Who should pay to support renewable electricity? Exploring regressive impacts, energy poverty and tariff equity

Paolo Mastropietro

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THE REGRESSIVE IMPACT OF RENEWABLE SURCHARGES AND IMPLICATIONS FOR ENERGY POVERTY

Paolo Mastropietro [a, *]

[a] Instituto de Investigación Tecnológica, Universidad Pontificia Comillas, Sta. Cruz de Marcenado 26, Madrid, Spain.
[*] Corresponding author. IIT, Universidad Pontificia Comillas, Sta. Cruz de Marcenado 26, Madrid, Spain.
Tel.: +34 91 542 2800 ext. 2740. E-mail: <Paolo.Mastropietro@comillas.edu>

Abstract

Even if the cost of producing electricity from non-conventional renewable resources has significantly decreased during the last decades, the cost of supporting these technologies is expected to grow worldwide until 2035. If these costs keep on being recovered through surcharges in electricity tariffs that are proportional to consumption, they will have a strong regressive impact that may intensify energy poverty issues. This short article analyses this regressive effect and presents some alternative methodologies to allocate renewable support costs within the society, promoting a just energy transition.

Keywords

Renewable energy; RES-E support; electricity tariffs; energy poverty; energy transition.

1 INTRODUCTION

In the last two decades, global warming urged governments around the world to undertake a process to decarbonise their economies; this process has to be accelerated in the next decades if the Paris Agreement (UN, 2015) is to be implemented and fulfilled. For different reasons, in many jurisdictions, this decarbonising effort has focused on the power sector, through the promotion of Renewable Energy Sources for Electricity (RES-E). These technologies registered a huge global growth in recent years and, nowadays, lead capacity additions worldwide (IEA, 2018). Even if the cost of producing electricity through these resources has dropped in the last decade, experts estimate that the economic support to RES-E will keep on growing until 2035. This has of course an impact on electricity bills; charges applied to recover RES-E support costs (together with other items usually referred to as policy costs) are the tariff element that grew most rapidly in the last decade, especially in Europe, where renewable incentives have historically been more generous (ACER/CEER, 2018; EURELECTRIC, 2016). The resulting growth in electricity prices for residential customers in an economic phase of strong recession (following the 2009 crisis) intensified, in many countries, energy poverty issues (Bouzarovski and Tirado Herrero, 2017; Tirado Herrero and Jiménez Meneses, 2016).

This article delves into the relationship between RES-E charges and energy poverty. Some recent investigations, many of which focused on Germany, showed the potential regressive impact of charges used to recover renewable support costs (wealthier households pay a much lower share of their income to cover RES-E support costs than the one paid by poorer household; see literature review in the next section). This brief article aims at demonstrating this regressive effect through a simple comparative analysis of the distribution of incomes and electricity consumptions, focusing on the context of developed countries. The goal is to put forward "easy" arguments to counteract the idea, very widespread (mainly, but not only) in the media, that renewables have an intrinsic positive impact on poverty.

1.1 Brief literature review and research objectives

In the news industry, renewable resources are often mentioned as a tool to alleviate poverty (The Guardian, 2015; The New York Times, 2015; The Huffington Post, 2012). This statement highlights the positive effect that distributed renewables may have in the context of rural electrification in developing countries[1]; however, many times this argument conveys a more generic message that is supposed to be valid also for more advanced economies. Some documents from the European Commission and from some political parties across Europe seem to share this vision[2], especially when analysing the impact of self-consumption or energy communities.

These arguments are far from being supported by academic research. On the one hand, distributed energy resources have not proved to be the most economic efficient way to guarantee affordable supply to vulnerable customers. On the other hand, many scientific articles studied the effect of RES-E charges on low-income consumers and found a regressive impact that could intensify energy poverty[3]. Many of these studies focus on the German energy transition (Neuhoff et al., 2013; Schlör et al., 2013; Frondel et al., 2015; Diekmann et al., 2016; Böhringer et al., 2017), due to the significant impact on electricity tariffs of the EEG surcharge (see the next section); other articles analyse the problem from a more theoretical perspective (Bouzarovski and Tirado Herrero, 2017; Farrell and Lyons, 2015; Ürge-Vorsatz and Tirado Herrero, 2012), focusing on the relationship between energy poverty and energy transitions.

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[1] See, among others, Geal et al. (2018), Yadar et al. (2019), and Ma and Urpelainen (2018).

[2] The H2020 call for proposals "LC-SC3-EC-2-2018-2019-2020: Mitigating household energy poverty" states that "*energy efficiency measures at the household level and increased use of renewable energy are key tools in addressing energy poverty*"; the Spanish political party Podemos published on its official website an article stating that "*self-consumption has proved to be a tool to fight against energy poverty*".

