the second budget. The same logic is needed to incentivise afforestation. There are scientific methods that can be used, if needed, to calculate what that carbon credit could be. The fundamental issue is that carbon credit cannot be counted twice. That is what we said in our letter to the Department.

As it happens and as the Senator knows, the regulations that were adopted, I believe in the beginning of October, do not in fact address this issue. I do not know if it is a matter that the Department is still considering, or considering for future purposes, but that is the rationale and what we said in our letter, given the analysis that we did. Dr. Styles was being polite in some of his comments. I hope that I was a little clearer on my earlier appearance before the committee but I will certainly be clearer today. We are in a serious hole in respect of our afforestation rate in this country and it is an immediate and urgent challenge to get the policies right to reverse that. Otherwise, so much of the other work that we do will be unsuccessful because we have to have a sink in place. We have the land opportunity and the knowledge of how to do it and that is one of the highest policies on our agenda right now.

If I may, Chairman, I will come back to one of his other questions perhaps at the end.

Chairman: Yes, that is fine. I see that Dr. Daly is indicating.

Dr. Hannah Daly: I would like to perhaps offer some clarifying points on the Paris test and on the top-down assessment to the Senator. The question on the Paris test is a very good one as to how we assess the compliance of different carbon budgets against the Paris Agreement.

To be clear, first, the modelling was led by the requirement for emissions to reduce by 51% by 2030. That was the bottom-up scenario that was given and is fundamentally where the carbon budgets that were recommended came from. The council then assessed the implications of those budgets against the global carbon budget on how much the potential global carbon budget was for different temperature limits. The Paris test is one such way of doing that. The carbon budget fellows Andrew Smith and Paul Price did literature reviews. It was very clear that the assessment of what is the fair share against the Paris Agreement goals is very normative. It requires an assessment of what the temperature goal is. Are we going for 1.5° or well below 2°? What is the likelihood that we want to achieve that goal? This is a very different global carbon budget if one has a 66% chance of meeting a 1.5° target versus a 50% chance of well below 2°.

Another issue Senator Higgins alluded to was the fairness of this. Do we divide that global carbon budget on a *per capita* basis? Do we, for example, take into account historic responsibility and capacity? Then also, what is the starting point? Even if one has a starting point at 2015 versus 2020, the fair share for Ireland is very different.

The carbon budgets that were assessed are the cumulative emissions over the next ten years. We also have to take into account a number of different factors when measuring their assessment towards the global carbon budget. What is the speed of decarbonisation post-2030 and what is the scale of negative emissions that can be achieved once we get to net zero, which would potentially offset the positive emissions in the next ten years?

What is also very important is the measurement of the relative impact of methane emissions. We are almost unique as a developed country in having a high share of methane emissions and the metric used to assess the ongoing warming impact of methane creates a very different answer. I wanted to clarify that there is not just one solution but there are many different effects and the council assessed that the Paris test was the mechanism that required the fewest normative judgements.

Chairman: I thank Dr. Daly and Senator Higgins.

Senator Alice-Mary Higgins: I did not get the answer, Chairman, to one question. I am glad that the regulations do not include the full counting but I wanted to ask because it would mean that we were not compatible with the 51% in 2030 in the legislation if emissions are sequestered from after 2030, was this potentially being modelled or calculated in the carbon budgets tonnage. Again, it sounds like that is perhaps not happening but I would like a written assurance on that because that fundamentally affects whether we are consistent with the law.

Chairman: I thank the Senator and I believe Ms Donnelly is keen to come back on that point.

Ms Marie Donnelly: Yes, on that point I refer the Senator to the letter. The letter came in two parts. One was in regard to the carbon budget and the second was a more general comment on what we discovered on land use and afforestation. What she has referred to was in the second part and was not a sectoral comment.

Senator Alice-Mary Higgins: These are groups two and three and are referred to by the Minister as to how the sectoral ceilings might be reached. The sectoral ceilings when they all add together only barely get us to the 51%. There is a knock-on concern for the sectoral ceilings in their credible relationship with the 51%. We will probably come back to this again.

Ms Marie Donnelly: As I say the first part of our letter was specifically addressing the car-

bon budget and it was the assessment report 5 and the global warming potential 100 standards to use. Again, this is not intended to be an evasive answer, but ultimately the sectoral ceilings will be a decision for Government.

