



Rialtas na hÉireann
Government of Ireland

Valuing Greenhouse Gas Emissions in the Public Spending Code

LAURA KEVANY

CLIMATE CHANGE UNIT, DPER

JULY 2019

This paper has been prepared by IGEES staff in the Department of Public Expenditure and Reform. The views presented in this paper do not represent the official views of the Department or Minister for Public Expenditure and Reform.

IGEES

Irish Government Economic and Evaluation Service

Executive Summary

- In November 2018, the Department of Public Expenditure and Reform issued a consultation paper on valuing greenhouse gas emissions in the Public Spending Code.
- The consultation paper proposed changing the methodology for the valuation of greenhouse gas emissions in the Public Spending Code from one based on the market value of allowances in the EU Emission Trading System (ETS) to one based on the estimated marginal abatement cost that Ireland will face to reduce greenhouse gas emissions to reach binding EU climate targets.
- Nine responses were received to the public consultation from a variety of sources. The responses broadly agreed that moving to a shadow price of carbon based on an abatement cost model was the most appropriate methodology for capturing the greenhouse gas emissions impact of public investments.
- The most common reservations expressed in the responses received were around the appropriateness of using abatement costs derived from costs in the energy sector as a proxy for the economy as a whole, the use of separate values for greenhouse gas emissions in the ETS and non-ETS sectors and the consistency of the shadow price of carbon over time. Section 3 of this paper summarises the responses received over the course of the consultation.
- Section 4 of this paper sets out the Department's response to these observations. To summarise, on balance, the Department has concluded that it is appropriate to alter the methodology for valuing greenhouse gas emissions in economic appraisals along the lines set out in the consultation paper. The specifics of this approach are set out in Section 2 of this paper.
- It is important to note that despite relying on abatement cost projections from the energy sector for the valuation of greenhouse gas emissions, the Public Spending Code applies to all public economic appraisals and hence takes into account emissions from all sectors of the economy.
- A circular will issue from the Department of Public Expenditure and Reform alongside the publication of this paper. This circular will confirm the changes to the Public Spending Code and make the revised arrangements for valuing greenhouse gas emissions mandatory for use in all public sector economic appraisals.

- However, the Department has incorporated some of the views expressed in the consultation into future work streams planned for the Public Spending Code.
- The view was clearly expressed that public sector bodies would benefit from practical guidance on incorporating the shadow price of carbon into appraisals. As such, DPER will develop and issue practical guidance on this in the second half of 2019. This guidance will provide examples to illustrate the practical steps that public bodies should undertake to measure and value changes in energy use and the associated greenhouse gas emissions in economic appraisal.
- As climate research is a rapidly evolving frontier, both domestically and internationally, it appears appropriate to keep the shadow price of carbon under more regular appraisal than the other technical factors underpinning the Public Spending Code. DPER will commit to keeping the shadow price of carbon under more frequent review than other technical factors.
- In addition, as committed to in the new Climate Action Plan, DPER will commence a broader review of the environmental characteristics of the public spending code in Q4 2020. This review will examine the practical difference the revised shadow price of carbon has made in public project appraisal, determine whether further reforms are necessary and will consider the scope for the inclusion of other environmental factors and potential co-benefits in future iterations of the Public Spending Code.

Section 1. Introduction

As part of the process of updating the Public Spending Code, the Department of Public Expenditure and Reform (DPER) conducted a public consultation on the proposed amendments to the methodology for Valuing Greenhouse Gas Emissions in the Public Spending Code in November 2018¹.

This consultation closed on the 14th of December 2018. The Department received 9 submissions to the consultation. These have since been considered, conclusions have been drawn, and the views have fed into the process of updating the Public Spending Code. This decision paper gives a brief summary of the submissions received, the Department of Public Expenditure and Reform's responses to the views expressed in these submissions and details the final changes to the Public Spending Code on the valuation of greenhouse gas (GHG) emissions.