[3] The impact of progressive and regressive taxes is a topic widely covered in economic literature and conflicting opinions can be found. However, there is a certain consensus on the fact that regressive taxes represent a burden for the poor; for a comprehensive review, see Martin and Prasad (2014)

The goal of this paper is to study this regressive impact from a different perspective, analysing the divergence in the distribution of incomes and electricity consumptions in industrialised economies. The document is organised as follows. Section 2 presents recent figures on the evolution of RES-E support costs. Section 3 focuses on the allocation of these costs, both from a theoretical point of view and looking at international experiences. Section 4 demonstrates the regressive impact of RES-E charges through data from international surveys and presents alternative methodologies for the allocation of these costs. Section 5 concludes.

2 RECENT AND EXPECTED EVOLUTION OF RES-E SUPPORT

The deployment of RES-E technologies, wind and photovoltaic above all, has registered a dramatic acceleration in the last decade. Even if these resources still account for a relatively small share of electricity generation worldwide, they lead global capacity additions (new capacity installed each year) since 2015, as shown in the upper chart of Figure 1.

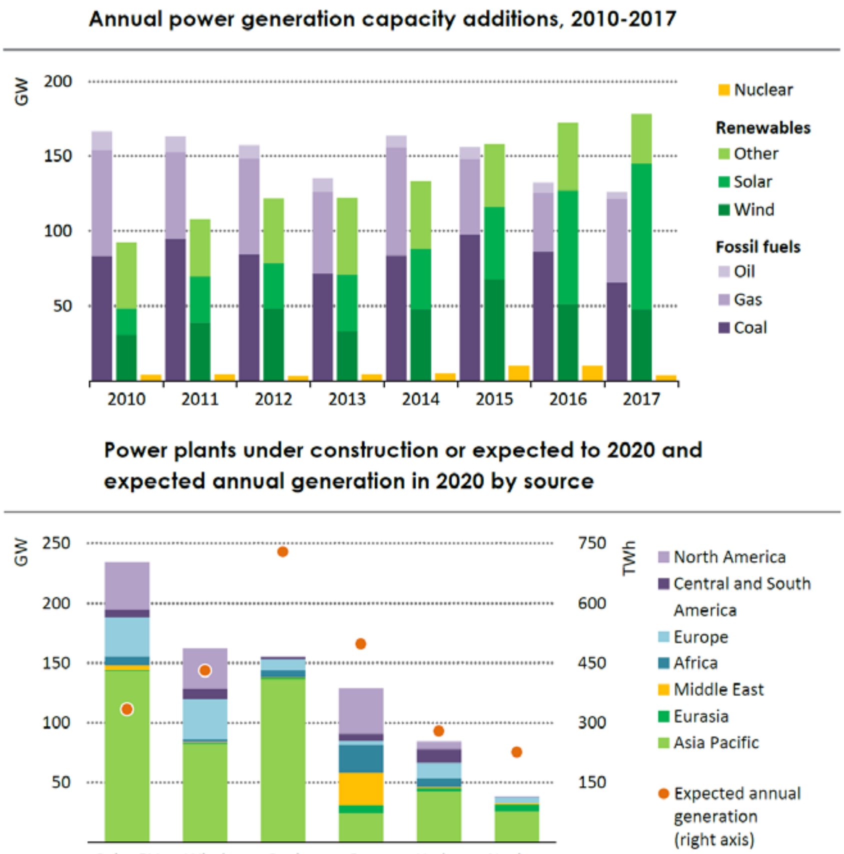

Figure 1. Historical capacity additions and power plants currently under construction worldwide; captures from IEA (2018)

Out of 870 GW of generation capacity currently being installed worldwide, more than 45% is wind or solar photovoltaic (lower chart in Figure 1). The cost of producing electricity through these technologies already lays in the fossil-fuel cost range (IRENA, 2018). This result has been achieved through RES-E support schemes that allowed a fast-paced scale-up of renewable energy. Some countries invested a huge amount of money to incentivise the deployment of renewable technologies in their power sectors. Figure 2, Figure 3, and Figure 4 present the evolution of the total RES-E support budget in three representative European countries (Germany, Spain, and Denmark, respectively).

