MODELLING MACROECONOMIC IMPACTS OF CARBON CONSTRAINED ENERGY SYSTEM USING IRISH-TIMES MSA

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Overview

This abstract outlines work integrating the Irish-TIMES energy systems model with the Macro-Stand-Alone (MSA) model to estimate the macroeconomic impacts of carbon constrained scenarios to 2050 on the Irish economy.

Methods

TIMES (The Integrated MARKAL-EFOM System) is a techno-economic model generator for local, national or multi-regional energy systems, which provide a technology-rich basis for estimating energy system dynamics over a long-term, multi period time horizon. TIMES computes a time varying inter-temporal partial equilibrium in inter-regional energy markets. The objective function maximises total surplus. This is equivalent to minimising the discounted total energy system cost while respecting environmental, technical and scenario constraints.

Irish-TIMES is a technology rich partial equilibrium model of the Irish Energy System. The technology database contains descriptive time dependant economic and technical data for approximately 1600 supply and demand side energy technologies. The model specification has 12 annual time slices; four seasons, day, night and peak for a time horizon of 45 years, from the base year of 2005 to 2050. The model is calibrated to the base year energy balance and is driven forward in time with physical energy service demands derived from macroeconomic drivers. These demand driver projections are based on the Economic and Social Research Institutes 2013 recovery projections from the in house HERMES macroeconomic model in conjunction with GEM-E3. Commodity prices are derived from the IEA 2012 world energy outlook.

MACRO Stand Alone is an inter-temporal general equilibrium model which maximises utility for a representative producer agent. It enables the assessment of general macro-economic implications of changes to the energy system, such as climate constrained scenarios. The model formulation consists of a Cobb-Douglas production function with substitution between an aggregated good of capital and labour with energy. The MSA model has been calibrated to the Irish reference energy system and economy for this analysis testing the sensitivity of a range of input parameters.

Results

The results outline energy system pathways for a reference scenario (REF), a carbon constrained scenario with CO2 reductions of 80% relative to 1990 levels (CO2-80), and an equivalent scenario with the macroeconomic impacts integrated into the analysis.

The MSA scenarios cause a 10% reduction in final energy consumption by 2040 due to reduced demand as a result of increased energy system cost and a reduction of consumption in the economy. Interestingly this alters the fuel mix most notably in the transport and residential heating sectors as carbon constraints become less binding and so fuel switching is delayed. The loss of GDP in the CO2-80 scenario rises to -1.5%/yr by 2050, with the CO2-95 scenario at -2.5%.

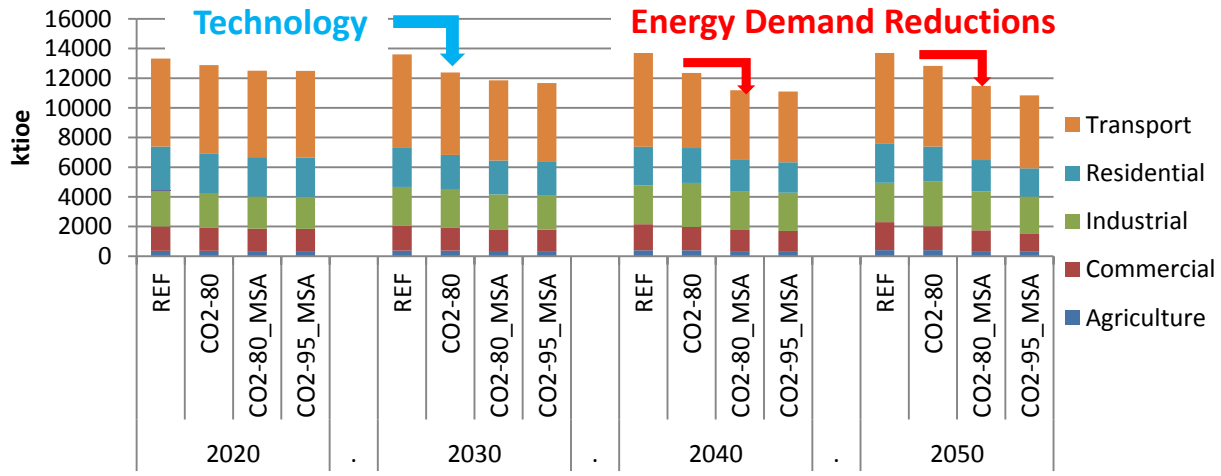

Figure 1 Total Final Energy Consumption across all sectors

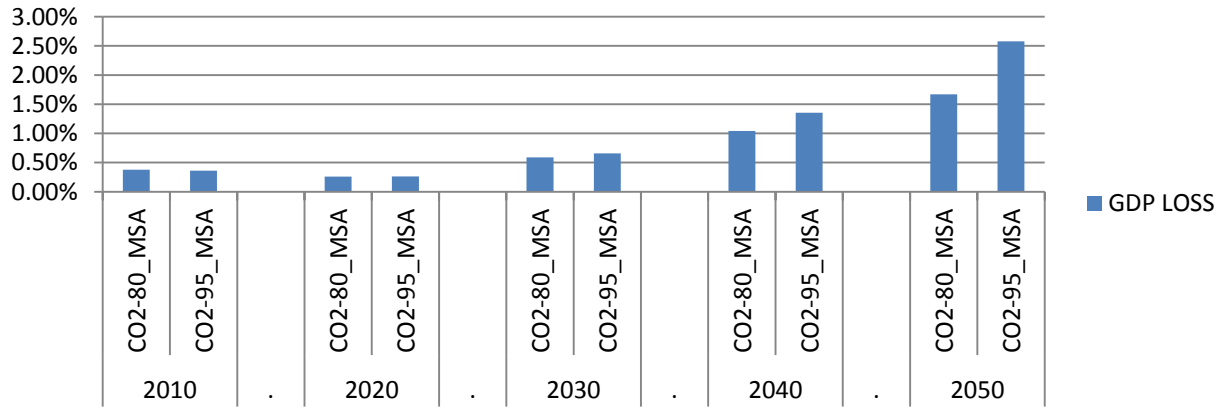

Figure 2 GDP Loss due to carbon constrained energy system

Conclusions

The integrated analysis of both changes to the energy system and the resultant macro economy provides feedback to energy service demands. This feedback provides estimates and insight into potential loss in consumption, GDP and by proxy other macro-economic impacts as a result of carbon constraints to the Irish energy system.