Section 2. Changes to Public Spending Code

The section details the revised procedures that will apply to all economic appraisals conducted in the public sector. These changes will be confirmed in a circular from the Department of Public Expenditure and Reform and the changes will be published on the Government's website².

Under the new circular it will be mandatory for all economic appraisals to value emissions from the "basket of seven" greenhouse gases. These emissions must then be valued according to the estimated abatement cost that Ireland will face to reach binding climate targets. Where it is deemed that there are no greenhouse gas emissions associated with an investment, the appraisal must include a statement setting out how this conclusion was reached.

In addition, it is now also mandatory for economic appraisals to consider and value any emissions of non-greenhouse gas emissions that may affect air quality (NOX, SO₂, PM and NMVOCs). It also recommended that appraisals continue to place a value on noise where appropriate.

The following tables detail the revised procedures that public bodies must follow and the values which must be used in any economic appraisal.

¹ <https://igees.gov.ie/wp-content/uploads/2018/11/Valuing-Greenhouse-Gas-Emissions.pdf>

² At <https://publicspendingcode.per.gov.ie/> & <https://www.gov.ie/en/publication/public-spending-code/>

Table 1: Valuing greenhouse gas emissions

Valuing greenhouse gas emissions in economic appraisal	
1	<p>Economic appraisals are required to value emissions from the “basket of seven” greenhouse gases which can be converted into CO₂e (carbon dioxide equivalent) using GWP (Global Warming Potential) conversion rates – Carbon Dioxide (CO₂), Methane (CH₄), Nitrous Oxide (N₂O), Sulphur Hexafluoride (SF₆), Hydrofluorocarbons (HFCs), Perfluorocarbons (PFCs) and Nitrogen Trifluoride (NF₃) - where emissions are considered relevant, significant and practicable for inclusion. In any cases where emissions are not considered to be relevant, significant or practicable for inclusion, public bodies should note how this conclusion was arrived at in the economic appraisal.</p> <p>These emissions should then be monetised according to the shadow price of carbon, differentiating between non-ETS emissions (Table 2) and ETS emissions (Table 3).</p>
2	<p>Economic appraisals are required to monetise the value of emissions of other specified non-GHG emissions (NO_x, SO₂, PM and noise) where such emissions are considered relevant, significant and practicable for inclusion. In any cases where emissions are not considered to be relevant, significant or practicable for inclusion, public bodies should note how this conclusion was arrived at in the economic appraisal.</p> <p>These emissions should then be monetised according to the values for non-greenhouse gas pollutants included in this document.</p>
3	<p>Greenhouse Gas Emissions should be converted into CO₂e using the latest available and Intergovernmental Panel on Climate Change adopted conversion factors for GWP³.</p>
4	<p>The shadow price of carbon for non-ETS emissions (Table 2) is based on the estimated cost to Ireland of removing emissions from the atmosphere i.e. the abatement cost. The shadow price of carbon for ETS emissions (Table 3) is based on market projections to 2025 and official EU Reference Values thereafter.</p>
5	<p>For monetising the other specified non-GHG emissions recommended for inclusion in economic appraisal (Particulate Matter with a diameter of less than 2.5 micrometers (PM_{2.5}), Nitrogen Oxide (NO_x), Non-Methane Volatile Organic Compounds (NMVOCs) and Sulphur Oxide (SO_x)), recommended values, based on EU reference values, are provided in Table 4. The PM_{2.5} values are disaggregated by rural, suburban and urban exposure, to reflect the increased damage costs in more densely populated areas where human exposure is higher.</p>
6	<p>The introduction of a carbon tax impacts on the appropriate price of CO₂e for inclusion in economic appraisal. The shadow price is used to account for the external costs associated with CO₂e emissions. If this is partially or fully internalised in the product or input purchase price through the carbon tax then the price needs to be adjusted to</p>

Notes:

CO₂e emissions from inputs/materials purchased from organisations/facilities/installations with the EU ETS sector should not be included in the quantification of emissions for a project scenario as this would be double counting.

Direct CO₂e emissions from sources within the State’s jurisdiction, including those from direct construction and operation should be included in CBAs bearing in mind not to double count. In certain instances consideration may need to be given by project managers to indirect emissions.