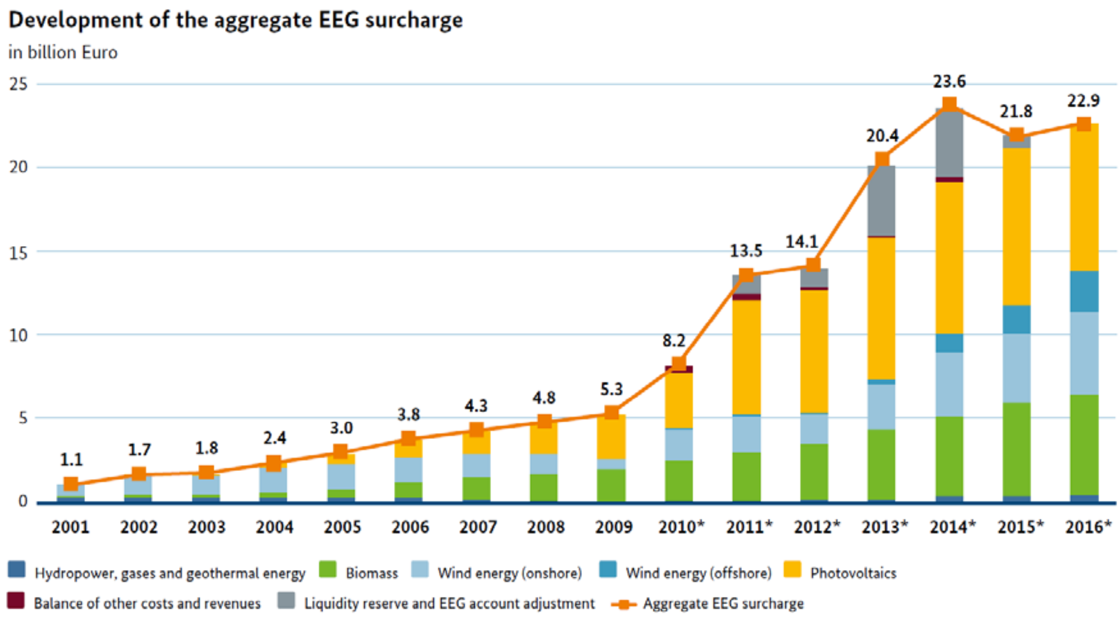

Figure 2. Total yearly RES-E support costs in Germany (BMWi, 2016)

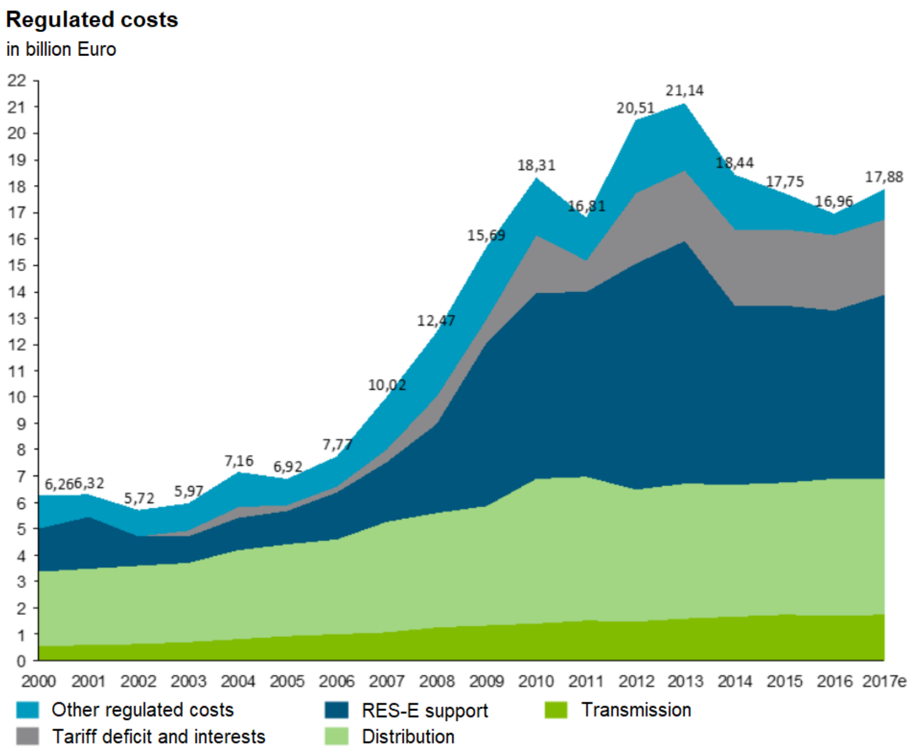

Figure 3. Total yearly regulated costs in Spain (energiaysociedad.es on CNMC data)

