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Manuel Frondel, Stephan Sommer, and Colin Vance[1]

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Abstract

Germany's energy transition has been accompanied by a near doubling of power prices for private households since the outset of the new millennium. Millions of poor households and those that are close to the poverty threshold are likely to suffer from these increases in electricity cost. Focusing on low-income households, this paper illustrates the distributional implications of Germany's energy transition by investigating their electricity cost burden between 2006 and 2012, using data from the German Residential Energy Consumption Survey (GRECS). Our estimates suggest that in 2012, on average, households at poverty risk allocated 5.5% of their income to power and, hence, paid nearly as much for covering their electricity consumption as for heating purposes. Given Germany's ambitious targets to expand the share of costly renewable technologies in electricity consumption, which has broad support among the electorate, it is to be expected that households' expenditure for power will increase in the upcoming years. This raises the urgent question of how to mitigate the regressive impact of further increasing electricity prices on poor households. Direct cash transfers are suggested here as a non-distortionary instrument for easing the burden of high prices, one that is directly targeted at those endangered by energy poverty.

JEL Classification: Q21, Q28, Q47

Keywords: : Energy transition; feed-in tariff; German Residential Energy Consumption Survey

January 2015

1 Manuel Frondel, RWI and RUB; Stephan Sommer, RWI; Colin Vance, RWI and Jacobs University Bremen. *– We thank Mark Andor for valuable comments and suggestions and the Federal Ministery for Education and Research for the financial support within the project AKZEPTANZ (Grant 01 UN 1203C).* *– All correspondence to: Manuel Frondel, RWI, Hohenzollernstr. 1-3, 45128 Essen, Germany, e-mail: frondel@rwi-essen.de*

1 Introduction

Germany's transition of its energy system – in German called the Energiewende – is primarily characterized by two measures, the promotion of renewable energy technologies and the nuclear phase-out stipulated by the end of 2022 in response to the catastrophe in Japan's Fukushima. While there is a broad support among the population for both measures, this transition will inevitably lead to further increasing electricity prices (Tews, 2013:3). Although this is the price that has to be paid to reduce these risks, as well as the dependence on oil and gas imports, this transition bodes poorly for many low-income households, as power prices for German households have virtually doubled since the introduction of the feed-in-tariff promotion scheme for renewable energy sources (RES) in 2000.

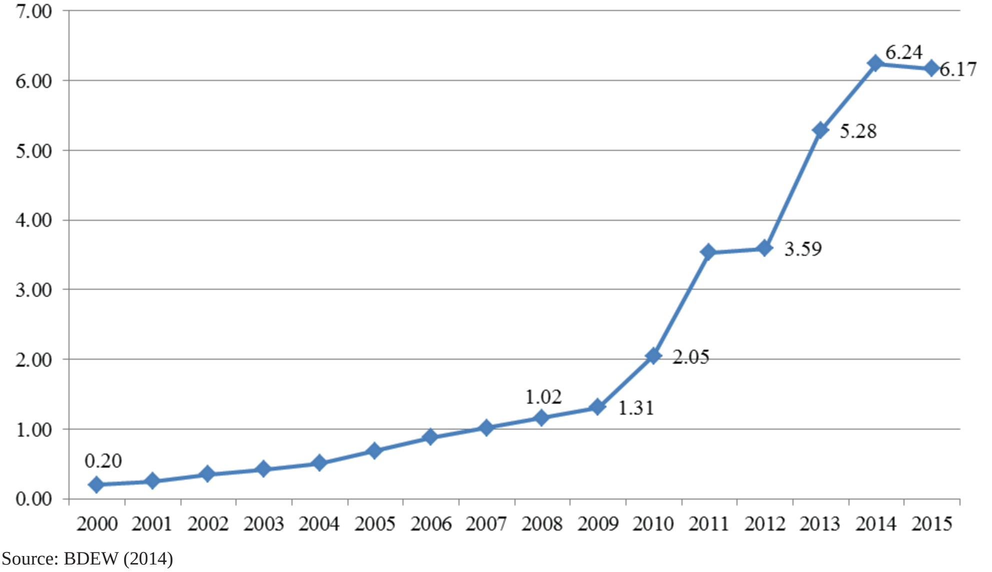
Under this promotion regime, which is legally codified under the Renewable Energy Sources Act (Erneuerbare-Energien-Gesetz, EEG), utilities are obliged to pay technology-specific feed-in tariffs far above own production cost to those who produce green electricity using alternative technologies, such as solar and wind power plants. Ultimately, though, it is the industrial and private consumers who have to bear the cost induced by the promotion of renewable energy technologies through a surcharge on the price of electricity, called the EEG levy (Frondel et al., 2010).

The financial support stipulated by the EEG is indispensable for increasing the share of "green electricity"; without it, the high cost of most renewable energy technologies would make it impossible for them to compete with conventional electricity production. Between 2009 and 2014, this surcharge almost quintupled, rising from 1.31 Euro Cent per kilowatt-hour (kWh) to 6.24 ct/kWh (Figure 1). A major reason for this strong increase was the massive installation of photovoltaic (PV) capacities in recent years: At the end of 2014, total PV capacities exceeded 38 Gigawatt (GW), an amount that was more than six times higher than the 6 GW installed in 2008 (BMWi, 2014a, Table 1). With 6.17 ct/kWh in 2015, the EEG levy will temporarily stagnate, but a further increase in this levy and, hence, electricity prices is most likely if Germany keeps a similar pace in expanding its share of renewables in electricity production as over the past 15 years.