Chairman: I thank the Senator and Ms Donnelly.

Senator Alice-Mary Higgins: Incentives are wonderful but we should never adjust the facts and should try to find other incentives.

Chairman: I thank Senator Higgins and call Deputy Christopher O'Sullivan.

Deputy Christopher O'Sullivan: I thank the Chairman. I have two further brief further questions. I will put my first to Professor Ó Gallachóir. Judging by the contributions from witnesses so far there appears to be a high level of consensus and agreement. During the process of coming to the proposed carbon budget and the 4.8% for the first period and the 8.3% for the second period, what level of agreement or consensus was there among the carbon budgets committee members? Was there much debate? I do not want to land Professor O Gallachóir in it or anything but I am just wondering how difficult was it to come to a consensus on the proposed budget between the entire carbon budgets committee membership?

My second question follows on from the Chairman's question on biodiversity. Professor Ó Gallachóir's opening statement and responses on how the proposed carbon budget was arrived at referred to just transition, economics and economic viability, social issues, etc. How much attention was given to the potential impacts on biodiversity and the potential role of biodiversity in achieving these targets?

Professor Brian Ó Gallachóir: I thank Deputy O'Sullivan for that easy question. I suspect this committee has produced reports previously and they are presented in a certain way. I presume the discussions leading up to the development of those reports are robust. This reflects what happens in the committee. We have many things to grapple with and various people on the committee have various levels of expertise in each of these areas. In arriving at a consensus I would have been disappointed if there was not robust discussion on the analysis or if there were no differences in perspective and viewpoints. Sometimes in our discussions, as would be expected, we veered. If we were looking at sectoral emissions targets and pathways, we might start talking about the interactions between them in the context of discussions relating more to the implications for sectoral emissions savings but they were not part of our remit. My sense, and others can feel free to contribute, is that everyone participated with the perspectives, analysis and viewpoints they brought to the table. From my perspective, the discussions were very robust and productive. At the start of the process, I did not anticipate we would be able to arrive at the point we did with the report within a six-month period. There were very robust discussions but there is a strong consensus on the final report.

We got some analysis on biodiversity and it is contained in the report. It is not my area of expertise. It is an area we were anxious to include in the analysis. A challenge was to grapple within the six-month period with all we had to grapple with and, at times, to identify and be able to draw in the analysis as we would have liked to have had if we had a longer time period. We certainly included some analysis on the biodiversity implications included in the report. Perhaps Mr. Donnellan can answer this.

Mr. Trevor Donnellan: I will try to be as brief as possible. There is a high level of awareness of the four friction points between agriculture and the environment. These are greenhouse

gases, ammonia, water quality and biodiversity. One of the points made clear in the discussions we had was that some of the solutions in respect of climate need to pay heed to biodiversity issues. We need to look at the solutions and troubleshoot them or validate them in the context of what they mean for biodiversity. In an ideal world we would like to imagine a situation where solutions on climate are also optimal solutions for biodiversity. I suggest that might not always be the case and there may be the need for consideration of the trade-offs between solutions that might deliver heavily with respect to climate and might not be as successful as other solutions with respect to biodiversity. This will come down to choices.

Going back to my previous intervention, I would say having data to tell us about what is happening at a national level in respect of biodiversity will be particularly important. We need to measure properly to understand how it is changing over time and how interventions with respect to providing climate solutions are also affecting biodiversity.

Chairman: I am aware I might be pushing the witnesses to comment on matters outside their remit but I would appreciate any insight they have. I was putting together my submission for the greater Dublin area transport strategy yesterday. The greater Dublin area accounts for approximately one quarter of all of our transport emissions. The proposed target, as set out in the draft, is to reduce these emissions by between 30% and 40%, not by 2030 but by 2040. It struck me that if this is the level of ambition set out by a State body for carbon mitigation in what accounts for a significant portion of our transport emissions, I would be fearful about our sincerity in tackling climate change. Is there a role for the Climate Change Advisory Council? I know it is probably separate from the work the carbon budget committee has done but it is related. I suppose the carbon budget committee has engaged extensively in the modelling and there may be views among the members on this particular point. I would be very interested to hear them. I do not know whether this is a fair question but I ask Professor Ó Gallachóir to have a go.