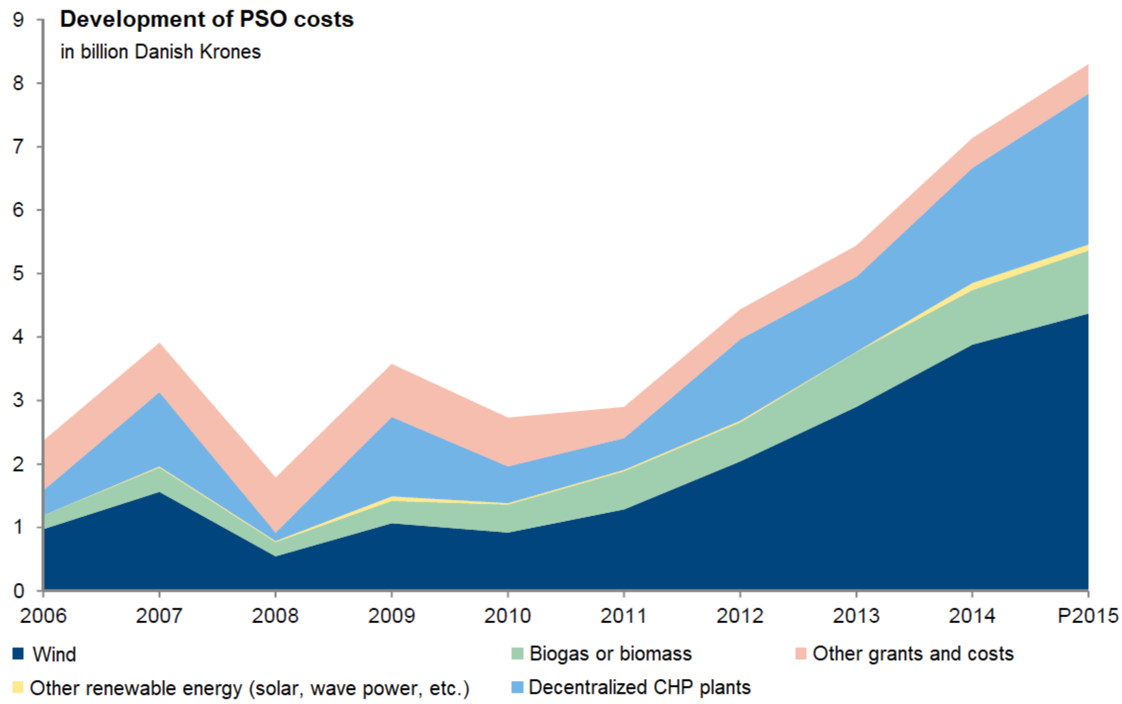

Figure 4. Total yearly PSO costs in Denmark (Klimarådet, 2016)

As it will be analysed in the following section, the growth of the annual budget dedicated to RES-E support had a significant impact on electricity tariffs in many European countries, especially for residential consumers.

Now that renewable technologies start being competitive in electricity markets, with levelised costs in the same range of conventional resources, it may be thought that RES-E support will decrease in the following decades. However, experts expect these costs to grow from 143 billion USD in 2017 to 300 billion USD in 2035 (IEA, 2018), as shown in Figure 5. This is due, on the one hand, to the larger pool of renewable generation capacity eligible for support, and on the other hand, to the deployment of RES-E technologies that are still not competitive, as off-shore wind. If the allocation of these increasing costs follows the current trend, this growth will be reflected in electricity tariffs.

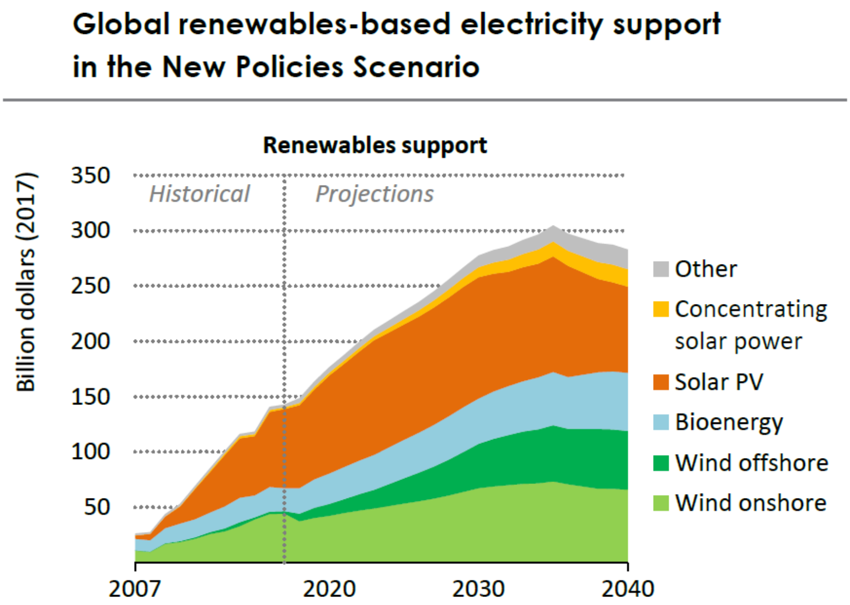

Figure 5. Historical and expected global RES-E support per technology; capture from IEA (2018)

