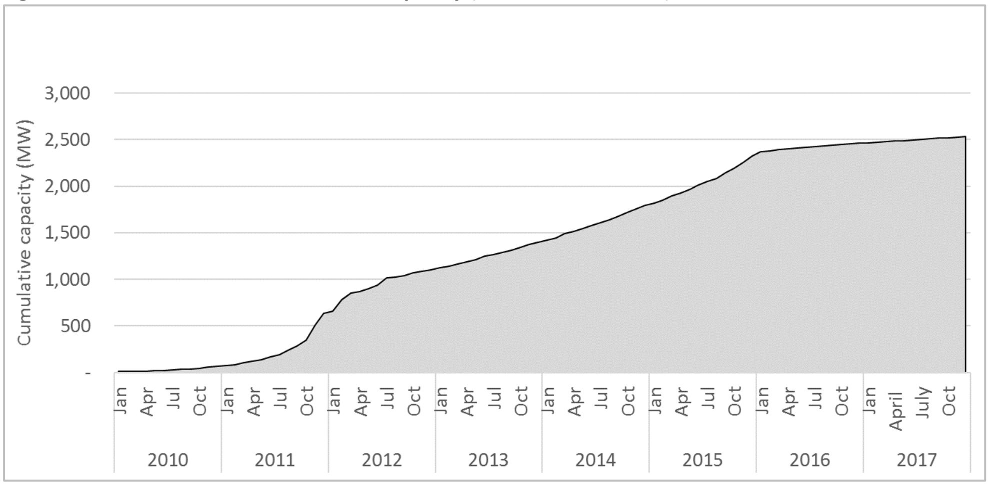
BIEE Abstract: Modelling Take-Up of Residential Solar PV in the UK

Sophie Heald, Cambridge Econometrics

Abstract

In February 2016, the solar PV feed-in tariff rate in the UK was reduced from 12.47 p/kWh to 4.39 p/kWh. Since that date, growth in small-scale residential solar PV in the UK has slowed dramatically (see Figure 1). The UK government has subsequently announced a complete phase-out of the feed-in tariff by April 2019.

Figure 1 Cumulative installed solar PV capacity (of size: 0 to ≤ 4 kW)



Source: BEIS (2018), 'Solar Photovoltaics Deployment in the UK'

As part of ENABLE.EU[1], and in a recent study for the European Commission[2], we have developed a new methodology to model prosumers' investment decisions in the UK and Europe. We develop baseline projections and a series of scenarios to assess how take-up of residential Solar PV in the UK (and the wider EU) may be affected by future changes in policy and technology.

Our method takes account of the fact that households weigh up a multitude of both financial and non-financial factors when deciding whether to invest in solar PV. In relation to these financial and non-financial drivers of investment, there is considerable heterogeneity among households. We derive distributions for the cost-effectiveness and overall attractiveness of investment among households in the UK and use this to develop projections of take-up of solar PV.

For each year up to 2030, under specific assumptions about CAPEX and OPEX costs, policy support, future electricity prices and consumer preferences, these distributions are used to derive the share of households for which investment is an attractive option, to derive take-up in each year.

We develop a series of scenarios where different policy and technology assumptions are varied. Our results reflect the balance of two offsetting effects: an improvement in the cost-effectiveness of

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[1] ENABLE.EU, 'Enabling the Energy Union through understanding the drivers of individual and collective energy choices in Europe'. For more information, see: https://ec.europa.eu/inea/en/horizon-2020/projects/h2020-energy/social-sciences-and-humanities/enable.eu

[2] GfK, Cambridge Econometrics et al (2017), 'Study on Residential Prosumers in the European Energy Union' Ch. 5. Available online at: https://ec.europa.eu/commission/sites/beta-political/files/study-residential-prosumers-energy-union_en.pdf

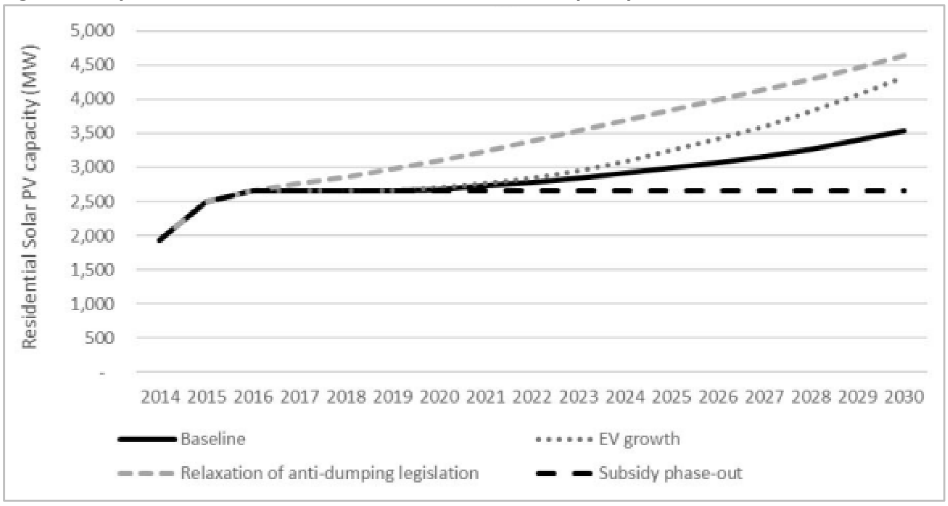
solar PV investments over time (due to higher electricity prices and lower CAPEX costs) balanced against a smaller pool of potential investors (as those with most favourable preferences towards solar PV, and for which investment is most cost effective, have already installed).