Focusing on low-income households, as these are prone to the risk of fuel poverty (e.g. Heindl, 2014:3, Moore, 2012:19), this paper illustrates the distributional implications of Germany's energy transition by analyzing the evolution of the households' electricity cost burden between 2006 and 2012, using panel data from the German Residential Energy

Consumption Survey (GRECS).[1] Our estimates suggest that low-income households are particularly adversely affected by recent power price increases: On average, our sample households spent 2.6% of their income for electricity in 2012, while households below the poverty risk line, defined by Germany's fourth Poverty Report at 60% of the median income, allocated 5.5% of their income to power. For some types of low-income households, this burden is even much higher and has steadily increased over time. Meanwhile, it is comparable to the proportion that households spend to satisfy their demand for space and water heating. For a significant number of sample households at poverty risk, total energy cost adds up to more than 10%, a threshold at which the British Department of Energy and Climate Change (DECC 2013) used to define households suffering from fuel poverty.

Figure 1: EEG Surcharge on Electricity Prices for the Promotion of Renewable Technologies in Cent per Kilowatt-hour (kWh)



Source: BDEW (2014)

Given Germany's ambitious targets to expand the share of costly renewable technologies in electricity consumption, which various surveys indicate to have broad public appeal (e.g. Andor, Frondel and Vance, 2014), it is to be expected that households' power expenditure will further increase in the upcoming years, not least due to the phase-out of the remaining power plants until 2022. This raises the urgent question of how to mitigate the regressive impact of increasing electricity prices on poor households and those that are

[1] For more information on the panel and the German Residential Energy Consumption Survey (GRECS), see the project homepage: http://en.rwi-essen.de/haushaltsenergieverbrauch

endangered by poverty. After all, low-income households suffer more from a growing electricity cost burden than wealthy households, clearly indicating the regressive nature of rising energy prices (Nelson et al., 2011, 2012). Since it is likely that Germany continues its widely respected energy policy, as the best strategy to offset the resulting regressive impact on the poor, we suggest unconditional cash transfers to households whose income qualifies them for assistance with their energy expenses.

The following section presents figures on the dramatic growth of renewable capacities since the enactment of the current promotion scheme in 2000, as well as the resulting increase in electricity prices. Section 3 illustrates the distributional implications of Germany's energy transition by analyzing the evolution of the households' electricity cost burden between 2006 and 2012, while Section 4 sketches possible future scenarios for electricity prices. The last section summarizes and concludes.

2 Renewable Electricity Production in Germany

In Germany, renewable energy technologies are promoted via a feed-in-tariff (FIT) system that has established itself as a role model and has been adopted by a wide range of countries in the world, even countries with a high endowment of sun such as Australia (Nelson et al. 2011). Among the countries of the European Union, FITs have become the most popular promotion scheme (CEER 2013). Since the implementation of Germany's FIT system in 2000, installed capacities of renewable energy sources (RES) have increased remarkably. In 2013, these capacities were almost seven times higher than in 2000 (penultimate column of Table 1). Photovoltaic (PV) systems and onshore windmills have experienced the largest expansion, with PV capacities sky-rocketing: In 2010 alone, more than 7,000 Megawatt (MW) were installed, an amount that easily exceeded the cumulated capacities installed by 2008.

Total capacities of RES amounted to about 84 Gigawatts (GW) in 2013, just 10 GW below those of conventional power plants (Table 1). Nevertheless, the share of green electricity in gross electricity consumption was only about 25% (Figure 2). This relatively modest share owes to the fact that wind and solar power are not available 24 hours a day.[2]

[2] For instance, while a year consists of 8,760 hours, a PV system installed in Germany exhibits just about 900 full load hours on average (BDEW 2014). The incongruous circumstance of Germany's limited endowment with sun, contrasted by its abundance of PV capacity, becomes particularly evident when compared with Australia, one of the sunniest countries in the world. While the average hours of bright sunshine ranges between 2,300 and 3,300 in Australia, it lies between 1,300 and 1,900 in Germany (Frondel et al., 2014:4).

Consequently, to reach Germany's renewable goal of a 50% share in gross electricity consumption set for 2030, a multiple of today's capacities have to be installed, an endeavor that will inevitably lead to higher cost of electricity generation. Moreover, a large portion of today's conventional power plants has to be sustained to compensate for the intermittency of wind and sun, since storing volatile green electricity is likely to remain unprofitable for decades. In short, future electricity prices will rise further if Germany actually reaches its renewable goals (Hessler, Loebert 2013:350).