³ The Group recommends the 100-year Direct Global Warming Potential (GWP) values from IPCC AR4 as the best measure currently available to convert other gases into CO₂e. See Annex 1 of report for the latest Direct Global Warming Potentials from IPCC 4th Review (AR4). The latest available and IPCC-adopted conversion factors for the GWP should always be used. These were revised as part of the IPCC’s 5th Review (AR5).

	reflect this and avoid double counting. This readjustment should be performed by deducting the current level of the carbon tax (€20 a tonne) where it is included in costs.
7	CO ₂ e emissions from materials directly attributable to the construction phase of a project which are purchased from organisations/facilities/installations operating within the EU ETS should not be included in the quantification of emissions for a project scenario as this would be double counting.
8	Direct CO ₂ e emissions from sources within the State's jurisdiction, including those from direct construction and operation should be included in economic appraisals bearing in mind not to double count (see previous point). In certain instances consideration may need to be given by project managers to indirect emissions. For example, any rebound effects that the project may give rise to.

For the price of CO₂e⁴ emissions in the **non-Emissions Trading Sector (non-ETS)** the following values should be applied out to 2050:

Table 2: Shadow Price of Carbon 2019-2050 (per tonne of CO₂e) for the Non-ETS sector

Shadow Price of Carbon 2019-2050 (per tonne of CO ₂ e) for the Non-ETS sector	
Year	Carbon Price Non-ETS Sectors
2019	€20
2020	€32
2021	€39
2022	€46
2023	€52
2024	€59
2025	€66
2026	€73
2027	€80
2028	€86
2029	€93
2030	€100
2031	€105
2032	€110
2033	€116
2034	€122
2035	€128
2036	€134
2037	€141
2038	€148
2039	€155
2040	€163
2041	€171
2042	€180
2043	€189
2044	€198
2045	€208

⁴ Carbon Dioxide (CO₂), Methane (CH₄), Nitrous Oxide (N₂O), Sulphur Hexafluoride (SF₆), Perfluorocarbons (PFCs), Hydrofluorocarbons (HFCs) and Nitrogen trifluoride (NF₃)

2046	€218
2047	€229
2048	€241
2049	€253
2050	€265

For emissions originating in the **Emissions Trading System (ETS)** the price of CO₂e emissions should be based on the following values:

Table 3: Shadow Price of Carbon 2019-2050 (per tonne of CO₂e) for the ETS sector

Shadow Price of Carbon 2019-2050 (per tonne of CO ₂ e) for the ETS sector	
Year	Carbon Price ETS Sectors
2019	€23.6
2020	€23.6
2021	€23.6
2022	€23.6
2023	€23.6
2024	€23.6
2025	€23.6
2026	€24.7
2027	€26.9
2028	€29.1
2029	€31.3
2030	€33.5
2031	€35.2
2032	€36.9
2033	€38.6
2034	€40.3
2035	€42
2036	€43.6
2037	€45.2
2038	€46.8
2039	€48.4
2040	€50
2041	€53.8
2042	€57.6
2043	€61.4
2044	€65.2
2045	€69
2046	€72.8
2047	€76.6
2048	€80.4
2049	€84.2
2050	€88

For other specified non-GHG emissions the following values should be used in economic appraisal:

Table 4: Valuations for the estimated damage costs of non-greenhouse gas pollutants

Estimated damage costs in € per tonne					
PM2.5			NOx	NMVOCs	SOx
Rural	Suburban	Urban			
16,512	47,420	194,660	5,688	1,398	6,959

Section 3. Overview of Responses to Public Consultation

1. The Climate Change Advisory Council

The Climate Change Advisory Council (CCAC) was of the view that, in valuing long-lived projects, the valuation methodology should not distinguish between emissions in the ETS and the non-ETS sectors. The Council noted that *“To ensure the full welfare cost is evaluated requires consideration of the shadow price of carbon, the timespan of the analysis and the discount rate applied overall”*.

