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Network charging and residential tariffs: A case of household photovoltaics in the United Kingdom

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ABSTRACT

Currently, about one million households in the United Kingdom (UK) have installed solar photovoltaic (PV) panels with about two-thirds of them are using the panels for self-generating power. According to the UK Department of Energy & Climate Change, solar PV deployment in the UK (measured in megawatt) has grown considerably (from 95 MW in 2010 when the feed-in tariff was introduced to 11,429 MW in 2016). The popularity of the solar PV among the UK households made the government to introduce major changes to the scheme.

Our paper focuses on the two major questions: Could it be that the system already favours richer consumers or certain types of network user who do not bear either the efficient or fair share of the total system distribution (and transmission) costs? Does the apportionment of charges between fixed, per kW peak and per kWh use of system charges need to be changed to be more cost reflective?

We employ the data from the smart meters readings provided by the Customer-Led Network Revolution monitoring trial conducted with the 199 households in the Northern England that provides the data for the household electricity use and tariff behaviour between October 2012 and July 2014.

Our analysis demonstrates that, similar to other studies conducted around the world, the increase in the solar PV resulted in a transfer of wealth and costs between customer groups. Due to their own production, UK solar PV consumers yield a lower share of the per kWh costs of the distribution system which leads to the increase of per unit charges as well as the changes in the distribution of their payment between different types of households.

1. Introduction

In 2008, the UK government adopted the 2008 Climate Act and set up a target for itself to decrease the carbon emissions by 35% in 2020, and by 80% in 2050. Although UK (alongside with France) is amongst the most reluctant countries when it comes to the binding renewable commitments which can be attributed to the regulatory issues and administrative barriers, it is also one of the most hard-line supporters of carbon reduction [24]. One of the most useful ways how to achieve this ambitious goal is the increasingly wider use of distributed renewable energy (DRE), in particular domestic solar photovoltaic (PV) systems. In the UK, similar to many countries, it is done through generous capital subsidies for households installing solar PV [26,27].

Solar energy occupies the leading position among other renewables both with regard to its popularity among the general public and with its broad support by the stakeholders and policy-makers. Similar to many other countries, the UK government initiated subsidies for households installing solar photovoltaic systems (solar PV). This has been done despite the fact that due to its geographical position and its climate, the use of solar energy in the UK might be not a very practical model in comparison with, for example, the case of the Masdar city in the Persian Gulf with its year-round sunlight [25].

1.1. Electricity prices and tariff methods

Electricity service is dealing with the delivery of both power (kW), energy (kW h) and power quality (e.g. voltage, frequency, or blackouts and interruptions) in particular geographic locations. Electricity consumers value each of these attributes directly, reveal their preferences for each attribute and theoretically and technically it seems possible to charge for each of these dimensions of service. However, it has become a tradition on electricity markets to offer customers bundled prices.

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From the economic point of view, the welfare Ramsey-Boiteux pricing suggests that more fixed costs should be recovered from richer or price-inelastic customers with a trade-off between these two characteristics, thence it seems that some network charges should be targeted on generation side to provide correct signals. In doing so, it would be possible to apportion fixed costs by income, property value, kW connection capacity or another indicator of income (or ability to pay, such as possession of an electric vehicle (EV) charging point) which did not result in electricity market distortions. Among alternative network charging principles are, for example: cost reflective charging, traditional public service pricing, platform market pricing, or customer-focused business model pricing.

As the renewable energy sources start to gain larger shares of the traditional electricity markets, the total system costs come down, the total fixed costs are reduced, and system marginal costs are reduced. However, the question arises: when the total system costs fall, should it be the new users or the existing users who benefit from this?

The solution might be in introducing new changes to the existing tariff methods such as maximum kW export charge, based on the design rating of the household with PV which both consume and export their electric energy. Our paper analysis these issues and attempts to find new arguments and solutions for new charges and tariffs in the situation with photovoltaics deployment on the traditional electricity markets.

Currently, UK households are currently paying one of the lowest retail electricity prices in the EU 15 being well under the EU 15 median and belonging to the group of the EU countries with the similarly low electricity prices such as Finland, France or Luxemburg (and far away from the counties with the highest prices such as Denmark, Belgium and Germany). According to DECC (2013) [13], wholesale gas and electricity costs currently make up the largest proportion of an average household energy bill and constitute around 47% in 2013. Transmission, distribution and metering costs accounted for 20%, other supplier costs and margins accounted for 19% and VAT 5%.