Our modelling results for the UK suggest that:

- In a scenario where FiT rates are maintained at their current level, there will be a huge slump in solar PV investments in the short term until a point is reached where electricity prices are sufficiently high and CAPEX costs sufficiently low to incentivise new investments.
- In a scenario with phase-out of FiTs in 2019 (in line with planned government policy), residential solar PV investments will cease.
- There are some opportunities for residential solar in the future, given the recent relaxation of EU anti-dumping legislation (which is expected to reduce the CAPEX costs of solar PV) and roll-out of electric vehicles and battery storage technologies (which could lead to higher self-consumption shares). However, these measures are not expected to be sufficient to incentivise new investment in residential solar, given the planned phase-out of the FiT.

In the short-term, continued roll-out of solar PV faces challenges, as increasing the share of intermittent renewables on the grid could lead to increasingly peaky electricity supply, causing grid congestion and stability issues. Despite these short-term challenges, it is envisaged that, in the medium term, improvements in demand response and roll-out of smart meters, battery and grid storage technologies, as well as increases in electricity demand and synergies with technologies such as electric vehicles, will create opportunities for solar PV capacity to further increase. Our analysis shows that, despite considerable reductions in CAPEX costs over recent years, continued policy support is crucial to achieve further growth in residential solar PV capacity in the UK.

Figure 2 Projections for cumulative residential Solar PV capacity in the UK



Source: GfK, Cambridge Econometrics et al. (2018), ‘Solar Photovoltaics Deployment in the UK’

1 Introduction

Since residential solar PV technologies became commercially viable in the early 2000s, costs have fallen considerably, and the potential benefits of investment have become more widely understood, leading to rapid growth in capacity. A Feed-in Tariff (FiT) policy was introduced in the UK in 2010, which boosted the cost-effectiveness of solar PV, creating further incentives to invest. In addition to electricity bill savings and compensation for each unit of electricity generated, the FiT scheme included an export tariff which compensated for surplus electricity fed back into the grid. By January 2018, over 800,000 households in the UK had invested in solar PV. By this date, total solar PV capacity reached almost 12.8GW, of which around 2.5GW was small-scale rooftop solar PV.

In recent years, the level of support available to new solar PV investors in the UK has substantially declined and the UK government has recently announced a closure of the Feed-in Tariff scheme to new applicants from April 2019. The purpose of this paper is to present the potential impact of these measures on households as investors and to understand the wider implications on the UK energy system.

2 Methodology

Our methodological approach involves the development of a model of annual residential solar PV investments. We develop a baseline projection and a series of scenarios to model future take-up of residential solar technology in the UK. In the baseline projections, it is assumed that existing financial support for self-generation is continued. Future technology scenarios have been developed to assess the impact of factors affecting cost and consumer preferences on take-up. Specifically, the scenarios assess the impact of:

- A phase out of policy support
- Relaxation of EU anti-dumping legislation
- Growth in the number of households owning a plug-in electric vehicle (EV)

To develop projections of take-up of solar technologies requires information about the distribution of consumer preferences and cost-effectiveness of investment. For each year up to 2030, under specific assumptions about CAPEX and OPEX costs, policy support, future electricity prices and consumer preferences, these distributions are used to derive the share of households for which investment is an attractive option. The investment shares are calibrated using the latest year of data and are then applied to estimates of total technical potential for solar PV in the UK, to derive take-up in each year.

The following sections describe key aspects of our methodology, including: the key drivers of investment in residential solar PV, the derivation of total potential residential Solar PV capacity and our modelling approach for take-up of solar PV.