Table 1: Conventional and RES Capacities in Germany

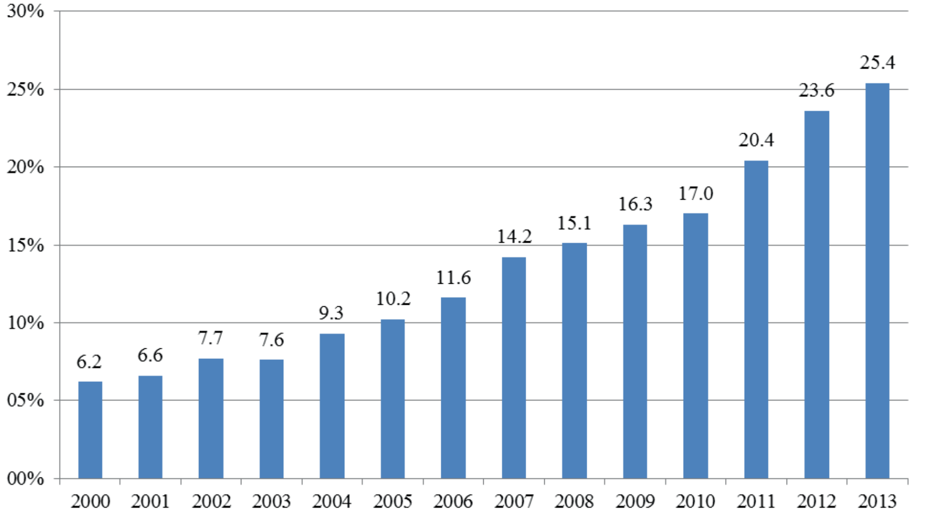
Year	Hydropower (MW)	Onshore-Wind (MW)	Offshore-Wind (MW)	Photovoltaic (MW)	Biomass (MW)	RES Capacities (MW)	Conventional Capacities (MW)
2000	4,831	6,097	0	114	1,288	12,330	107,500
2001	4,831	8,738	0	176	1,412	15,157	106,800
2002	4,937	11,976	0	296	1,615	18,824	100,900
2003	4,953	14,593	0	435	2,329	22,311	99,400
2004	5,186	16,612	0	1,105	2,630	25,533	100,900
2005	5,210	18,375	0	2,056	3,526	29,167	98,800
2006	5,193	20,568	0	2,899	4,283	32,943	98,400
2007	5,137	22,183	0	4,170	4,723	36,216	99,800
2008	5,164	23,815	0	6,120	5,256	40,358	101,700
2009	5,340	25,632	60	10,566	5,995	47,601	101,300
2010	5,407	27,012	168	17,554	6,599	56,748	104,000
2011	5,625	28,857	203	25,039	7,148	66,880	98,000
2012	5,607	30,996	308	32,643	7,537	77,103	97,300
2013	5,613	33,757	903	35,948	8,086	84,338	94,000

Source: BMWi (2014a). With an installed capacity of 24 MW in 2013, geothermic systems are of negligible relevance and thus not included in the table.

Some sense for the extent of this rise can be gleaned from past developments. Between 2000 and 2013, electricity prices more than doubled, from 13.94 to 28.84 ct/kWh (Figure 3). For typical households with an electricity consumption of 3,500 kWh per annum, this implies an additional burden of about 520 Euro per year. A key factor of this increase was the exploding installation of PV modules: The real net cost for all those modules installed between 2000 and 2013 accounts for some 110 Bn (Frondel et al., 2014:9) with PV currently comprising only about 5% of total electricity production.

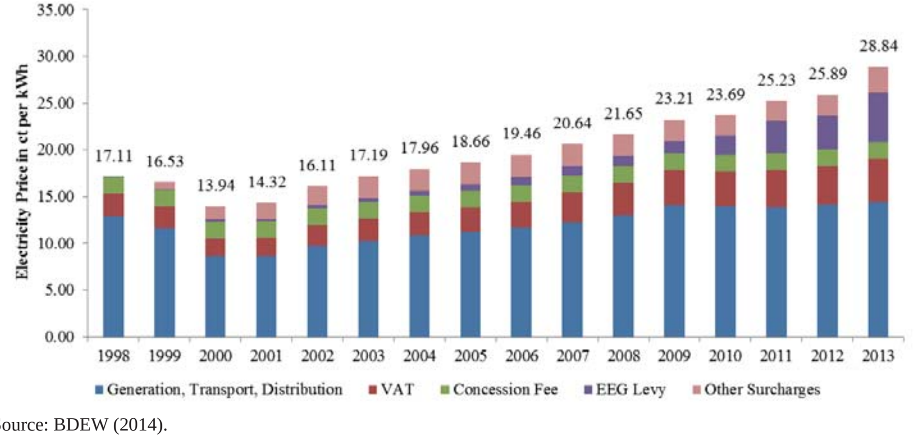
In terms of purchasing power parities, German households now incur the highest power prices in the European Union (EU) (Table 2). In a similar vein, prices for industrial customers are also among the highest in the EU, although wholesale prices at power exchanges shrunk between 2007 and 2013, a decrease that was mainly due to the augmented supply of green electricity (Würzburg et al., 2013, Ketterer, 2014).

Figure 2: Share of Green Electricity in Germany's Gross Electricity Consumption



Source: BMWI (2014a)

Figure 3: Composition of Residential Electricity Prices in Germany



Source: BDEW (2014).

Lower wholesale prices from the increased supply of RES, however, does not translate into lower retail prices because of the EEG levy that is required to cover the increase in average costs caused by the introduction of RES. Taxes and levies accounted for about 50% of the residential electricity price in 2013, whereas this share was as low as 30% in 2007

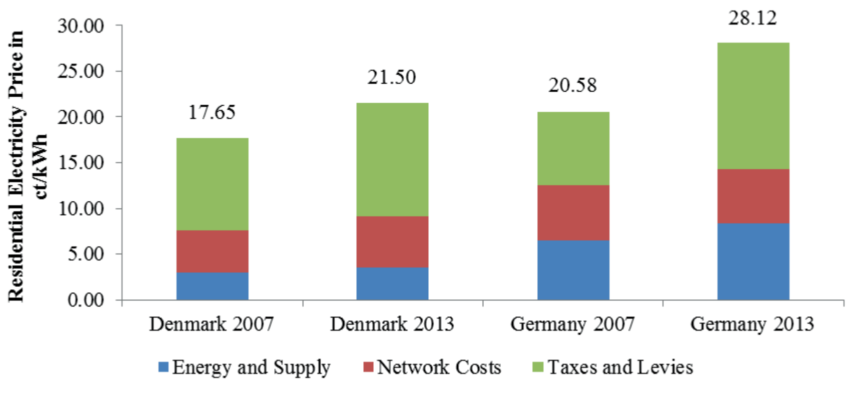
(Figure 4). Only in Denmark are taxes and levies of more significance than in Germany, accounting for 57% of the residential electricity price in 2013 (Figure 4). That the electricity prices for Danish households are among the highest in the EU is partly due to the subsidization of huge wind power capacities via feed-in tariffs (IEA 2011, ENS 2014), which, like Germany, was responsible for the fact that in this respect Denmark is among the leading countries in the world.

