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Modelling national policy making to promote bioenergy in heat, transport and electricity to 2030 – Interactions, impacts and conflicts

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ABSTRACT

Governments must increase bioenergy use to realise the Paris agreement ambition. Most countries have limited biomass resources and policy goals beyond carbon reduction. This can lead to policy incoherence. Previous studies tended to focus on one end-use sector or on optimising CO_2 reduction. This study goes beyond optimisation approaches and investigates cross sector impacts of bioenergy policy proposals via simulation methods for policy proposals in Ireland. As an EU member with ambition for increased bioenergy use, Ireland is a useful case to examine trade-offs. Using the BioHEAT policy decision support tool (Durusut et al., 2018) we find policy in the heat and transport sector close the gap to Ireland's 2030 climate targets by 3%. Policy supporting co-firing of biomass with fossil-fuel to produce electricity increases emissions by 8.3 $MtCO_2$ overall and reduces the policy impact on national climate targets by 63%. Co-firing uses more of the available biomass resources and this limits renewable uptake in the heat sector. Coal conversions and the use of advanced biofuels are found to rely on high availability of imports. Policy supporting biomass use in the power sector may make national climate targets less achievable for EU countries.

1. Introduction

Governments are implementing policy to stimulate the use of biomass resources for energy production (Bacovsky et al., 2016). The primary focus of these is to reduce greenhouse gas (GHG) emissions but specific polices are also influenced by considerations such as creating and protecting employment, energy security, and other environmental objectives (Berndes and Hansson, 2007; DCENR, 2014; Bacovsky et al., 2016). Over the longer term, the Intergovernmental Panel on Climate Change (IPCC), the International Energy Agency (IEA) and others show an increasing role for bioenergy in efforts to mitigate climate change (IEA, 2016; IPCC, 2015). Coherent policy measures will be required to deliver this. The range of policy objectives can be difficult to coordinate and action in one sector may have unintended negative outcomes in another. Competition for resources between the end use sectors can impact on overall deployment leading to more expensive policy interventions. Therefore, the modelling of bioenergy policy must consider the system wide and cumulative impacts of policy interventions.

Examples of policies that encourage bioenergy use in one or more of the three end-use sectors of heat, transport and power are already commonplace. In North America the policy focus has been on liquid biofuels. Through the Energy Independence and Security Act of 2007, the US aims to produce 36 billion gallons (136 Gigalitres) by 2022 (United States Congress, 2007). Canada has also had a focus on biofuel use. The Federal Renewable Fuel Regulations requires a 5% bioethanol blend and a 2% renewable content in diesel (Government of Canada, 2010). In Asia, Japan is focused on the use of bioenergy to produce electricity (METI, 2014) and China has policy measures for liquid biofuels and for power generation (Jiang et al., 2017). Policy in the Republic of Korea is also oriented towards supporting biofuels for transport, though recent measures have increased the use of bioenergy in the power sector (Bacovsky et al., 2016). In Europe, policy measures have been implemented to encourage bioenergy use for heat, transport and electricity – with many countries having policy instruments in place for bioenergy in each sector (Bacovsky et al., 2016). Germany, for example, has feed-in tariff support for bioenergy production from solid biomass and biogas (Bundestag, 2008) as well as mandates for CO_2 reductions through the blending of liquid biofuels into petrol and diesel (FNR,

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2015). The UK has bioenergy supports and regulations in place for heat (Government of the UK, 2009), transport (Government of the UK, 2015) and electricity (Government of the UK, 2017a, 2016). UK Government support has enabled some coal generation units to convert to using wood pellets to produce electricity (Government of the UK, 2017a) and support for bioenergy through the Renewable Heat Incentive has led to increased use of solid biomass for heat and increased production of biogas, for direct combustion and for injection into the gas grid as biomethane (Government of the UK, 2017b).

Tonini et al., 2017 highlight the importance of national considerations in bioenergy policy making (Tonini et al., 2017). As an EU country with several renewable energy policies in place, Ireland is a useful case study to examine the policy trade-offs at a national level. Like the EU as a whole, Ireland has limited domestic biomass resources and ambitious decarbonisation goals. As is the case at a global level, Ireland's decarbonisation pathways are likely to see an increasing role for bioenergy (Chiodi et al., 2013). Ireland's Energy White Paper outlines the ambition to reduce Ireland's energy related GHG emissions by 80% by 2050, as compared to 1990 levels (DCENR, 2015). A number of Government documents set out policy aspirations in the area. These point to measures in all three end use sectors but also set out some principles for policy making including: "*policy should be economic,… bioenergy delivers genuine carbon reductions, … policy contributes to wider environmental policy objectives, … policy aims to optimise enterprise and employment opportunities, ….and energy citizens play an active role in the transition"* (DCENR, 2015; DCENR, 2014).

