The Coalition of Finance Ministers for Climate Action

# Macroeconomic analytical tools: the Ireland Environment, Energy and Economy (I3E) model

## Ireland—Department of Finance/ Department of Public Expenditure, NDP Delivery and Reform (DPENDR)/Economic and Social Research Institute (ESRI)

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**Topic:** Modeling tools relevant to Ministries of Finance

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**Access the full Compendium at www.greenandresilienteconomics.org**

## Introduction

As part of the Government-wide approach in Ireland to address the actions outlined in the Government's Climate Action Plan 2024, the Department is working with other Government Departments, Agencies, and other stakeholders in a coordinated manner to achieve the targeted reductions in overall greenhouse gas emissions by 2030 and reach net zero emissions by no later than 2050.

To this end, the Department of Finance is engaged with the Economic and Social Research Institute (ESRI) in Ireland and the Department of Public Expenditure, NDP Delivery and Reform (DPENDR), through a Joint Research Programme (JRP), to advance an macroeconomic and fiscal analysis of climate change using the Institute's Ireland, Environment, Energy and Economy (I3E) computable general equilibrium model. For further details on ESRI's I3E CGE model see de Bruin and Yakut (2021).

## Policy background/targets

In response to the global climate crisis, the need to design adequate climate change policies in Ireland is becoming increasingly important. Moreover, Ireland is obliged to decrease its emissions under the EU Commission's Climate and Energy Package; it is required to deliver a 42% reduction in greenhouse gas emissions not covered by the EU's Emissions Trading Scheme by 2030. Domestically, legislation that requires a reduction of 51% of greenhouse gas emissions using the Global Warming Potential (GWP) 100 metric by 2030 relative to 2018 has been enacted. Hence, designing appropriate energy policies to ensure a smooth and least-cost transition to a low-carbon economy is imperative. Research is needed to better understand the economic and environmental impacts of policies to advise the policymaking process. For this purpose, the I3E model has been developed.

## Model detail

The I3E model is an intertemporal computable general equilibrium (CGE) model, which reproduces the structure of the economy in its entirety. It includes productive sectors, households, and the Government, among others. In the model, the nature of all existing economic transactions between diverse economic agents is quantified. According to microeconomic behavior, producers (consumers) maximize their profits (utility) given their budget constraints. In other words, a CGE model examines how inputs and outputs flow between production sectors of the economy and finally result in final goods consumed by households.

The explicit modeling of sectorial interlinkages makes it possible to investigate the wider economic impacts of a specific shock or policy through the different transmission channels in the economy. Therefore, CGE models have become a standard tool of empirical analysis. They are widely used to analyze the welfare and distributional impacts of policies whose effects may be transmitted through multiple markets and channels in the economy. Because of its nature, CGE modeling is highly useful for policy design and evaluation, specifically when policy measures are expected to lead to indirect, as well as direct, effects, as in the case of energy-related policies. For example, the economic implications of an energy tax in the transportation sector can be evaluated both for the transportation sector and other sectors through intersectoral spillovers.

Due to the level of detail, it is also possible to simulate specific policies, e.g., taxes on coal inputs, subsidies for renewable energies. Hence, the impacts of different types of energy policies that lead to the same mitigation goal can be investigated. Furthermore, CGE modeling presents the opportunity to evaluate distributive effects within the economy, and therefore identify winners and losers from certain policies, at the household level.

The I3E model includes energy flows and emissions in addition to the standard monetary flows. Each production sector produces an economic commodity using labor, capital, material, and energy inputs. The I3E model explicitly comprises a set of carbon commodities, including peat, coal, and natural gas, as well as crude oil, fuel oil, liquefied petroleum gas (LPG), gasoline, diesel, kerosene, and other petroleum products. Production activities produce commodities in the cheapest way possible by using

the optimal set of capital, labor, energy, and other intermediate inputs, based on both relative prices and substitution possibilities. When an energy policy is implemented (e.g., an increase in carbon tax) or in an external shock (e.g., an increase in international energy prices or ETS price) occurs, production sectors will, where possible, substitute energy inputs for other inputs and/or decrease the carbon content of their energy inputs by demanding cleaner energy. From the consumers' perspective, higher prices of goods with a higher carbon content will encourage them to consume less carbon-intensive products. The explicit inclusion of emissions makes it possible to evaluate the emissions reduction associated with a specific policy or to calculate the specific policies needed to reduce emissions to a certain target.

I3E is a dynamic model, which incorporates economic growth over the modeling horizon, which runs to 2050. Economic growth originates from three sources: the growth of employment driven by population growth, the growth in capital stock driven by investment, and the growth in total factor productivity or productivity of factors of production. It is assumed that the total population grows at a constant rate and the technology, i.e., the productivity of the labor force, also grows at a constant rate.

Note that development of the I3E CGE model for Ireland is ongoing to capture all sectors of the Irish economy in greater detail. The core structure and current limitations of the I3E model are set in the technical documentation (de Bruin and Yakut, 2021).

## Reference

de Bruin, K., and Yakut, A. (2021) *Technical Documentation of the I3E Model, v4.0.* ESRI Survey and Statistical Report Series 109, Dublin: ESRI. https://doi.org/10.26504/sustat109