Professor Brian Ó Gallachóir: Any question is fair but what is within our remit to answer might be different. I will not comment on the specific greater Dublin area proposal because it goes beyond the remit of what we were asked to do in terms of arriving at the proposed carbon budgets. The level of ambition the Chair mentioned reflects the challenge. Some of the earlier points that came up in discussion go beyond the remit and go to the next stage of what happens next. The carbon budgets need to be approved, the sectoral emissions ceilings need to be developed and approved and there needs to be a policy roll-out that can enable delivery of this. Our focus was on the carbon budgets. There are a lot of examples of policies that are implemented and developed that indicate the penny has not dropped. With regard to the role of the advisory council on aspects such as this, I am not in a position to answer. I do not know whether Ms Donnelly or other members of the council would be interested in answering that question.

Ms Marie Donnelly: I will respond on that specific question. To some extent it jumps a little towards the end. The legislation sets the ambition for Ireland. It sets up the carbon budget and the structure that will put in place the sectoral ceilings. It also puts mandates the Climate Change Advisory Council to conduct, as part of its annual review, an assessment of where we are on achieving our budget by sector. This is a new mandate for the council. It is one we are structuring and putting in place. It means we will be following each of the sectors individually as part and parcel of our annual review process. Without pre-empting what will be in it, I will take heating as an example. It has been debated at great length today and represents almost 40% of our emissions. There are a number of issues to consider. Where are we starting from? What are the policies in place? Will the policies deliver? Are they being put in place to deliver?

Are they sufficiently ambitious to lead to an outcome? We are developing a number of indicators that can be used across each sector to precisely monitor and track the performance of the sector against its sectoral ceiling. The Chair mentioned the greater Dublin area targets, which would classically be one area. I have not done the analysis so cannot comment specifically. However, where the ambition of a policy falls so far short of a sectoral target, that kind of issue will be called out by the Climate Change Advisory Council as part of its annual review.

Chairman: I welcome those comments. We will go into a quick third round. I am keen to give Ms Donnelly a few minutes at the end, as she requested. Will five minutes be okay?

Deputy Darren O'Rourke: I have a question on the assessment of the investment required for transition. I am looking at the technical report. How was that assessed? Table 3.4 has reference to taking €5 billion as the average per annum upfront investment required. Where does that €5 billion come from? On my read of the 51% reduction, it looks more like €10 billion. I seek information on that as to whether I am reading it the wrong way round.

Deputy Richard Bruton: I thank the witnesses for the interesting contributions. Did the CCAC have the need or opportunity to consider how this trajectory will impact Ireland as a small, open trading economy in terms of competitiveness? How do we need to think about that? It comes into sharp perspective when you see the price of gas for us versus in the US versus in Germany. Will there be tensions as we adopt these policies? How will we contend with that?

I was impressed with what Dr. Styles talked about regarding integrated solutions. Many of the changes we will have to undertake can be easily seen as zero-sum games for players in the sector who believe they will lose X or Y, that diesel cars are going or that they will have to cut their herd. It creates all these negative vibes. How do the witnesses structure the thinking about integrated solutions? We work in silos. Agriculture probably has not thought about how forestry in many years' time will be a valuable asset from a national point of view. That does not factor into agricultural policy today and we are losing an opportunity. How do we create the integration mentioned?

I know Ms King has been involved in the NESC. That council had a paper some time ago which impressed me and which referred to the need to talk about this in terms of resilience. It is about how our farm or business can be resilient in ten years' time. That puts this challenge into a perspective that people can get their heads around. They do not want to see their farm being a stranded asset in ten years' time because they did not make the changes today. Apart from using the language of resilience, would the witnesses suggest ways we can create that new insight?

Deputy Cormac Devlin: I thank the witnesses for all their work to date. As a precursor to their work, we had to navigate the Bill in pre-legislative scrutiny so we feel their pain over recent months. The fact they had met more than 15 times by September, despite the pandemic, is to be commended, because I am sure it is not easy with everybody coming from across the country. I apologise for not coming in earlier, I had another meeting.

Professor Ó Gallachóir mentioned the issue of transition and monitoring the pace of change in various sectors and Departments. I apologise if this has already been asked, but will he outline how that will be monitored for the purposes of the annual review? He mentioned in his opening statement the offsetting of targets within sectors and how that might be done. I think he mentioned negative targeting. Will he elaborate on that?

