



Original research article

Who should pay for renewable energy? Comparing the household impacts of different policy mechanisms in Ireland

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ABSTRACT

Along with environmental impacts, renewable energy affects societal welfare through subsidy costs and electricity price changes. Identifying the distribution of both these impacts is of increasing importance as deployment grows. Subsidies are commonly financed by consumption-based Public Service Obligation (PSO) levies. We compare the distributional impact of different PSO levy structures using the example of a market with high and rising renewables penetration: Ireland. A flat-rate charge is more regressive than a unit-based charge. The regressive impacts of a fixed per-unit charge are greater for a subgroup of heavy electricity users, some with low incomes. Incremental Block Pricing (IBP) exaggerates these effects. A hybrid fixed/variable structure reduces regressivity for heavy users but lessens overall regressivity reduction. Redistributive mechanisms structured like Ireland's Household Benefits Package imperfectly target poorer households, with income and household size-based measures more effective. Including electricity price reductions due to renewables deployment, fixed per-unit charges have a neutral effect while flat charges redistribute some burden from rich to poor. IBP shifts cost to heavy electricity users, predominantly large households. IBP yields a negative net burden for most households across all income groups. These findings are generalised to inform equitable renewable energy subsidy mechanisms both in Ireland and elsewhere.

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1. Introduction

Ambitious renewable energy targets exist at both an international [1] and national [2,3] level. As electricity generated by renewables tends to be more costly than that generated by conventional sources, public subsidy is often required to create a viable investment environment [4,5]. Feed-in Tariffs (FiTs) and premiums, where price guarantees are offered for each unit of electricity generated and sent to the grid [6], are commonly employed renewable energy support mechanisms [6,7]. Worldwide, FiTs have aided the deployment of 64% of all wind and 87% of all photovoltaic (PV) solar capacity since 2010 [8,53]. These subsidies are commonly financed through an additional charge on electricity consumption, often referred to as a Public Service Obligation (PSO) levy [7,9]. If renewables continue to maintain a cost premium over other

forms of generation, the PSO cost per household will increase with increasing deployment of renewables.

Subsidising renewables may also have the countervailing effect of reducing wholesale electricity prices. Wind and solar generation are capital intensive but as wind and sunlight are free, the marginal cost of electricity generation from these sources is zero. Thus, the displacement of conventional generation by renewables can lower wholesale electricity prices [10]. In Ireland, it has been found that the countervailing effects of increasing subsidy costs and decreasing wholesale electricity prices mean that wind power has had a net impact on total cost of approximately zero [11].

Whilst increasing penetration of renewables does not necessarily change total electricity cost, the composition of electricity cost is changing. With more renewables, a greater portion of each consumer's electricity expenditure will comprise the PSO cost instead of the unitary electricity cost. As a result, the unitary electricity cost for consumers will decrease according to the proportion of this cost reduction that suppliers pass to consumers. However, there may be an increase in the required subsidy. The means by which this cost is recovered thus becomes more important. To illustrate, a PSO recovered using a flat-rate charging structure (e.g. Ireland's

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PSO levy) will constitute a greater proportion of the weekly budget for consumers with low incomes. Alternative levy structures, along with accompanying social transfers, will have different patterns of incidence.

Fully understanding the distributional effects of PSO levy cost and electricity price changes is important to inform appropriate PSO levy design. This paper explores these effects by comparing levy structures, whilst analysing the potential for social transfers to mitigate any regressive impacts. The importance of considering the distributional effects of energy policy has been stressed in the literature [12–14], with Chawla and Pollitt [15] advocating greater debate on identifying the distribution of incidence associated with different levy structures. Bazilian et al. [13] have discussed the importance of considering energy affordability in the governance of energy systems. Concentrating on developing countries, they find that appropriate governance structures for affordable energy services are important, an issue that is also valid for developed countries [14,16,17]. Stern [18] notes the importance of identifying how individuals and households are affected by developments in the energy system, whilst Sovacool [19] suggests that further research is required in the areas of energy poverty and identifying acceptable means to internalise environmental externalities.

Microsimulation methodologies have become the standard approach to estimate distributional impacts of public policy [20–22] by simulating the effects of a policy change on a dataset of units such as individuals, households or firms [20]. The applied nature of this methodology requires that a suitable case study must be chosen. Ireland is chosen as it is a leader of renewable energy deployment with suitable data availability, allowing for clear identification of distributional impacts. Results are immediately relevant for countries with similar socioeconomic structures. Socioeconomic trends underlying findings are emphasised when presenting results. This allows for general interpretation and interpretation according to different socioeconomic contexts. Furthermore, the methodology presented may be applied to alternate countries with similar household expenditure and renewable energy subsidy data.