The CCAC expressed concern that, based on their present values, the 2050 values for the shadow price of carbon proposed in the consultation paper are not consistent with the more immediate term values. In other words if one applies the Test Discount Rate (4%) to the projected carbon price in 2050, the implied value for 2019/2020 is higher than the rate proposed in the DPER consultation.

The submission notes that the complete lifetime costs of emissions, the benefits of the avoided emissions and any ‘co-benefits’ should be fully capitalised over the technical lifespan of long-lived infrastructure projects.

The CCAC also express the view that where appraisal takes place over a relatively short time period, residual impacts must include the cost or benefit of emissions to welfare throughout its operational lifetime. Such longer timeframes are consistent with practices now common across OECD countries, and with the provisions of the Climate Action and Low Carbon Development Act (2015) and the National Adaptation Framework (DCCA, 2018).

2. The Economic and Social Research Institute (ESRI)

The Economic and Social Research Institute (ESRI) submission agreed with the Department that applying an accurate shadow price of carbon to estimate the greenhouse gas emissions attributable to public investment decisions is an appropriate metric. Given the constraints faced by the

Department, the ESRI also agreed that the estimated marginal abatement cost is the most appropriate means of pricing these greenhouse gas emissions.

The ESRI noted that using a marginal abatement cost curve based on the energy sector likely does not reflect the cost of reducing nationwide emissions. To overcome this issue, they suggest the shadow price of carbon be updated as new evidence from economy-wide environmental models becomes available.

3. Ervia

Ervia's submission noted that the use of a marginal abatement cost based approach to value greenhouse gas emissions seems to be the most practical and transparent methodology to adopt. The submission pointed out that the agricultural and land use sectors have important contributions to make on Ireland's path to decarbonisation. In the long term, Ervia are of the view that abatement costs from all sectors, and not just energy related abatement costs, will need to be incorporated. Ervia also stated that a detailed methodology note about how the abatement costs are calculated should be provided.

The submission stated that valuing greenhouse gas emissions in the emissions traded (ETS) and non-emissions traded sectors (non-ETS) should not be done using different methods, as this might lead to distortions. Ervia is of the view that the model used to value these emissions should include a blend of abatement measures from both the ETS and non-ETS sectors. Ervia also suggested that work should be carried out to understand the impact of the proposed change in methodology for valuing the shadow price of carbon on investment plans by both public and state bodies.

4. Friends of the Irish Environment

The Friends of the Irish Environment submission was broadly in support of the consultation paper. The authors noted the fact that there is no obvious objective method of valuing greenhouse gas emissions, each having various advantages and disadvantages. The paper does suggest examining each of the available methodologies for valuing greenhouse gas emissions and comparing the outcomes, stating it may be the case that *"some forms of appraisal would be more suited to certain kinds of projects, especially infrastructural ones, than others"*. The submission notes that applying a shadow price of carbon to capture the climate consequences of investment is only adequate where there is a likely to be an accurate estimation of the greenhouse gas emissions arising from a particular project.

More broadly, the submission critiqued the use of Cost Benefit Analyses for investment appraisal and suggested that there are policy deficits inherent in the Public Spending Code. The authors are of the belief that *“A shadow price is a good start”* to correct these deficits but that it will not correct historic issues with respect to planning and public transport related investment.

In relation to the marginal abatement cost curve, Friends of the Irish Environment are of the view that tailored approaches for each sector that reflect the real policy changes required to improve environmental quality and to achieve the targets are optimal. The submission does not approve of using values based on costs in the energy sector as a proxy for the whole economy. The recommendation in the consultation paper to apply linear increases of 5% to the non-emissions traded sector (non-ETS) values for CO₂e after 2030 are considered to be overly conservative.

5. Gas Networks Ireland

The Gas Networks Ireland (GNI) submission stated that the practical consequences for project appraisal of imposing higher shadow carbon prices and any potential unintended consequences, particularly given the scale of the increase proposed, should be considered.