3 ALLOCATION OF RES-E SUPPORT COSTS

3.1 Principles of ratemaking

How should these growing RES-E support costs be recovered? The leading ratemaking principle to be followed in this case is probably cost-causality (Pérez-Arriaga, 2013) or its dual principle, i.e., beneficiary-pays. If the latter is to be considered, who benefit from RES-E support? The final outcome is a reduction in greenhouse gases that allows to slow down global warming, which, by definition, is a global problem; thus the beneficiaries of these measures are the entire world population. Of course, it is hard to envision a global charge to be paid regardless of the location of these resources. However, if the analysis is limited to a single country, it can be stated that all the citizens of such country benefit in the same way from the penetration of renewable resources. The application of the beneficiary-pays principle, therefore, would result in including the RES-E support costs in the state budget, thus asking a contribution from all taxpayers. Nonetheless, as discussed in the following subsection, this is by far the less widespread solution.

3.2 Current trends

In most of the countries that incentivised the deployment of renewable resources, RES-E support costs remain within the accountability of the electricity sector, being recovered through specific charges in electricity tariffs. Therefore, even if all citizens benefit from these regulatory measures, only electricity consumers pay for them. It may be argued that, in modern economies, the set of taxpayers coincides with the set of electricity consumers (since almost all families pay some tax and almost all families pay an electricity bill); however, the implications are completely different, as analysed in the following section.

A comprehensive revision of RES-E allocation methodologies in Europe can be found in Batlle (2011). As analysed in this article, the vast majority of regulators opted to recover RES-E cost through simple volumetric charges[4] (€/kWh), calculated dividing the overall budget of the support scheme by the overall electricity consumption. In certain jurisdictions, the pool of electricity consumers who have to pay the RES-E charge has been restricted, excluding industrial consumers who compete on international markets[5], thus increasing the burden for residential customers.

This widespread cost allocation methodology has translated the sustained growth of the annual budget for RES-E support in a continuous rise in electricity tariffs. In Europe, the

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[4] In some cases, as in Spain, the RES-E surcharge is divided into a volumetric charge (€/kWh) and a capacity charge (€/kW-month), but the impact for consumers can be expected to be the same. The findings of this article should be valid also with such tariff design, since the assumptions regarding the relationship between electricity consumption and household income can be replicated for the contracted capacity.

[5] This is the case, for instance, in Germany, where, under the so-called Special Equalisation Scheme, companies with high electricity costs pay only 15% of the surcharge for all consumptions exceeding 1 GWh.

share of renewable charges in the electricity bill of end-consumers has more than doubled between 2012 and 2017, as shown in Figure 6.

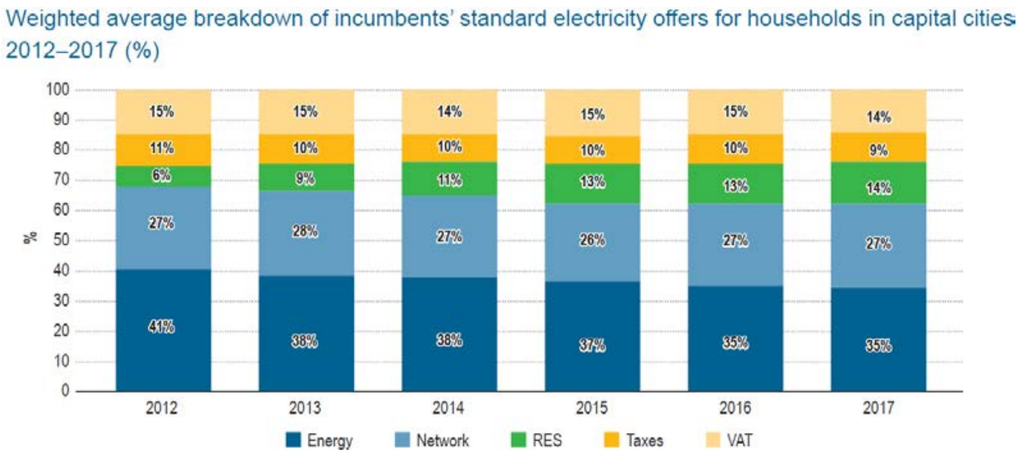

Figure 6. Evolution of the main electricity tariff component in Europe; capture from ACER/CEER (2018)

This situation is forcing some European countries to pursue alternative solutions. In Denmark, the country with the highest share of renewables in the continent, the Government decided to phase out the so-called PSO charge between 2017 and 2022 (The Danish Government, 2018) and to cover RES-E support costs through the state budget[6].