This paper proceeds as follows. Section 2 provides a literature review and motivates this analysis. Section 3 presents the methodology and data employed for this analysis. Section 4 analyses the incidence of cost. Redistributive measures are analysed in Section 5. Section 6 considers the distributional impact of both costs and price reductions together. Section 7 provides a discussion. Concluding comments are given in Section 8.

2. Literature review and motivation

Recently, PSO levies and equivalent surcharges have grown, with the magnitude and equity implications of this increased cost becoming an active topic of discussion in literature of academic [23,34], policy [12] and general interest [24,25]. These trends have been observed in many countries. The EEG surcharge, Germany's PSO levy, finances renewable energy deployment through a surcharge on domestic electricity consumption. In 2013, 18% of domestic electricity cost in Germany was comprised of the EEG surcharge [24–27]. A 2014 increase of approximately 20% [28] resulted in the EEG surcharge totalling over €0.06/kWh [29].

Ireland's PSO levy is used to subsidise renewable energy, indigenous peat generation and other security of supply provisions [30]. The Irish PSO levy for the 12 month period of October 2013–September 2014 was €42.87 per domestic consumer, a rise of 54% relative to the previous 12-month period. This rose to €64.37 for the period October 2014–September 2015 [30,31].

Although such increases are unlikely to take place every year, these levies may be subject to continued growth in the future. Electricity generated from renewable sources is expected to grow as a proportion of total electricity consumed: for example, 2020 penetration levels of 40%, 40–45% and 100% are expected in Ireland [2], Germany [32] and Scotland [3], respectively. Should these targets be achieved, renewable energy costs will comprise a larger share of total electricity cost, holding all else equal. To illustrate, the Renewable Energy Feed-In Tariff (REFIT) subsidy alone may constitute between 6.8% and 17.2% of the Irish gross wholesale electricity price by 2020, if renewable energy deployment is high [33]. Other subsidies in the Irish PSO are not covered by this calculation. For many countries, PSO levies may thus constitute a growing and substantial segment of electricity bills in the future. As a result, the equity effects of charging structures will become increasingly important with greater deployment of renewable technologies. In analysing the impact of PSO levies, this paper addresses three specific gaps in the literature.

First, this paper compares the distributional impact of different PSO charging structures. To date, the literature has focussed on quantifying the distributional impacts of a single policy structure. The distributional impact of costs associated with environmental and energy efficiency policies in the UK has been analysed by Chawla and Pollitt [15]. They find that the cost as a proportion of income has risen, with a greater burden being imposed on households with low incomes. The household-level distributional impact of the German energy transition has been analysed by Neuhoff et al. [23]. Although they discuss a number of alternate policy options, they do not carry out an in-depth quantitative comparison of these options relative to the income distribution. When one incorporates revenues associated with solar PV ownership, it has been found that Germany's EEG surcharge increases income inequality and the scheme is mildly regressive [34]. Furthermore, it has been found that the Italian A3 surcharge¹ would be less regressive if financed by a carbon tax [35]. This is because electricity expenditure is a necessary item and comprises a high proportion of expenditure for low income groups, whilst a carbon tax incorporates progressive expenditure items such as motor fuels.

Previous research has analysed the deadweight loss and distributional effects of various electricity [36] and gas [37] price structures. However, different price structures for PSO-type levies have not been analysed to date. Neuhoff et al. [23] discuss different charging structures for PSO-type levies but do not quantitatively compare the impacts of different structures. Preston et al. [12] compare a PSO-type levy to an income tax-based financing structure but do not quantitatively compare different PSO levy structures. We contribute to this literature by comparing the quantified equity implications of different PSO levy structures. As this discussion and Chawla and Pollitt [15] identify, this is a deficiency in the current literature. We also elicit socioeconomic factors associated with any potential regressive impacts. This has not been analysed in the literature and facilitates a general interpretation of findings.

The second contribution of this paper is to analyse how measures to offset regressive impacts of PSO levies may be efficiently designed. We analyse the effectiveness of Incremental Block Pricing (IBP) and hybrid flat-rate/per-unit pricing schemes to minimise regressive impacts. Regressive impacts may also be reduced through changes in taxes, social transfers and a progressive allocation of offsetting benefits. Rosenow et al. [14] and Neuhoff et al. [23] discuss the targeting of benefits (e.g. energy efficiency upgrades) by social group to offset regressive impacts. Callan et al. [38] have

¹ The A3 surcharge is an Italian surcharge to finance renewable energy deployment in a similar manner to the Irish PSO levy and the German EEG surcharge.

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