Table 2: Electricity Prices in Purchasing Power Standards EUR ct/kWh for Households and Industry in 2014

Country	Households	<500 MWh	<2,000 MWh	<20,000 MWh	<70,000 MWh	<150,000 MWh
Austria	18.14	13.83	11.72	10.31	8.99	7.77
Denmark	22.04	18.22	17.63	17.59	16.82	16.81
EU 28	20.47	18.28	15.27	13.41	11.79	10.61
France	14.08	12.41	10.28	8.84	7.94	7.02
Germany	28.57	23.09	19.85	17.45	14.96	13.88
Italy	24.17	23.25	19.76	16.93	15.07	11.26
Netherlands	16.55	15.52	11.33	10.31	8.79	8.54
United Kingdom	17.01	15.34	13.73	12.49	12.45	12.05

Source: Eurostat (2014). Average prices per kWh (including taxes and duties) in the first half of 2014 for households with an annual electricity consumption between 2,500 and 5,000 kWh, as well as industrial consumers of different consumption levels.

Figure 4: Electricity Prices in Purchasing Power Standards EUR ct/kWh for Danish and German Households with an Annual Consumption between 2,500 and 5,000 kWh



Source: Eurostat (2014).

3 Energy Cost Burden and Distributional Effects

Using panel data from the German Residential Energy Consumption Survey (GRECS) gathered by RWI and forsa (2011, 2013, 2015), this section's focus is on the regressive impact of rising electricity cost on households below the poverty risk line. This line is defined at 60% of the median of the equivalent (i.e., per-capita adjusted) household income (BMAS, 2013:461), henceforth equivalent median income (EMI).[3] This 60% threshold is a widely used relative measure of poverty (Neuhoff et al., 2013).

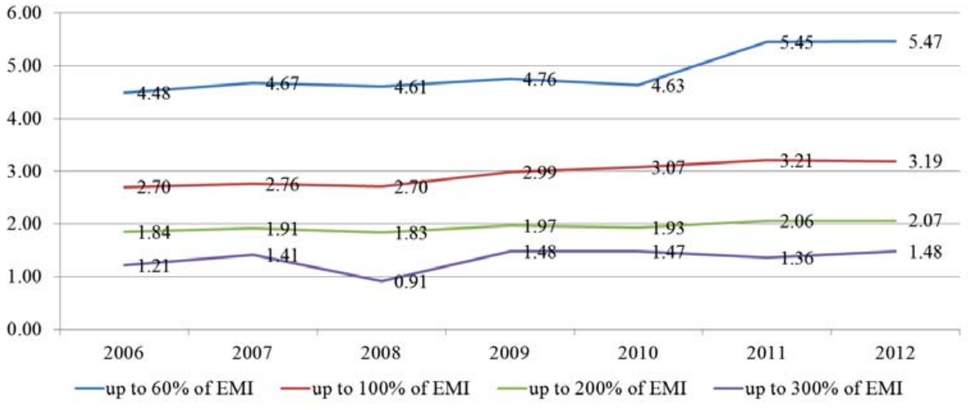
We employ data from three panel waves spanning the period 2006 to 2012 (RWI, forsa 2011, 2013, 2015), resulting in a database of about 7,800 households that at least once provided detailed information on their energy consumption and the related cost. For each of three panel waves, between 2,600 and 4,700 valid observations on households' electricity consumption and the resulting cost are available. In addition to detailed energy consumption data, respondents provide information on socio-economic and building characteristics.[4] While expenses for space and water heating are also available and account for a substantial share of energy-related expenditures, mobility costs are not included in our analysis. These costs are expected to be low among low-income households because such households often do not possess a car and instead use the public transport system, often with rebated tickets.

With respect to electricity consumption, the resulting burden – captured here primarily in terms of the proportion of electricity cost in net household income – tends to have increased for virtually all types of households, irrespective of their position in the income distribution (Figure 5). This increase, however, was most pronounced for those households that fell below the poverty risk line: In 2012, our sample households with low incomes spent, on average, almost 5.5% of their (equivalent) income on electricity, whereas the respective share was as low as 1.5% for wealthy households with incomes of up to three times the EMI. This gap between poverty-vulnerable and wealthy households has widened since 2006, when the respective proportions amounted to about 1.2% and 4.5%.

[3] Following other analyses, such as Neuhoff et al. (2013), the transformation of household income relies on the modified OECD scale, which assigns a weight of 1 to the head of household, 0.5 for each additional adult member (over 14), and 0.3 for each child (Hagenaars et al. 1994).

[4] Income is defined here as the net household income including salaries and, *inter alia*, all kind of transfers, capital gains, and incomes from rent.

Figure 5: Ratio of Electricity Cost to Disposable Income of German Households for a Variety of Income Levels.