In 2013, the average household electricity bill in the UK was £576 (in real 2012 prices and before rebates). Wholesale energy costs were estimated to make up around 37% of an average household electricity bill. According to the Customer-Led Network Revolution (CLNR) project [9], in 2011 suppliers made a margin of around 4% of the total electricity cost and the distribution charges represented 16% of the cost of the electricity bill.

In the UK, the load profile (the time of the day and year that electricity is used) has a strong influence on the price paid per unit of electricity by the consumers. Those customers who do not use half-hourly metered data, the exact daily consumption is not known and the periodic meter readings (typically a few times a year) is recorded and converted for billing purposes into half-hourly profiles based on standardised load profiles, or profile classes (see Table 1).

About 80% of non-HH users (around 23.5 million UK households) fall under an "Unrestricted" profile class. A further 18% of non-HH users are under a "Economy 7″ class and have a two-rate meter that allows for a cheaper off-peak (and higher daytime) tariff. Moreover, Table 2 provides a comparison of distribution charges and average customer bills in the UK for the year 2013.

From the overview of charges and average customer bills, it becomes apparent that between 7% and 20% of the HH customers' network costs are recovered in fixed charges while about 80–90% are recovered in kW h charges.

1.2. UK's household solar PV and FiT

Domestic solar PV technology is playing an important role in the transition to a low carbon energy network as one of the most affordable and effective sources of distributed renewable energy generation. The CLNR [10] study reported that the UK solar PV households annually generate an amount of electricity equivalent to over 40% of their annual electricity consumption and that 80% of that electricity is typically used on site.

UK's generation of renewable energy is fostered by Renewables Obligation (RO). The RO was initiated in 2002 and it obliges electricity suppliers to source an increasing percentage of generation from renewable sources. Electricity generators receive Renewable Obligation Certificates (ROCs) for the renewable electricity they generate from Ofgem (the Office of Gas and Electricity Markets).

Both in UK and worldwide, traditional carbon fuel generators have to set up their prices depending on time and location of generation and are being separately paid for capacity, energy, and ancillary services,-renewable energy generators are charging FiTs for the energy they produce regardless of the system condition or the network constraints [2].

Feed-in tariff (FIT) programs usually mean long-term contract under which the utility agrees to purchase the excess generation from a distributed generation (DG). Following these arrangements, the utility companies usually come up with a per-kW h purchase price with the rates varying from utility to utility thus resulting in a lot of contention. In the long run, the utility company pays the DG in a similar manner as they would pay a non-utility wholesale power producer. Under a FIT program, the DG is compensated at the predetermined rate for their surplus power.

In the UK, FiTs were first introduced in April 2010 to provide a fixed payment for generation from RES-E plant under 5 MW. The tariffs can be credited with driving the rapid deployment of PV in the UK, pushing up installed capacity from almost zero to 2.4 GW by June 2013 (DECC, 2013 [13]).

The majority of UK solar PV installations are concentrated in the residential and commercial sectors, while small-scale PV systems

Table 1
Electricity meters, billing type and consumption by profile classes in the UK.
Source: Adapted from [16]

Group	*Description*	*General billing type*	*Average annual consumption*
Profile Class 1	Domestic Unrestricted Customers	Estimated/Prepayment	2000 kW h (low) 3100 kW h (medium) 4600 kW h (high)
Profile Class 2	Domestic Economy 7 Customers	Estimated	2500 kW h (low) 4300 kW h (medium) 7200 kW h (high)
Profile Class 3	Non-Domestic Unrestricted Customers	Estimated	15,000 kW h
Profile Class 4	Non-Domestic Economy 7 Customers	Estimated	25,000 kW h
Profile Class 5	Non-Domestic Maximum Demand (MD) Customers with a Peak Load Factor (LF) of less than 20%	Estimated	82,000 kW h
Profile Class 6	Non-Domestic Maximum Demand Customers with a Peak Load Factor between 20% and 30%	Estimated	110,000 kW h
Profile Class 7	Non-Domestic Maximum Demand Customers with a Peak Load Factor between 30% and 40%	Estimated	130,000 kW h
Profile Class 8	Non-Domestic Maximum Demand Customers with a Peak Load Factor over 40%	Estimated	150,000 kW h