The potential distortions arising from large differences between the treatment of greenhouse gas emissions in the emissions traded and non-emissions traded sectors was also considered to be an issue of concern, particularly given the continuing divergence out to 2050.

With respect to investment in the gas network, GNI noted the wider impacts of investment in this sector on the decarbonisation of the economy more broadly, particularly given the potential for renewable natural gas or hydrogen. GNI believes that the inclusion of non-greenhouse gas emissions in appraisal does not necessarily need to be a mandatory requirement.

6. The Green Party

The Green Party submission expressed the view that Ireland’s National Policy Position is not aligned with the Paris agreement or The Climate Action and Low Carbon Development Act, 2015. In relation to the shadow pricing of carbon in the Public Spending Code, the submission notes the previous implementation and success of policies which have costs above those at the higher end of the marginal

abatement cost curve contained in the consultation document. The submission states that *“This is because of a recognition that the overall public goal is the transition to a low carbon economy.”*

The party warn of *“an approach based in economic theory which aims at an ‘optimum’”*. It is of the view that this is not in sync with the possible consequences associated with the emissions path Ireland is on, nor the requirements of developed countries in the transition, and emphasises the need for speedy action.

The Green party recommend that all emissions are valued at the same cost. The submission states the approach chosen in the Public Spending Code should not incentivise emissions to move between the ETS and non-ETS sector simply to take advantage of differing values and that the consultation paper should not assume that the ETS will continue to under-price. The paper also makes a note that it considers burdening future generations with the costs of climate change to benefit the current generation as unfair.

7. Irish Forum on Natural Capital

The submission noted the importance of valuing our natural capital in a holistic manner. The Irish Forum on Natural Capital are of the view that modern economic systems fail to account for the degradation and depletion of natural capital, with the result that we are blind to both the risks this presents and the opportunities that can come from enhancing it.

8. Irish Water

The Irish Water submission agreed with the Department that the use of shadow pricing and the use of a marginal abatement cost (MAC) based approach are the most appropriate methodologies for capturing the climate consequences of public investment decisions. However, Irish Water do not believe using energy sector focused abatement costs are an appropriate proxy for economy wide abatement costs.

Given the huge task of decarbonisation, over the longer term Irish Water suggested that the indirect emissions from a project should also be considered. The submission also suggested that the impact of the increases to the shadow price should be considered and that the revised Public Spending Code should also set out a methodology to measure the effectiveness of the Code at mitigating climate change.

9. An Taisce

An Taisce do not believe applying shadow pricing to greenhouse gas emissions in appraisal is an appropriate method for capturing the climate consequences of investment decisions. The authors advocate the use of carbon budgeting.

For valuing the shadow price of carbon An Taisce does not agree with the use of marginal abatement cost curves based on either the costs faced in the energy sector or achieving Ireland's national climate targets, stating that costs should be based on the Paris agreement quotas. The organisation is of the view that the proposed methodology delays climate action. It is the authors' view that updated analysis be undertaken to take account of recent emissions levels.

An Taisce agree that the continuation of the current methodology for estimating the direct greenhouse gas emissions attributable to a project and the subsequent conversion of these emissions to carbon equivalent values is appropriate. The authors do not believe that cost benefit analyses are appropriate to quantify the impact that non-greenhouse gas emissions may have upon air quality. The submission states *"At present we cannot say if the values suggested for these air polluting gases are appropriate."*

Section 4. DPER Response to Views Received

The majority of submissions received were in agreement with the Department of Public Expenditure and Reform that the use of shadow pricing and a marginal abatement cost curve based approach were the most appropriate methods for valuing the greenhouse gas emissions attributable to public investment decisions.

However, there also appear to be a number of common concerns expressed by stakeholders in the submissions. In this section, the Department lays out its responses to some of the common concerns raised in submissions.

1. Using abatement costs based on the non-ETS energy-component of Ireland's greenhouse gas emissions as a proxy for nationwide abatement costs

A number of submissions suggested that energy sector costs may not provide an appropriate proxy for the cost of economy wide emissions abatement. This is acknowledged by the Department. As mentioned in the consultation paper, the use of a sectoral (rather than national) model is far from ideal.