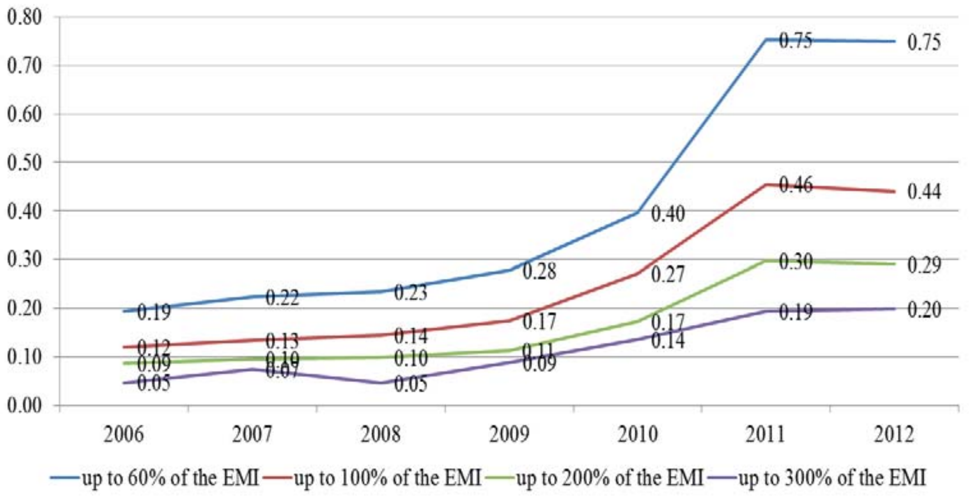


EMI = Equivalent Median Income

This regressive effect of rising electricity prices can also be observed for the surcharge for green electricity (Figure 6). In 2012, households below the poverty risk line spent 0.75% of their income for the promotion of renewables, compared with just 0.2% for those with a disposable income of up to three times the EMI. In 2006, these proportions were substantially lower and amounted to 0.19% and 0.05%, respectively. Coinciding with the tremendous increase in PV installations, particularly between 2009 and 2013 (Table 1), these shares began to surge in 2009, most notably for households at poverty risk (Figure 6). These results are in line with Nelson et al. (2011:113), who conclude that for low-income households in Australia, the effective taxation rate of FITs is three times that of the wealthiest households.

The distributional effects of increasing electricity prices become more apparent when focusing on particular household types that are prone to poverty. Single-person households are one such group. According to the fourth Poverty Report of the German government (BMAS, 2013:461), in 2011, 25% of single-person households earned an income that was lower than 60% of the EMI, while the overall poverty risk was about 15%. For our single-person sample households, the income proportion spent to cover their electricity needs rose by 26% between 2006 und 2012, from 4.1% to 5.2% (Table 3), most notably because average electricity prices increased by 30%, from 22.16 to almost 29 ct/kWh for this household type. Incomes grew much slower, by about 6%. Another indication of a mounting burden of single-person households is that electricity cost increased relative to housing rents: In 2012, the ratio of electricity cost to net cold rents averaged 13.5% for single persons below the poverty risk line, compared to 11.1% in 2006, an increase of somewhat more than 20%.

Figure 6: Cost Proportions of Green Electricity Promotion in Disposable Income of German Households



EMI = Equivalent Median Income

Table 3: Average Monthly Electricity Cost (in terms of the Median) of a Poverty-Vulnerable Single Person Household Earning up to 60% of the Median Income and Ratios of this Cost to both Net Income and Housing Rents.

Year	Number of Obs.	Price (ct/kWh)	Electricity Cost (€)	Income (€)	Portion of Income (%)	Obs.	Portion of Total Rent	Portion of Net Cold Rent
2006	60	22.16	28.27	694	4.13	42	8.21	11.14
2007	78	23.15	30.96	709	4.61	60	9.05	12.49
2008	81	24.05	32.89	723	4.65	62	9.14	12.88
2009	78	25.76	31.90	711	4.49	62	8.70	12.55
2010	114	26.07	34.10	724	4.71	97	9.45	13.29
2011	150	27.74	35.33	725	5.04	113	9.04	12.93
2012	177	28.80	37.30	738	5.20	142	9.21	13.50

Note that instead of marginal prices, in this and the following tables, we employ average electricity prices that are calculated by including the fixed base rate per kWh and adding it to marginal prices.

It is well-known that single parents are another group who are highly prone to poverty risks. In 2011, about 42% of all single parents earned an income of just up to 60% of the EMI, according to Germany's fourth Poverty Report (BMAS, 2013:461). According to our data, single-parent households are also particularly adversely affected by increasing power prices: In 2011, such households spent about 6.4% of their household income on electricity (Table 4), a rise of about two percentage points relative to 2006. Again, this owes to the fact that power prices have increased to a greater extent than incomes. Using net cold rents as an alternative benchmark, our data reveals that the ratio of electricity cost to the net cold rent increased from 12% in 2006 to almost 15% in 2011.

Childless couples at poverty risk appear to be yet another segment highly affected by rising electricity prices (Table 5). In 2012, their electricity expenditure accounted for more than 6.2% of their disposable household income.[5] This proportion marks an increase of 2.5 percentage points, from 4.7% since 2006. In contrast, with a corresponding share of 2.1% in 2012, childless couples with a household income of twice the EMI have a much lower electricity cost burden.