2.1 Investment drivers

When deciding whether to install rooftop solar PV, households must weigh up a multitude of financial and non-financial factors to assess whether investment is worthwhile. Financial-related considerations include: the upfront cost of installation, borrowing costs, the scale of the financial benefit (in terms of reduced electricity bills and available policy support) and the expected rate of return (and payback period) for their investment. Households' investment decisions are also heavily influenced by non-financial factors, including: views about the aesthetics of rooftop solar panels, perceptions of time requirements and disruption related to installing the technology, environmental values, desire for greater autonomy and prestige, as well as current trends and fashions. In addition to values and underlying preferences towards solar PV there are technological factors that may make solar PV investment more desirable (for example, ownership of an electric vehicle, smart meters or battery storage and demand response technologies).

In relation to these financial and non-financial drivers of investment, there is considerable heterogeneity among households. For example, whilst some people live in dwellings with large, south-facing roofs in regions with high solar insolation, where solar PV investment is very cost-effective, other households live in dwellings that are not as well-suited to solar PV (and therefore face higher costs per kW installed). Furthermore, differences in values and preferences mean that some households are more accepting of the technology than others.

Modelling the take-up of solar PV requires consideration of the interaction between the financial and non-financial drivers of investment across all households, in different circumstances, facing different costs/benefits and with different preferences. By modelling the variation in financial and non-financial drivers of investment across the entire population, an estimate can be formed for the proportion of households for which solar PV is both cost-effective and desirable, given their underlying preferences. The methodology is dependent on the assumption that cost-effectiveness of investment and consumer preferences are normally and independently distributed.

2.2 Total potential capacity

The technical potential for residential solar PV is calculated for the UK by applying reduction factors to estimates of the total rooftop area across all residential dwellings. This approach is similar to that applied in Parsons Brinkerhoff (2015)[3], Wiginton, L.K. et al. (2010)[4] and Lehman and Peter (2003)[5].

The total rooftop area of all residential dwellings is estimated based on Eurostat figures for the number of households[6] and the average size of dwellings[7]. A reduction factor is then applied to exclude the share of households for which solar PV installation would be unsuitable[8]. Based on estimates in Parsons Brinkerhoff (2015) and Eiffert (2003)[9], it is assumed that, of the dwellings deemed suitable for solar PV, 40% of the roof area would be unobstructed with a southerly aspect, suitable for solar PV installations. It is assumed that 0.13kW solar PV capacity would be installed per 1m^2 of suitable roof space[10]. Based on these assumptions, the total potential residential solar PV capacity and total potential number of residential solar PV prosumers was derived for the UK (as shown in Table 1).

[3] Parsons Brinkerhoff (2015), 'Small-Scale Generation Costs Update'
[4] Wiginton, L.K. et al. (2010), 'Quantifying Rooftop Solar Photovoltaic Potential for Regional Renewable Energy Policy'. Available online at: http://solar.maps.umn.edu/assets/pdf/roof-libre.pdf
[5] Lehman and Peter (2003), 'Assessment of Roof & Façade Potentials for Solar use in Europe'. Available online at: http://susi-con.com/downloads/roofs.pdf
[6] Eurostat (2017), data code: lfst_hhnhtych
[7] Eurostat (2017), data code: ilc_hcmh01
[8] In this case, we assumed that rented houses and apartments would be unsuitable for investment.
Eiffert, P. (2003). 'Non-Technical Barriers to the Commercialization of PV Power Systems in the Built Environment';
IEA (2001). 'Potential for Building Integrated Photovoltaics'.
[10] Energy Saving Trust (2015), 'Solar Energy Calculator Sizing Guide'. The 'average detached house', with roof area of 29.5m^2 would have space for 18 panels, with total capacity of 4kW; the 'average semi-detached house' with roof area of 20m^2 would have space for 12 panels (and total capacity of 2.6kW).

Table 1 Total potential capacity of residential Solar PV in the UK (2016)

Number of households (000s)	Estimated rooftop area of all residential dwellings (km^2)	Proportion of homes suitable for solar PV (%)	Total potential residential solar PV capacity (GW)	Total potential number of residential solar PV prosumers (millions)
28,219	1,340	59%	37.7	11.49

Source: Own calculations, based on Eurostat data.

Notes: The proportion of homes suitable for solar PV includes privately-owned houses (i.e. excludes apartments and rented houses). Estimates of total potential capacity were used to set an upper limit on solar PV investment in the UK.

2.3 The cost-effectiveness of installing solar PV

To model the profitability of investment, the net present value (NPV) of investment under the market interest rate is calculated as the sum of discounted future revenues (electricity bill savings, plus benefits from FiT) minus the sum of all costs (CAPEX costs, discounted OPEX costs, grid fees and tax). The net present value of investment in each year is then compared to the minimum net present value that is required by consumers to invest[11]. For the proportion of households where the net present value of investment is above their minimum requirement, we assume that they will invest with a given probability.