However, given the broad consensus that abatement costs are a more accurate reflection of the cost of transitioning to a low carbon economy than alternative methodologies and given the lack of a nationwide abatement cost model, it is necessary at this stage to choose a somewhat suboptimal approach for estimating these costs. This methodology can also perhaps be justified based on the predominant role that emissions reductions in the transport, services and residential sectors are expected to play in meeting Ireland's 2030 climate and energy targets, as set out the Government's new Climate Action Plan.

The Department is aware that these values are not a complete reflection of the costs of achieving said targets and is fully cognisant that there will need to be reductions in non-CO2 greenhouse gas emissions to achieve the 2030 climate and energy targets and indeed to achieve longer term targets.

The ESRI submission provided a useful suggestion to allow for flexibility within the Public Spending Code, so as to update the shadow price of carbon as new evidence from economy-wide environmental models becomes available. It is the intention of the Department to review the guidance on the shadow price of carbon at more frequent intervals than other technical factors, so as to ensure the most up to date and accurate modelling is used in the appraisal process. This will allow for the incorporation of outcomes from future modelling exercises which focus on economy-wide abatement potential.

The research relied upon in this study regarding abatement costs came from the modelling work undertaken to support the national mitigation plan. The goal of the research UCC and the ESRI were commissioned to undertake for the National Mitigation Plan was to analyse the cost implications of Ireland's medium and long term ambitions in transitioning to a low carbon economy. The analysis examined the energy-component of Ireland's greenhouse gas emissions in those sectors outside of the Emissions Trading Scheme. What this means in practice, is that the research work focused on energy use in the transport, residential and services sectors. Emissions in the other non-ETS sectors (i.e. agriculture and waste) were assumed to be in line with EPA projections.

Further detail on the modelling work used to evaluate these abatement costs can be found here:

<https://www.dccae.gov.ie/documents/ESRI%20Energy%20Modelling%20Paper%20May%202017.pdf>

&

<https://www.epa.ie/pubs/reports/research/climate/Irish%20TIMES%20Energy%20Systems%20Model>

2. Valuing emissions differently in the emissions trading (ETS) and non-emissions trading sectors

Quite a number of respondents expressed the view that it might be more appropriate to provide just one shadow price of carbon to price all greenhouse gas emissions, regardless of sector. There are pros and cons to this approach. Providing one shadow price of carbon for all emissions simplifies the calculation of carbon costs. It also ensures that there is a greater level of consistency across appraisals. However, adopting this approach could lead to distortions and on balance, the Department is of the view that these distortions are of sufficient risk that valuing ETS and non-ETS emissions differently is necessary to mitigate the risks.

Since every projection has ETS prices increasing at a slower rate over time than the costs of abatement in the non-ETS sector⁵, a hybrid approach, where one shadow price is used to value all greenhouse gas emissions, would lead to a lower shadow price of carbon over time, than the price currently suggested for emissions in the non-ETS sector. This price would likely overstate the cost of emissions in the ETS sector and under-price the cost of additional emissions in the non-ETS sector. The net result of this would be less decarbonisation than is optimal taking place in the non-ETS sector. Since Ireland's legally binding climate targets are based on emissions in the non-ETS sector, under-pricing emissions in the non-ETS sector will increase the risk that Ireland fail to reach these targets and consequently the cost of compliance that will be borne by society or the cost that society will bear to exercise more expensive mitigation options that could have been avoided through more prudent investment decisions.

In addition, as the quantity of emissions within the ETS is fixed by a cap, reductions in emissions from Irish installations within the ETS does not result in lower emissions globally. The value of abatement

⁵ Likely due to the greater availability of market-ready technologies to reduce the greenhouse gas emissions associated with electricity generation.

that occurs in an ETS installation represents a marginal reduction in abatement costs elsewhere, in that abatement should occur where it is cheapest for it to do so i.e. the operation of the market displaces more costly abatement for cheaper options. The value of these costs at the margin is given by the EU ETS price. This is the sectoral abatement cost. Based on a MAC model it is considered appropriate to value these emissions at the market allowance price. To value these emissions at a price higher than the ETS price would, in the opinion of the Department, be inaccurate.