With regard to just transition, will Ms King speak on how the monitoring of potential dis-

placement within sectors will be done and how it might impact on workers?

Senator Alice-Mary Higgins: It is about the question I finished on. I would note that we have a recommendation from our committee on the carbon dioxide piece. I think it was recommendation 48 in the Bill originally that the calculation, production and revision of carbon budgets should not rely on anything beyond what is measurable in the timeframe of the budget.

I want to ask about sectoral targets or sectoral ranges. Is there concern? Should those ranges be revised so the sectoral ceiling or the amount that will add up to 51% is sitting in the mid-point of the ranges, rather than the current scenario whereby it is only if everything works out perfectly in every sector that we achieve the 51%? That is fundamental because, as we have heard, there are a lot of assumptions there around the development of future technology that might make removals easier in some sectors and around business incentives and how they might or might not work.

As well as modelling of potential positive inputs in areas like removals, has there been modelling of further shocks to the system, for example, if the Thwaites Glacier was to go within this timeframe? That is an advantage of having a range which gives some wriggle room for doing better. It also means that if the external scenario disimproves, there is scope for us to still be on track for 1.5°C.

Will the witnesses comment on the sectoral ranges and on whether they assessed future shocks in the period of the three budgets?

Professor Brian Ó Gallachóir: Deputy O'Rourke asked about investment and Dr. Daly is best placed to answer that. On Deputy Bruton's question, we explored the impact on competitiveness. A bit like what was mentioned earlier in terms of employment, there are positives and negatives. It relates to the resilience question because if you look at how exposed we are to international fossil fuel crises, that exposure is increasingly limited as we migrate away from fossil fuels. The impacts on competitiveness are hugely complex. Professor Ryan might want to come in on that.

On integrated solutions, I agree fully on the need for these. This reflects the discussion we had earlier, not so much unifying the models but looking at how outputs from some models interact with others. That would be a useful way in which the modelling could contribute to more integrated solutions.

Regarding how to communicate the resilience, the resilience point is supported by NESC. There are many ways in which the communication of this and making some of the implications tangible are critical to farm businesses and others. The communication is the critical part. Modelling can help in providing some analysis of the impacts of certain decisions, but the communication of the resilience would be an add-on. Certainly, the modelling results could help to provide some of the inputs on how the resilience might be communicated and framed.

Deputy Devlin asked about the pace of change with the transition, which is an enormous question because there are so many aspects to it. At many points we have asked whether the penny has dropped yet in the policy system and in the political system. Has the penny dropped in different sectors in business? Has the penny dropped across society? My sense is that it has not because otherwise we would be in a different place than we are now. Critical to the pace of change is the penny dropping. Policy making in the political area is critical to enabling the pace of change to accelerate towards the transition.

Monitoring of the budgets goes beyond the remit of the committee; the chair of the advisory council might come in on that.

I was not quite clear about the question on offsetting targets. Essentially, we looked at different levels of ambition across different sectors. We looked at the expectations of different sectors achieving different levels of ambition in scenarios where the collective met the overall ambition. That informs trade-offs but it is not something we looked at in detail.

We had access to some information and data on negative emissions. For the period up to 2030, apart from negative admissions from forestry, which we have already discussed, negative emission technologies in terms of carbon capture and other aspects would be for a later period.

Senator Higgins asked about the central targets and ranges. I think she was talking about the climate action plan, which was not part of the committee's remit but it is something that the council reflects on in its annual review. I am aware that the climate action plan is an annual iteration. Therefore, it will evolve and change. Certainly, the next version will take into account the carbon budgets and the sectoral emission ceilings if those are finalised.

Senator Alice-Mary Higgins: Professor Ó Gallachóir just mentioned-----

Chairman: We do not have time. Professor Ó Gallachóir may go ahead.

Professor Brian Ó Gallachóir: The Senator talked about the geophysical system. We did not do any modelling on the science because we were focusing on the response more than the science. We did not model shocks to the energy system or agriculture explicitly. The levels of ambition we are talking about will develop their own, not so much shocks, but significant changes. We tried to model a range of scenarios to provide some useful information on the scale of what might be achieved. However, we did not specifically model shocks to the system. That provides a cursory overview.

Chairman: I appreciate we probably do not have sufficient time to answer those questions adequately. I thank Professor Ó Gallachóir for his efforts. I know some of his colleagues wish to speak before I call on the chair at the end.