4 POTENTIAL IMPACTS ON ENERGY POVERTY

The goal of this section is to study the implication of recovering RES-E costs entirely through surcharges in electricity tariffs. The objective is to answer the following question: if RES-E surcharges were equated to a tax, which kind of tax would they be?

[6] It must be remarked that this decision had two different motivations: i) to guarantee an affordable electricity supply to residential consumers; and ii) to increase the competitiveness of industrial consumers on international markets.

4.1 Diminishing marginal utility of electricity

The electricity consumption of a household has many determinants (Kavousian et al., 2013) and income is definitely one of them (Cayla et al., 2011; Vringer et al., 2007; Biesiot and Noorman, 1999). Wealthier households are likely, all other factors being equal, to consume more electricity than poorer households. However, this relationship is not linear, as it will be shown with figures in the next subsection. Two reasons can be mentioned for this lack of linearity. The first, of course, is the diminishing marginal utility of electricity supply. As consumption increases, the value of an additional kWh decreases. This means that, if a poorer family has one refrigerator, a wealthier family, whose income is, for instance, ten times larger, may have two or three refrigerators, but most probably will not have ten refrigerators in a single house. The second reason is related with the fact that wealthier families can afford more efficient appliances or better insulation in their household, and this may reduce their load. Therefore, household electricity consumption is expected to grow with the family income, but more slowly than the income grows.

4.2 An empirical analysis on energy consumption surveys

This effect can be observed in the results of surveys on energy consumption. This kind of surveys are widespread in English-speaking countries. This section focuses on surveys from the United States (EIA, 2015), the United Kingdom (CSE, 2013), Canada (Natural Resources Canada, 2011), and New South Wales in Australia (IPART, 2015). Data from these four jurisdictions are summarised in Table i.

Table i. Income vs. electricity consumptions in different jurisdictions; data from EIA (2015), CSE (2013), Natural Resources Canada (2011), and IPART (2015)

United States	
Annual income [USD]	Yearly consumption [kWh]
Less than 20 000	8 547
20 000 to 39 999	9 716
40 000 to 59 999	10 748
60 000 to 79 999	11 225
80 000 to 99 999	11 470
100 000 to 119 999	12 227
120 000 to 139 999	12 959
More than 140 000	14 053

United Kingdom	
Annual income [GBP]	Yearly consumption [kWh]
5 049	3 375
9 122	3 581
12 505	3 775
16 103	4 031
20 174	4 274
24 602	4 341
29 689	4 619
35 995	4 770
45 331	5 125
79 213	5 877

Canada	
Annual income [CAD]	Yearly consumption [kWh]
Less than 20 000	8 670
20 000 to 40 000	10 076
40 000 to 60 000	11 006
60 000 to 80 000	11 194
80 000 to 100 000	11 187
100 000 to 150 000	12 559
More than 150 000	13 172

New South Wales	
Annual income [AUD]	Yearly consumption [kWh]
Less than 41 600	3 885
41 600 to 78 000	5 061
78 000 to 156 000	6 050
More than 156 000	7 477

In order to highlight the different evolution of income and electricity consumptions among different income categories, data in Table i have been normalised dividing them by the parameter corresponding to the first income group[7] and the results are presented through charts in Figure 7.

[7] Where income is expressed as an interval, the average value is considered. In these cases, the last value (more than…) is obtained through an interpolation. These simplifications may generate some imprecision, but they are not expected to alter the results.

Figure 7. Normalised income and electricity consumption in different jurisdictions.

These charts clearly show the effect that was mentioned above: the family income grows more rapidly than the electricity consumption of the household. In other words, incomes are less evenly distributed among the population than electricity consumptions. This trend is likely to be found in other industrialised economies[8], so a similar behaviour can be expected, for example, in most European countries.

The implications of this trend are clear: if the contribution to RES-E support costs is directly proportional to the electricity consumption of the household, then it grows throughout income categories less rapidly than the income does, thus generating a regressive impact. This effect can be observed through an extremely simple example, presented in Table ii and Figure 8, where a renewable surcharge (in this case, equal to the German EEG surcharge for 2018, i.e., 0.068 €/kWh) is applied on the electricity consumption data of the United Kingdom (as presented in Table i). The exercise proposed in this numerical example is totally static, no demand elasticity is considered, since the objective is simply to analyse a hypothetical current allocation of RES-E support costs among different income categories.