As stated, it is the view of the Department that ETS and non-ETS costs are unlikely to reach parity at any point in the near future. While the U.K. apply an approach based on the development of a more comprehensive global carbon market, whereby the traded and non-traded prices of carbon converge post 2030, there is little evidence at present to suggest that this will in fact be the case. The prospect of abatement costs between both sectors reaching parity would appear to be further into the future than this assumption would suggest.

It is intended that a review of the methodology for valuing greenhouse gas emissions in the Public Spending Code will take place more frequently than other technical factors. As developments at EU level occur with respect to the ETS/non-ETS divisions, these can be factored into future approaches to valuing greenhouse gas emissions in investment appraisal in the Public Spending Code.

3. Concern over the consistency of the shadow pricing of carbon across time

There was a view expressed in the consultation that the longer term shadow pricing values are not consistent with the more immediate term values (based on the test discount rate to be included in the updated Public Spending Code).

The analysis on which the shadow prices are based used scenarios generated via the Irish TIMES energy systems model to produce the estimated marginal carbon abatement cost values that society would face in meeting Ireland's climate and energy targets. If these marginal abatement cost values are adopted unadjusted as a shadow price of carbon, it would provide for uneven shadow prices of carbon over time. There are a number of reasons for this and why the valuation of current abatement costs is not as simple as smoothing abatement costs across time.

Marginal abatement cost (MAC) curves are a product of the input information in the modelling process, including the constraints imposed. This is particularly relevant for the modelling used by SFI MaREI Centre at University College Cork (UCC) and the Economic and Social Research Institute (ESRI). The outcomes of this modelling are based on the achievement of Ireland's climate and energy targets in a least cost manner. The prices of the various technologies which are used in this model to decarbonise society varies considerably over time.

To give a practical example, electric vehicles are predicted to reach cost parity with fossil fuel vehicles sometime over the period 2023 – 2025. In advance of that date, it might be more expensive to achieve decarbonisation goals. This suggests that marginal abatement costs, and hence shadow carbon prices, can fall as well as rise. However, these technological assumptions that underpin marginal abatement cost calculations are inherently uncertain and this uncertainty rises as the time period under consideration lengthens.

The UCC/ESRI modelling suggests that the cost of decarbonisation is likely to increase sharply to 2025 but will then decrease to 2030 before accelerating again to meet the more ambitious national policy position 2050 goals. This increasing cost is reflected through a shadow price of carbon that increases faster over the period 2030 – 2050 than the test discount rate (4%).

This does not mean action is being postponed so that future generations will be required to compensate for our inaction now. With due consideration given to cost effectiveness, the 2030 target represents an appropriate share for Ireland to contribute to the wider EU 2030 emissions target. The consultation takes as given these targets. This is considered justifiable as they have been agreed in both national and with EU legislation and cannot be altered at this point.

A final point is that MAC curves value emissions at the last mitigation option necessary to achieve the climate targets the country has pledged to achieve, based on the least cost method of achieving these targets. This does not mean that policies which cost more per tonne of CO₂ emissions abated should not or will not be implemented. It is merely a method for valuation of greenhouse gas emissions in investment decisions. The Government is free to invest in policies beyond this cost if it so wishes.

Quality Assurance

Quality Assurance Process

To ensure accuracy and methodological rigour, the author engaged in the following quality assurance process.

✓ Internal/Departmental

- ✓ Line management
- Spending Review Sub-group and Steering group
- Other divisions/sections – Central Votes Section and the Public Service Reform and Delivery Office.
- Peer review (IGEES network, seminars, conferences etc.)

✓ External

- Other Government Department
 - Advisory group
 - Quality Assurance Group (QAG)
 - Peer review (IGEES network, seminars, conferences etc.)
 - External expert(s)
- Other (relevant details)