Table 4: Monthly Electricity Cost Burden of Single Parents

Year	Number of Obs.	Price (ct/kWh)	Electricity Cost (€)	Income (€)	Portion of Income (%)	Obs.	Portion of Total Rent	Portion of Net Cold Rent
2006	47	19.95	45.98	1 157	4.46	26	8.69	11.95
2007	50	21.56	47.70	1 181	4.77	27	10.02	13.61
2008	39	22.12	49.10	1 204	4.64	23	8.91	14.79
2009	55	23.55	52.02	1 186	5.71	29	10.48	13.71
2010	43	23.90	54.57	1 207	5.17	28	10.93	15.18
2011	54	26.36	57.88	1 209	6.41	27	10.16	14.75
2012	60	26.64	55.31	1 230	5.44	31	9.42	14.06

Table 5: Monthly Electricity Cost Burden of Childless Couples

Income Level	Year	Number of Obs.	Price (ct/kWh)	Electricity Cost (€)	Income (€)	Portion of Income (%)
Up to 60% of EMI	2006	44	20.11	46.94	1 157	4.65
	2012	104	26.15	62.79	1 230	6.23
Up to 100% of EMI	2006	183	19.59	49.62	2 083	2.73
	2012	538	26.14	66.97	2 213	3.24
Up to 200% of EMI	2006	339	19.29	56.63	3 009	1.80
	2012	944	25.69	70.91	3 250	2.10

Among all household types considered by the fourth Poverty Report, the lowest poverty risk exists for families with up to two children. In 2011, just one out of 10 of such households in Germany had a net income below the EMI (BMAS, 2013:461). Yet, for poverty-vulnerable sample households with up to two children, in 2012, the average electricity cost burden of 5.4% of net income was close to the average burden observed for all sample households at poverty risk (Figure 5 and Table 6).

In addition to power expenditure, poor households may suffer from heating cost, unless they receive basic or housing assistance that also covers this cost (Heindl, 2014:11). While data on heating cost is sparse in our database for some types of low-income

[5] While in 2006, the electricity cost of low-income couples aggregated to 11.2% of net cold rent, in 2012, this proportion was almost five percentage points higher.

households, particularly if fuels other than natural gas are employed for heating, we find that on average poor households spent about 7.1% of their income on heating when they use natural gas for this purpose (Table 7). Altogether, it may be easily the case that a low-income household's total energy cost for both electricity and heating adds up to a sizable portion of 12.6% of disposable income (7.1% for heating, see Table 7, and 5.5% for power, see Figure 1), thereby exceeding the 10% threshold for fuel poverty defined by the Department of Energy and Climate Change (DECC, 213).

Table 6: Monthly Electricity Cost Burden of Families with One Child or Two Children

Income Level	Year	Number of Obs.	Price (ct/kWh)	Electricity Cost (€)	Income (€)	Portion of Income (%)
Up to 60% of EMI	2006	75	19.00	67.94	1 620	4.50
	2012	120	25.35	90.21	1 721	5.43
Up to 100% of EMI	2006	192	18.62	68.18	2 546	2.69
	2012	439	25.18	87.76	2 750	3.09
Up to 200% of EMI	2006	243	18.68	74.74	3 935	1.97
	2012	443	25.45	96.87	4 429	2.04

Table 7: Monthly Gas Cost of German Households with Distinct Income Levels

Income Level	Year	Number of Obs.	Price (ct/kWh)	Gas Cost (€)	Income (€)	Portion of Income (%)
Up to 60% of EMI	2006	62	6.80	91.75	1 157	7.71
	2012	98	7.19	81.60	1 230	7.10
Up to 100% of EMI	2006	168	6.50	102.90	2 083	4.61
	2012	420	6.81	90.58	2 250	3.82
Up to 200% of EMI	2006	276	6.35	121.33	3 472	3.57
	2012	657	6.80	96.33	3 689	2.76

It bears noting that sample households below the poverty risk line have to pay a slightly higher average gas price per kWh than wealthier households (Table 7), which is due to the fact that the average price is calculated here by dividing total gas cost, including the fixed cost, by total gas consumption. As the gas consumption in kWh is lower for low-income households than for comparable wealthier households, the contribution of fixed cost to average per-kWh prices is larger than for wealthier households. Due to their higher gas consumption, which clearly correlates with household income, the monthly gas bill of wealthier households is nonetheless higher than for comparable low-income households. As with electricity cost, however, the heating cost share in household income is much larger for households at poverty risk than for wealthy households earning up to the double of EMI, 7.1% versus some 2.8% in 2012 (Table 7).

Although it is possible that future fuel prices may fall following recent plummeting prices in the oil market, it seems more likely that the energy cost of German households will tend to rise in the future, as electricity prices will most likely surge given Germany's ambitious renewable targets. According to these targets, the share of green electricity in gross consumption shall grow both fast and continually, to more than 35% by 2020, 50% by 2030, and 80% by 2050. Given the regressive nature of electricity prices that has been illustrated in this section, households at the lower tail of the income distribution would suffer more from the likely rise in electricity prices than wealthy households.

4 Future Electricity Cost of Low-Income Households

To describe the distributional impacts of further increasing power prices, this section presents two scenarios on future power prices, with Scenario 1, the more modest variant, being based on the so-called medium-term forecast for the EEG levy provided by the German Transmission System Operators (GTSO). In recent years, this surcharge was a major driver of household electricity prices (Figure 3). It is to be expected that this levy will continually rise further given Germany's ambitious targets for the expansion of renewable capacities in the upcoming decades. Scenario 2 thus presumes a constant growth of this levy by 0.81 ct/kWh per year (Table 8), thereby reflecting its average annual increase between 2010 and 2015. Apart from the EEG levy for renewables and the Value Added Tax (VAT) amount, which is additionally raised on the EEG levy, we assume that the other electricity price components presented in Figure 3 are presumed to be the same in both scenarios. (Note that because the EEG levy is already known for the years 2013 – 2015, the electricity prices reported in Table 8 are equal for both scenarios for these years and differ only later on.)