I see that Deputy Bruton has his hand raised, but we do not have time to bring him back in.

Ms Patricia King: Deputies Bruton and Devlin spoke about resilience. One part of the resilience piece will depend on how prepared we are and how prepared the economy is. We need to get ourselves ready for the reconfiguration of the economy as it will take place over the budget periods. Some of this we do not know about, but some of it we do. For example, the goal is to convert to 1 million electric cars over the period of the Government's plan. Given the type of engines that we use now we have many car mechanics who are not skilled in the electric vehicle area. We know that now. As the Deputy knows, I have no prowess in terms of models or anything else. However, it would not take a genius to work out that as we fill the place with electric cars, we will obviously greatly reduce the number of diesel and petrol cars. We could be getting ready now to train all those mechanics to become adept at what they will need to do with electric vehicles. We have not started to do it, by the way. Those are policy issues that need to be dealt with. We should be doing it now because we know it will happen.

The same applies for heating radiators. If the policy requires houses to have heat pumps and not have radiators, people engaged in making those radiators in factories at the moment will all need to transition to making heat pumps. We do not make heat pumps in Ireland, but we should.

We have opportunities to invest and to develop all that stuff. We have the knowledge that we need to have even at this stage at an elementary level which is all I am talking about. We have that level of knowledge which should guide policy development to prepare ourselves for our resilient economy so that when the day comes and people no longer want to buy radiators, all the people who are working on that will be retrained and will know how to produce a heat pump.

That is not pie in the sky. It is called preparedness and it is also called building the resilience in the economy so we do not end up with a whole load of redundant people and asking ourselves why we did not do this or that. That is what I call preparedness.

The council now has the remit for the annual review. As council members we should be asking questions in the various sectors as to how we are achieving those targets and what the consequences are for jobs and so on. I have no scientific background and have very little to offer on that. However, I would see my role as asking those questions at the council so that we can provide good advice to the Government. After that, it is up to the policymakers.

Chairman: I thank Ms King for her very valid and original insights. We are running slightly over time, but I will now call Professor Ryan followed by Dr. Daly after which we will hear from the chair, Ms Donnelly.

Professor Lisa Ryan: I wish to elaborate on what Ms King suggested. It is really talking about the level of investment that will be required. More modelling certainly needs to be done on the macroeconomic impacts. We are talking of a figure of €50 billion and how that is split. For example, in the power sector, we are talking about €30 billion. There is a question regarding competitiveness. What we really need to think about is capturing a lot of that value chain domestically. Ms King spoke about producing heat pumps in Ireland. We can look at employment numbers we have so far. A total of 15,500 people are involved in the sale of auto fuels. What are those people going to do? A total of 15,500 people are employed in metals manufacturing. We know that about €25 billion needs to be spent on wind. A good portion of that will be spent on wind turbines. Consoles must be manufactured here but €6 billion will be spent on the construction of those wind turbines. I am elaborating on Ms King's point. We need to split and do a lot more modelling on the capital investment and some of the labour investment. In particular, we need to watch the construction sector very carefully because it is already very tight. We have targets for building new houses, deep retrofits and shallow retrofits. Some of those investments are going to be on labour while others will be on the actual technology going into that housing.

Regarding spatial awareness, particularly in the residential sector, we know that more than half of D-rated properties on the building energy ratings register in Ireland are to the west of the country. Most A and B-rated properties are around the Dublin area. If we are talking about retrofitting, we are going to end up focusing on rural Ireland so many of the construction jobs will be scattered geographically. These are important points to think about as we get into implementation. We need to make sure our investment is spread.

I am getting into another area here in asking who is going to pay for this. How much will be public cost and how much will be private? A lot of work needs to be done in this area and we would be happy to contribute to that at some time in the future.

Chairman: Our session on Thursday will probably go much deeper into this discussion. I encourage Professor Ryan to tune in for that. Does Dr. Daly wish to respond?