Much of the previous literature has focused on specific elements of the bioenergy supply chain and climate mitigation optimisation and does not consider other rationales (Berndes and Hansson, 2007). Assessments of the optimal use for a specific resource, the optimal size and location of bioenergy plant and factors that influence the cost of feedstock refinement are common. Some studies have taken a broader view and examined energy security implications (Chiodi et al., 2015; Glynn et al., 2017), or the optimal allocation of feedstock to bring about the largest overall CO_2 emissions reduction impact. Several literature reviews discuss these approaches in more detail (Bentsen et al., 2014; Graham et al., 2011; Schmidt et al., 2010; Steubing et al., 2012; Wahlund et al., 2004) but few studies deal with the simulation of policy in all end use sectors and examinations of the use of bioenergy in the heat sector are rare. Goal-seeking models can plot optimal pathways towards achieving particular policy goals. The bioenergy literature has tended to focus on the deployment of bioenergy resources to meet carbon reduction or supply chain optimisation goals. Simulation methods, like the model presented in this paper, are limited in their ability to plot optimal pathways but their strength lies in their ability to examine the policy measures proposed to realise the optimal path. This paper simulates actual policy proposals, including policy in the heat sector. Several studies have noted that the variability in outcomes of national level analyses (Berndes and Hansson, 2007; Steubing et al., 2012; Bentsen et al., 2014). These studies focused on informing policy development rather than a detailed examination of policy instruments. This paper aims to add to the literature in this regard using Ireland as a case study.

The BioHEAT model - a techno-economic simulation model that integrates bioenergy and heat including the co-dependencies between the heat, power and transport end use sectors - is used for our analysis (Durusut et al., 2018). Using BioHeat, this paper examines the interactive and cumulative impacts of separate policy instruments aimed at increasing renewable energy output through bioenergy supply chains. Scenarios examine the impact of converting existing generation units from fossil-fuel to biomass fuel, the mandated use of advanced biofuels in transport and the extension of the support for renewable heat to 2030. Impacts such as the total renewable energy production from bioenergy, energy related CO_2 reductions, and the overall resource efficiency of bioenergy use in Ireland are evaluated. A key strength of the modelling approach is the detailed representation of heat demand and the lifelike representation of the consumer decision making process.

Actual policy proposals incorporate wider considerations beyond maximising the greenhouse gas reduction benefit from bioenergy. The policy simulations help to understand what outcomes are likely from a policy to support bioenergy in one end-use sector, as well as the impacts on bioenergy in other sectors. For example, European Union member countries could benefit from an enhanced understanding of policy to incentivise bioenergy use in power generation on the uptake of bioenergy technologies in the heat sector and any resultant impact on national emissions reduction targets. The purpose of this paper is to explore the trades-offs and identify areas where policy conflict could reduce the emissions benefits from the perspective of a national Government. The contribution of this paper is to show how various policy proposals interact and to highlight the interdependencies and trade-offs, in the context of actual policy goals and considerations at a national level. The modelling employed is applicable to other jurisdictions and can help develop targeted and more effective bioenergy policy supports.

Section 2 provides background, Section 3 presents methodology and data, Section 4 shows the results discussed in Section 5 and Section 6 outlines the policy conclusions.

2. Background

2.1. EU policy context

The EU has set a target to reduce GHG emissions by 40% as compared to 1990 levels by 2030 (UNFCCC, 2015) and to increase the share of renewable energy to at least 32% of energy consumption (European Council, 2016). To achieve this, the emissions trading scheme, which covers electricity generation and other energy intensive producers, is undergoing changes with the aim of increasing the price signal to prompt increased mitigation action (European Commission, 2016). In addition, CO_2 reduction targets have been agreed for each member state to share the effort of reducing emissions in those sectors that are outside the emissions trading scheme (non-ETS) by 30% as compared to 2005 levels by 2030 (European Council, 2016). A large majority of the energy related non-ETS emissions come from transport and heating fuel combustion (EEA, 2017). The draft second EU Renewable Energy Directive proposes legislation to meet the 32% renewable energy target (European Council, 2016). Specific targets are proposed for transport with the proposed directive setting a limit on the amount of biofuels that can come from 1st generation biofuels as well as minimum amounts that must come from advanced biofuels.The proposals would also require increases in the shares of renewable heat in each member state.

The combination of these proposals should increase the focus of national climate policy on the heat and transport sectors with the revamped ETS guiding investment in the electricity generation and energy intensive industry.

2.2. Irelands energy sector

Fig. 1, developed by Ireland's Energy Statistics and Policy Support Unit, shows the breakdown of the 2016 energy balance for Ireland by end use sector and fuel use (SEAI, 2017a). Ireland's energy system is reliant on imported fossil fuels. In 2016, Ireland imported 69% of the 603 PJ of primary energy used, down from 88% in 2015 due to the commissioning of a new gas field. In addition to the new gas field, indigenous fuels come primarily from peat (5.1%) and renewable sources (8%). Oil accounted for 48% of primary energy, all of which is imported, with natural gas use accounting for 29.4% and imported coal 9.5%. Fuel use is evenly spread across end-use sectors with 34.4% of fuel used for transport, 33% for Electricity and 32.6% for heat.

Energy related emissions were 39.4 $MtCO_2$ in 2016 and accounted for 60% of Ireland's total emissions. 53.2% of the energy related emissions were in the non-emissions trading sector. Renewable energy

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