Based on these scenarios for the EEG levy and the households' individual electricity prices for 2012, we calculate individual forecasts for their future electricity prices by subtracting both the levy and the VAT on it from the prices for 2012 and adding both the levy for future years as reported in Table 8 and the respective VAT, thereby holding all other price components constant.[6] To estimate future electricity cost shares, we assume that the households' individual electricity consumption remains constant at the average level of the years 2006-2012, for which respondents provided information. Moreover, household income is presumed to rise at the average rate of the EMI observed in the past.

[6] This assumption may not be warranted for several reasons, for instance, because grid cost and the preservation of conventional power plants may increase electricity prices further (Hessler, Loebert, 2013:350), as well as because wholesale prices at power exchanges may shrink due to the ever-increasing supply of green electricity.

Table 8: Two Scenarios for the Future Level of the Renewables Levy and Household Electricity Prices in ct/kWh

Scenario 1: Medium Term Forecast							
	2013	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**
Levy	5.28	6.24	6.17	6.66	7.22	7.67	7.93
VAT	1.00	1.19	1.17	1.27	1.37	1.46	1.51
Price	28.68	30.42	30.97	32.19	33.51	34.74	35.74
Scenario 2: Linear Extrapolation							
	2013	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**
Levy	5.28	6.24	6.17	6.98	7.79	8.60	9.41
VAT	1.00	1.19	1.17	1.33	1.48	1.63	1.79
Price	28.68	30.42	30.97	32.57	34.19	35.84	37.51

Source: BDEW (2014), GTSO (2014) and own calculations.

According to Scenario 1, in which the EEG levy rises to 7.93 ct/kWh by 2019, the average household electricity price increases by nearly 25% between 2013 and 2019, to almost 36 ct/kWh (Table 8). If Scenario 1 materializes, in 2019 households below the poverty risk line would spend, on average, roughly 6.8% of their income on electricity (Figure 7). This proportion is almost four times higher than that for households with an income of up to three times the EMI, for which the respective portion amounts to just about 1.8% in 2019.

This gap is even more pronounced in Scenario 2 (Figure 8), in which the electricity prices in 2019 would be almost 2 ct/kWh higher than in Scenario 1. This is due to the presumption of a stronger increase of the renewable levy, which reaches 9.41 ct/kWh by 2019 in Scenario 2, compared to just 7.93 ct/kWh in Scenario 1. With a proportion of more than 7% of income in 2019 for households at poverty risk (Figure 8), the burden originating from electricity cost alone would come close to the well-known 10 percent threshold at which British households would be designated as suffering from fuel poverty. This appears to be particularly dramatic, because fuel cost for space heating commonly account for a large share of residential expenses as well and may be even higher than the electricity cost (Tables 6 and 7, Heindl, 2014:33, Chawla, Pollitt, 2013). Overall, both Figure 7 and Figure 8 clearly indicate that the regressive impact of rising electricity prices widens the gap between poor and wealthy households over time. As a result, it is likely that Germany's energy transition will enhance social problems that are caused by the distributional effects of growing power prices.

Figure 7: Electricity Cost relative to Net Households Incomes in % under Scenario 1

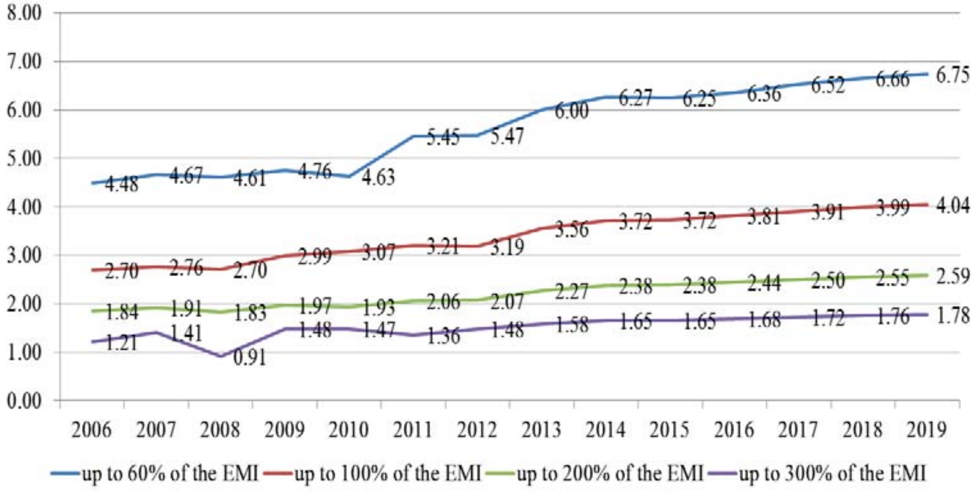
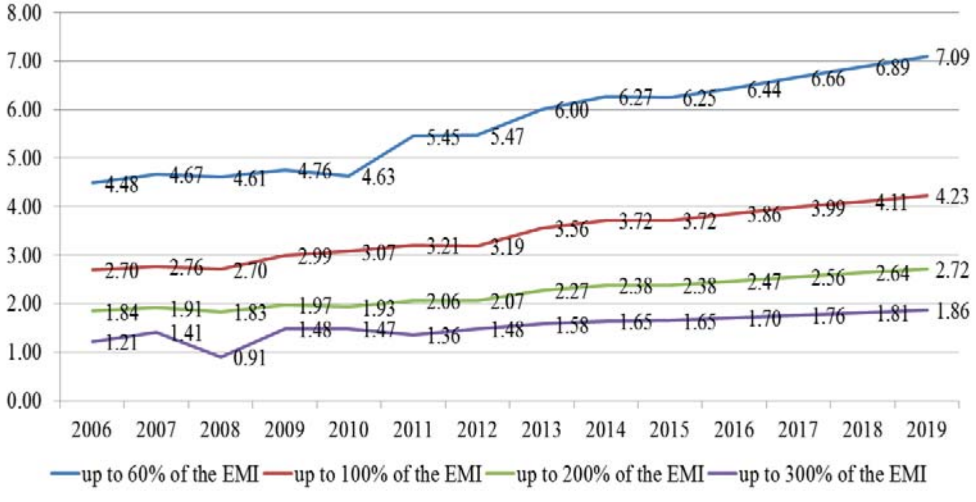