Dr. Hannah Daly: Regarding investment costs, the table Deputy O'Rourke asked about is the upfront total investment cost in the energy system, which ranges from €5 billion to €7 billion per year on average for the next decade. I wish to clarify that this does not take into account the huge savings in reduced fossil fuel consumption that is brought about by different scenarios because of efficiency, replacing it with renewables and demand reduction. It is the upfront cost rather than the average cost over the lifetime of an investment. It is about how much finance is needed over the next decade. If we average it out, it is around half of that or less because much of the investment will replace investment that would be needed in any case in the business-as-usual scenario or lower climate action scenario and will have a longer lifetime over the next ten years.

Ms Marie Donnelly: I thank the Chairman and other members of the committee for the opportunity to have this conversation following on from the previous one we had a couple of weeks ago. They can rest assured that the council and the carbon budget committee members are entirely at the disposal of the committee for any questions it might have or any analysis that would be of benefit to it. The committee should not hesitate at any stage to make contact with us. We will certainly try to facilitate that.

I return to the earlier question about the connection between science and policy and between policy and politics. If I stand back and look at where we are in Ireland, first, we have set ourselves a really ambitious target. As Professor Ó Gallachóir has said, we have about the second highest ambition globally at the moment. We have even put it in legislation and set out a mechanism to have a roadmap with milestones to achieve that. A milestone in this context is the carbon budget and it is built on science. I hope the discussion today has illustrated the depth of scientific expertise that has been brought to bear in terms of the carbon budget recommendations that have been made. Again, I express sincere gratitude to all the members of the carbon budget committee and their colleagues behind them who have supported the work on and development of the proposals we were able to come up with at the end of last year.

The next step, hopefully, is the finalisation of the carbon budget but, equally, the policies necessary in order to travel this road of transition to achieve its objectives. Already, the Chairman has pinpointed the necessary element in the legislation, namely, the feedback loop mechanism. That is built into the legislation and this is the mandate the committee has placed on the shoulders of the council. We came out with some preliminary comments in our annual review in November gone by but we are now putting in place a structured approach to each of the sectors to monitor and assess their performance on an annual basis *vis-à-vis* the sectoral ceilings. This process will run on an ongoing basis and be reflected not just in punctual comments by the council, and there will be punctual comments, but as an intrinsic part of our annual review process.

To return to an earlier question because it is important that we link this, this transition is really about the hearts and minds of people. We can have market mechanisms, regulations and technologies but if the hearts and minds of the population of the country are not fully engrossed in this exercise in the way that they feel it is part of their future, not just a political or policy objective, and it is something people want for themselves, their families and their future, we will not be able to do it. In that context, one of the challenges we have is translating all of the science we were talking about today into some sort of vision that is entirely understandable by everybody in the country. What does 1 January 2050 actually look like in Ireland? When we wake up - if we wake up that far head is a bit of question - what will Ireland look like? What is the vision we have for Ireland? In order to develop that vision, we need a lot of information and

we need to have a lot of dialogue with people in the country. We need to have the supports that will allow the people of the country to move in that direction - incentives, market mechanisms, regulation and technology.

Perhaps one of the most important issues, and I say it today because I think it is the right place to say it, is the fact that we need leadership. This is the link between science, policy and political parties because at the end of the day, our politicians are our leaders who will set the pace, direction of travel and ambition we will achieve in this space. In that context, the Chairman asked a very pertinent question because the logic is that we should use the science and have the policy mechanism but, most importantly, we need the leadership. In that context, I assure the committee that both the council and the members of the carbon budget committee are available to support it now and as we go forward on this journey. Members should not hesitate to come back to us with any questions they might have. We will be delighted to support and continue the dialogue with this committee.

Chairman: I thank Ms Donnelly for those words, which underline the challenge we have. As she said, this process involves incentives, technology, regulation. She is also correct, however, that it is down to hearts and minds along with leadership. All of us on this committee are working very hard but we have more work to do in convincing our colleagues across the political spectrum to take our society and political system to where they need to go.

This has been a very thorough and engaging session. I am looking forward to reading back over the transcript. There was so much in the discussion that stimulated me and, I am sure, members of the committee and members of the public watching. I hope there is significant uptake in the media because these are very important sessions. We will have three more meetings following today's session. I thank Professor Ó Gallachóir for leading his team today and for fielding so many of the questions. I thank all his colleagues as well for coming before us and giving us their expert insight, which is very important for us to hear. It will contribute greatly to the report we submit to the Government in a few weeks time.

The joint committee adjourned at 3.10 p.m. until 1.30 p.m. on Wednesday, 12 January 2022.