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THE ROLE OF BIOENERGY IN CLIMATE CHANGE MITIGATION – ECONOMIC AND ENERGY SECURITY IMPLICATIONS

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Overview

The Copenhagen Accord established political consensus on the 2°C (global temperature increase) limit and for deep cuts in greenhouse gas (GHG) emissions levels to achieve this goal. This requires a radical transition to low carbon fuels and points to a significant increase in renewable energy. The European Union (EU) has set ambitious GHG targets for the year 2020 (20% below 1990 levels) and for 2050 (80 – 95% below 1990 levels), with each Member State developing strategies to contribute to these targets. This paper focuses on one Member State, Ireland and explores the role of bioenergy in the achievement of an 80% reduction in GHG emissions. The results point to interesting implications for energy security and for the economy. Ireland is an interesting case study for this analysis for a number of reasons, including high growth in energy use, significant import dependency and recent acceleration in renewable energy deployment.

Context

Despite the recent economic recession, energy demand growth has been significant (2.8% per annum on average between 1990 and 2009 [Howley et al., 2010]) driven largely to high economic growth (5.2% per annum on average growth in real GDP). This resulted in a 36.7% growth in energy-related carbon dioxide (CO_2) levels since 1990, in contrast to the reducing trend [EEA, 2010] in other EU Member States. Ireland has introduced a number of significant and successful policy measures since 2000 to increase renewable energy production in Ireland, but these have largely focussed on wind energy [Ó Gallachóir et al. 2008, Foley et al., 2012]. A more recent policy focus on biofuels [Smyth et al., 2010] resulted in a 1.8% contribution of renewable energy to road and rail transport of in 2009, from a low base of 0.03% in 2005. Bioenergy for thermal uses (mainly biomass) grew from 2.4% in 2000 to 4.2% of fuel consumption in 2009, but this was due to economic growth in the sectors using bioenergy rather than specific policy measures. It is against the context of low bioenergy usage that this paper discusses the transition to a very different situation in 2050.

Methods

The tool used to carry out the analysis is the Irish TIMES model (originally extracted from the PET36 model and then updated and reviewed) developed within TIMES (The Integrated MARKAL EFOM System) energy systems modelling tool. Four main scenarios are compared, which three of them seek to deliver the 80% emissions reduction target for 2050, but differ in terms of the intermediate targets and the extent to which non-energy sectors can deliver emissions reduction. The main scenarios assumptions are listed in the table below.

Scenario	Description
REF	Least cost optimal pathway delivers the energy system demands in the absence of emissions reduction targets. This scenario has been calibrated according to national energy forecasts and is used as benchmark: it provides a starting point against which other scenarios can be measured.
CO2-80	The energy system is required to meet by 2050 interim target of 80% GHG emissions reduction below 1990 levels. The pathway comprises a 20% CO_2 reduction by 2020 relative to 2005 levels, 40% and 60% below 1990 levels by 2030 and 2040. Non-energy emissions are implicitly assumed to reduce at a similar rate to energy related emissions.
NETS-80	Encompasses the effect of extending current EU GHG mitigation legislation (based on Directive 2009/29/EC and Decision 2009/406/EC) beyond 2020. This scenario delivers 80% GHG emissions reduction target by mean of separate targets between ETS and Non-ETS sectors. The pathway comprises reductions of 40% and 60% below 1990 levels for both sectors by 2030 and 2040. Applying these targets directly to the energy system assumes implicitly that the other sectors also achieve the same targets.

GHG-80 The energy system is required to meet by 2050 a reinforced 95% GHG emissions reduction target below 1990 levels. The pathway comprises 26.8% GHG reduction by 2020 relative to 2005 levels, 50% and 70% below 1990 levels by 2030 and 2040. This is designed to evaluate the effect on the energy system of compensating for lower emissions reduction achievements in non-energy sectors (notably agriculture). By 2050 this reduction is set at about 50% relative to 1990 levels is alignment with results of the EU Low Carbon Roadmap.

Results

The scenario results provide a range of energy system configurations for Ireland that each deliver projected energy service demand requirements optimised to least cost and subject to a different policy constraints for the period out to 2050. It provides a means of testing energy policy choices and scenarios, and assessing the implications for the Irish economy (technology choices, prices, output, etc.), for Ireland's energy mix and energy dependence, and for the environment, as greenhouse gas emissions. This paper i) investigates the specific role of bioenergy imports versus domestic bioenergy, ii) illustrates the impact in terms of land usage (by mean of GIS maps) and iii) discusses the economic impacts of bioenergy. The results (see Table below) quantify Ireland's import dependency under each scenario and the contribution of bioenergy.

%imports	**Scenario**	**2005**	**2020**	**2030**	**2040**	**2050**
Primary Energy	*REF*	86.9%	80.3%	83.3%	84.2%	74.5%
	CO2-80	86.9%	77.3%	75.0%	70.1%	69.6%
	NETS-80	86.9%	75.1%	70.2%	70.1%	68.0%
	GHG-80	86.9%	77.2%	71.1%	72.5%	71.4%
Bioenergy	*REF*	1.0%	0.0%	0.0%	0.0%	0.0%
	CO2-80	1.0%	0.0%	64.8%	53.5%	51.7%
	NETS-80	1.0%	39.4%	61.5%	53.6%	51.5%
	GHG-80	1.0%	0.0%	69.8%	59.3%	69.4%

The implication on the economy is also provided, focussing on marginal abatement costs, total energy system costs and investments costs. Different scenario assumptions result in significant variation in the marginal cost of CO_2 abatement that reaches by 2050 $€_{2000}$274 /t CO_2 in the 80% CO_2 scenario and $€_{2000}$1,344 / t CO_2 in the 80% GHG scenario. Investments in the energy system in 2050 approach 4.7% of GDP in 2050, although this 3.7% for the Reference scenario (in the absence of a mitigation target).

Conclusions

The model results from the 2050 scenarios indicate that these deep emissions cuts are possible, while also meeting our future energy service demands by incorporating radical changes in energy demand side and supply side technologies. By 2050 renewable energy will account between 76% and 83% of final energy consumption (in the 80% CO_2 and the 80% GHG cases), which 71% and 75% of these renewable resources will be bioenergy. While the oil and gas dependency will reduce for all mitigation scenarios (about half of importations of 2005 by the year 2050), high bioenergy demands push to a growth of domestic bioenergy production (mostly biomass and biogas), but also to higher importations of biofuels, such biodiesel and, in the 80% GHG scenario, also biomass. The results respond directly to a number of key policy questions such the estimation of the impact on land availability and on import dependency, but also raise new questions about the role of importations that should be carefully scrutinized in wider works, i.e. *Is bioenergy trade sustainable from a life cycle perspective? Should national energy balances include international transportation emissions? Should policy limit bioenergy trades? Do bioenergy influence food prices?*

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