[8] On the contrary, this result may not be valid in developing countries, where many people have no access to modern electricity services. In these countries, electricity consumptions may be less evenly distributed than incomes. Jacobson et al. (2005) examined this difference between industrialised and industrialising economies through the calculation of Gini coefficients for both income and energy consumption.

Table ii. Numerical example on the regressive impact of a volumetric RES-surcharge

Annual income [GBP]	Yearly consumption [kWh]	RES-E expenditure [GBP]	RES-E expenditure [% of income]
5 049	3 375	201	3,99%
9 122	3 581	214	2,34%
12 505	3 775	225	1,80%
16 103	4 031	240	1,49%
20 174	4 274	255	1,26%
24 602	4 341	259	1,05%
29 689	4 619	276	0,93%
35 995	4 770	285	0,79%
45 331	5 125	306	0,67%
79 213	5 877	351	0,44%

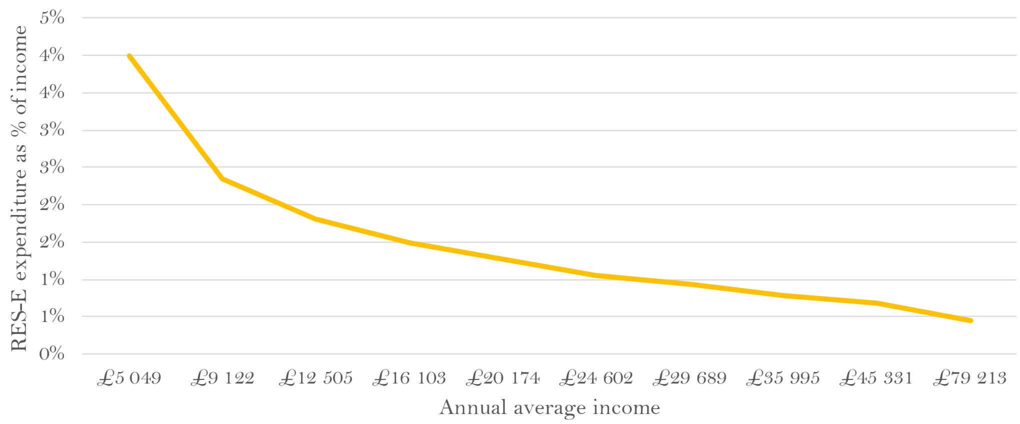

Figure 8. Decreasing RES-E expenditures as percentage of annual incomes, from the numerical example

As the income increases, the share of the household income used to cover RES-E support costs becomes smaller and smaller. An average customer in the poorer segment would be spending almost 4% of her incomes on this cost item, while an average customer in the wealthier segment is paying only 0.4% of her incomes. If the RES-E surcharge were a tax, it would defenitely be a regressive one[9].

[9] The impact of renewable energy technologies on electricity tariffs may actually go beyond RES-E surcharges. Distributed energy services may hamper the recovery of some network and policy costs (Oppenheim, 2016; Picciariello et al., 2015), thus creating a further impact on energy poverty. Many jurisdictions are now facing

4.3 Possible alternative allocation methodologies

In order to avoid this regressive effect and its potential impact on energy poverty, possible alternatives must be studied for the allocation of RES-E support costs. This section considers four alternative options, presented hereunder.

Recover RES-E support costs from all energy consumers

As already mentioned, many countries focused their emissions-reduction efforts on the electricity sector. This approach may be economic-efficient, because interventions in the electricity sector may have a higher benefit at a lower cost if compared with other energy sectors. However, the methodology defined for the allocation of these costs must take into account the distribution of the overall emissions-reduction target among different sectors. Batlle (2011) proposed to divide the RES-E support burden among different energy sectors according to their contribution to total emissions. For instance, a surcharge could be included in the price of gasoline to cover part of the RES-E support costs.

This alternative is efficient from an economic perspective; however, it may not solve the distributional effect that has to be tackled. In fact, the same uneven distribution observed between income and electricity consumption may be registered between income and the consumption of other energy vectors; thus, the impact of these surcharges may still be regressive.

the need for a redesign of their electricity tariffs. However, this topic exceeds the scope of this article. See Batlle et al. (2018) for a comprehensive discussion.

Assign RES-E costs through some proxy of wealth

If RES-E support costs must remain within the electricity sector, a possible approach to elude the regressive impact is to avoid volumetric charges (or capacity charges). RES-E costs may be recovered through an uneven fixed charge that factors in the wealth of the household. The fixed charge could be proportional to some proxy of wealth, as, for example, the property tax of the household. A similar solution has been proposed in MITEI (2016) for the allocation of residual costs.