Figure 8: Electricity Cost relative to Net Household Income in % under Scenario 2



5 Summary and Conclusion

Electricity prices for German households have virtually doubled since the outset of the new millennium. In terms of purchasing parities, German citizens have to pay the highest power prices of all EU countries in 2014. Among other reasons, such as the increase in the eco-tax on electricity, a key factor for the substantial rise in electricity prices was Germany's transition of the energy sector, most notably the massive promotion of renewable energy technologies due to the introduction of a feed-in-tariff system in 2000.

The consequences of Germany's widely recognized promotion of alternative technologies, above all photovoltaics (PV), are mixed: On the one side, the share of green electricity in gross electricity consumption increased with a speed seen nowhere else in the world, from less than 7% in 2000 to more than 25% in 2013. On the other side, this increase has been accompanied by regressive distributional effects in that poor households and those that are close to the poverty threshold suffer more from increases in their electricity cost than wealthier households. The number of households endangered from poverty in Germany is substantial, currently amounting to 7.5 million (Neuhoff et al., 2013:52). In other words, almost one fifth of Germany's 40 million households (destatis, 2014) earn an income that, by definition, is lower than 60% of the median income. Given that the rapid extension of renewable capacities in the past already came at high cost, most notably due to the exploding growth of PV capacities in recent years, the question arises as to whether electricity consumers are willing to accept or, in case of poor households, are able to bear the increasing power expenditure.

Focusing on low-income households over the period spanning 2006 to 2012, this paper has analyzed the evolution of the electricity cost burden. In accordance with other studies, such as Bardt and Niehues (2013) and Neuhoff et al. (2013:46), we find that Germany's promotion of renewable energy technologies has strong distributional implications: Poor households have to spend increasing portions of their income on electricity bills. Our results are perfectly in line with the conclusion of Nelson et al. (2011, 2012), who find that feed-in tariffs imply a regressive form of taxation. This tendency will be enhanced if Germany should actually reach its ambitious national goals on the share of green electricity in gross electricity consumption. It is Germany's declared aim to increase this share from about 25% today to 35% in 2020 and 50% in 2030, with an ultimate target share of above 80% in 2050.

Realizing these targets implies additional cost in the form of subsidies for newly installed renewable energy technologies, as well as for sustaining conventional power plants. Because of the volatility of the electricity generation from wind and solar power, conventional backup power plants will be required to ensure supply security if large storage capacities are lacking and remain expensive in the future. The load hours and, hence, the profitability of these conventional plants, however, is undercut by the increased share of the very renewable technologies they are intended to back up. One frequently suggested solution to this security-of-supply-conundrum is the introduction of so-called capacity mechanisms. Yet, these mechanisms would imply additional cost for consumers, as they remunerate the pure existence of backup capacities that would be needed in times of low wind and solar electricity production. Furthermore, electricity grids have to be expanded (Hessler, Loebert, 2013), as the electricity produced in the north of Germany on the basis of wind power must be transported to the south, where capacity deficits already prevail, and will become more serious as a consequence of Germany's nuclear phase-out.

For these reasons, it might well be the case that the future electricity cost exceeds the burden resulting from the scenarios presumed in this article. This raises the urgent question of how to mitigate the social consequences of increasing electricity cost for households at poverty risk. There are numerous suggestions that address this issue. For example, to alleviate the distributional effects, one option would be to drop the surcharge for the promotion of renewable technologies and instead finance the subsidies for renewables through the general tax system (Bardt et al., 2012:12).

Given the progressive income tax tariff in Germany, wealthier households would then have to bear a higher burden, whereas low-income households would pay much less than under the current consumption-based renewable subsidization regime (Bardt et al., 2012:12). Yet, this suggestion would be counterproductive for environmental reasons, as without the EEG surcharge, electricity prices would less reflect the true external cost of generating electricity. As a result, incentives for reducing electricity consumption would be weakened and, hence, negative environmental effects from it would increase.

Another option suggested by Neuhoff et al. (2013:51) is a consumption threshold up to which a reduced eco-tax on electricity is raised, thereby dampening the electricity cost burden of all consumers, not just poor households. This suggestion is also subject to the criticism that incentives for electricity savings would be weakened by lower cost. Moreover, all households would enjoy this reduced burdened, including those not threatened by energy poverty. Yet another alternative, and one which we advocate, would be to extend means-tested cash transfers to poor households to compensate them for the rise in the electricity cost. This alternative has two virtues: it is directly targeted at aiding the poor and, by maintaining high electricity costs, preserves the conservation incentive for households across the income spectrum.

In addition to the social-policy option of raising transfers, it would be highly reasonable to switch to another renewable promotion scheme to dampen future electricity cost increases for German households. In fact, as suggested by the Monopoly Commission and the German Council of Economic Experts (SVR, 2011:253), Germany's very costly feed-in tariff (FIT) system should be abolished and replaced by a much more cost-efficient promotion scheme, such as a renewable quota system combined with green certificates. Otherwise, the broad acceptance of Germany's energy transition among the citizenry might abate.

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