This approach may partially reduce the regressive effect analysed in this article, but the outcome may be imprecise, since it is related to a proxy that may not be able to accurately reflect income distribution. Beyond that, this methodology may be subject to technical problems (some jurisdictions do not apply any property tax, especially on the first dwelling) and may have low political acceptance.

Include RES-E support in the state budget

In subsection 3.1, it was mentioned that, since all citizens benefit in the same way from renewable penetration, the application of the beneficiary-pays principle to RES-E costs would imply including these expenditures in the state budget, allocating them among all taxpayers. RES-E surcharges disappear from the electricity bill and so does, apparently, their regressive impact. Nonetheless, it must be remarked that moving RES-E costs to the state budget may have a progressive or regressive impact depending on the overall design of the taxation system of each country and on the equilibrium among income taxes, property taxes, sales taxes, etc. However, even if the impact kept on being regressive (because the majority of the state budget is collected through regressive taxes), this solution would be preferable, because the “regressivity” of the whole taxation system would still be the outcome of a regulatory decision and would be continuously monitored, while this is not the case with the regressivity of the RES-E surcharge in electricity tariffs.

This alternative is usually subject to two main criticisms (see, for instance, Diekmann et al., 2016). The first is that this form of RES-E financing may cause a stop-and-go policy, due to potential restrictions in annual budgets that may generate economic cycles in renewable investments. Nonetheless, there are many services financed through the state budget that do not suffer this kind of volatility (education, healthcare, etc.) and a stabilisation fund may be introduced in order to cover large or unexpected yearly variations. The second criticism regards the impact on energy efficiency. According to some authors, removing RES-E surcharges from the tariff leads to lower electricity prices and this may reduce the incentive to be energy-efficient. Nonetheless, this line of thinking is contrary to basic economic theory on tariff design. The optimal incentive for energy efficiency is a properly defined electricity price that reflects the marginal cost of providing such service, with a sufficient level of spatial and temporal granularity. RES-E costs, which, in many jurisdictions, can be considered as residual costs, do not affect the marginal cost. If these costs have to be recovered through electricity tariffs, most experts agree that they should be included in a fixed charge that does not affect the optimal signal conveyed by the marginal price (MITEI, 2016).

RES-E support costs are currently covered through the state budget in Finland, Malta, Latvia (CEER, 2017), and The Netherlands (Batlle, 2011); this approach will be adopted also in Denmark after the phasing-out of the PSO charge (The Danish Government, 2018).

Cover RES-E support costs through the revenues of auctions for emission allowances

Many emission trading schemes have been implemented worldwide in the last decades to limit greenhouse gas emissions. The European Union Emission Trading System (EU ETS) is probably the most famous experience, but there are similar schemes in place also on the other side of the Atlantic (as the Regional Greenhouse Gas Initiative and the Western Climate Initiative), while China has recently introduced its own National Emission Trading

Scheme. All these mechanisms rely, to a greater or lesser extent, on the auctioning of emission allowances.

According to EC (2017), the European Union collected almost 12 billion EUR from these auctions in the period 2013/2015 and redistributed these revenues among Member States. According to the Ecologic Institute (2016) part of these revenues is already being used to support renewable energies; however, most of these funds are invested in R&D projects or programmes that incentivise distributed energy resources or smart grids.

According to EC (2017), the revenues from the auction of emission allowances are expected to grow significantly in the next decade. Using these revenues to cover part or the totality of RES-E support costs may certainly reduce the burden on those who are less well-off.

5 CONCLUSIONS AND POLICY IMPLICATIONS

The French yellow-vests movement, with all its complexities, evidenced the high political and social cost that energy transitions may have. World regulators acknowledged this important aspect in the fight against global warming and are already claiming for a just transition, as in the Silesia Declaration (COP24, 2018). These claims are focusing on the impact that energy transitions may have on specific sectors of the economy or on specific categories of workers. Nonetheless, the evolution towards a low-carbon economy must be backed by a huge economic effort (see Figure 5) and the fairness of this transition should consider also how these costs are allocated within the society.

This article demonstrates how RES-E surcharges currently included in electricity tariffs represent a regressive "tax" that increases the burden on the poorer sector of society and can intensify the problem of energy poverty. This thesis has been demonstrated through very simple arguments (related to the different distribution of incomes and electricity consumptions) that can be used to counteract the idea, very widespread (mainly, but not only) in the media, that renewables have an intrinsic positive impact on poverty. The article also puts forward some alternative approaches to avoid this regressive effect, such as, among others, covering RES-E costs through the state budget or financing this support through the revenues of the auctions for emission allowances. These measures, or a combination of them, must be included in the climate agenda of industrialised countries for their energy transitions not to come at a very high social cost.

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