The NPV of solar PV is initially calculated for the mean household in the UK and in each year over the period to 2030. Cash flows are calculated for each year over the policy horizon, future years are discounted and then all years are summed to derive the NPV. The NPV calculation is as follows:

$$Net\ benefit = NPV\ Export\ Income + NPV\ Generation\ Income + NPV\ Electricity\ Bill\ Saving - NPV\ Costs$$

Where:

$$NPV\ Export\ Income = \sum_{t=0}^{T} \frac{Generation_t \times Percentage\ exported_t \times Export\ tariff_t}{(1+r)^t}$$

$$NPV\ Generation\ Income = \sum_{t=0}^{T} \frac{Generation_t \times Generation\ Tariff_t}{(1+r)^t}$$

$$NPV\ Electricity\ Bill\ Savings = \sum_{t=0}^{T} \frac{Generation_t \times Percentage\ consumed_t \times Electricity\ prcie_t}{(1+r)^t}$$

$$NPV\ Costs = CAPEX\ cost + Installation\ cost + \sum_{t=0}^{T} \frac{OPEX\ costs_t}{(1+r)^t}$$

r = market interest rate
T = lifetime of Solar PV (i.e. 20 yrs)

Key inputs to the calculation include assumptions for:

- the mean size of installations (in kWp)
- mean CAPEX and OPEX costs
- current and future expected electricity prices
- market interest rates
- load factors

[11] The minimum net present value required by consumers is calculated from information about the required rate of return on investment, based on consumer preferences

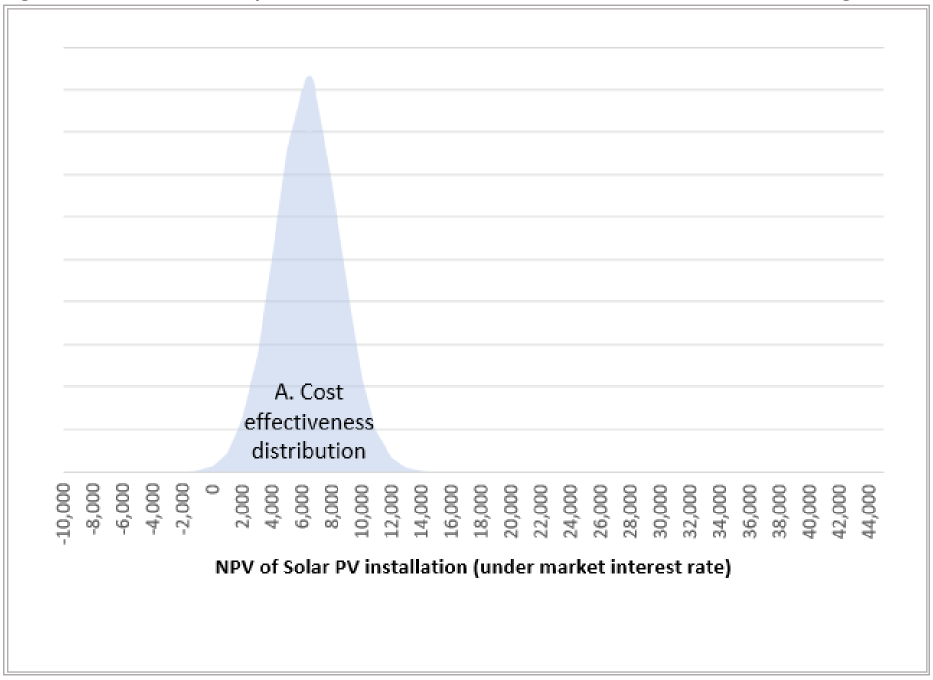
The key policies that were included in the cost-effectiveness calculation included:

- Feed-in Tariffs (3.93 p/kWh) and Export Tariffs (5.24 p/kWh)[12]
- Reduced rate of VAT (5%) for solar PV systems

Figure 3 shows an example of the 'cost-effectiveness' distribution (expressed in net present value terms under market interest rates). The total area under the distribution is reflective of the technical potential for residential solar PV installations. In this example, the NPV of investing in solar PV is + £7,000 for the mean household. The right-hand tail of the distribution reflects the households where solar PV investment is most cost-effective i.e. households with large roof areas, facing low CAPEX and OPEX costs, living in regions with high levels of solar irradiation and, therefore, facing high load factors (for example, households located in the south of the UK).

In this example, the NPV of solar PV installation is positive for almost all households. However, this is not to say that most households would install solar PV. In practice, most households are not aware of the financial benefit of investment. In addition, there are a number of non-financial barriers that reduce the attractiveness of investment.

Figure 3 Illustrative example of the distribution for the cost-effectiveness of installing solar PV



2.4 The distribution of consumer preferences

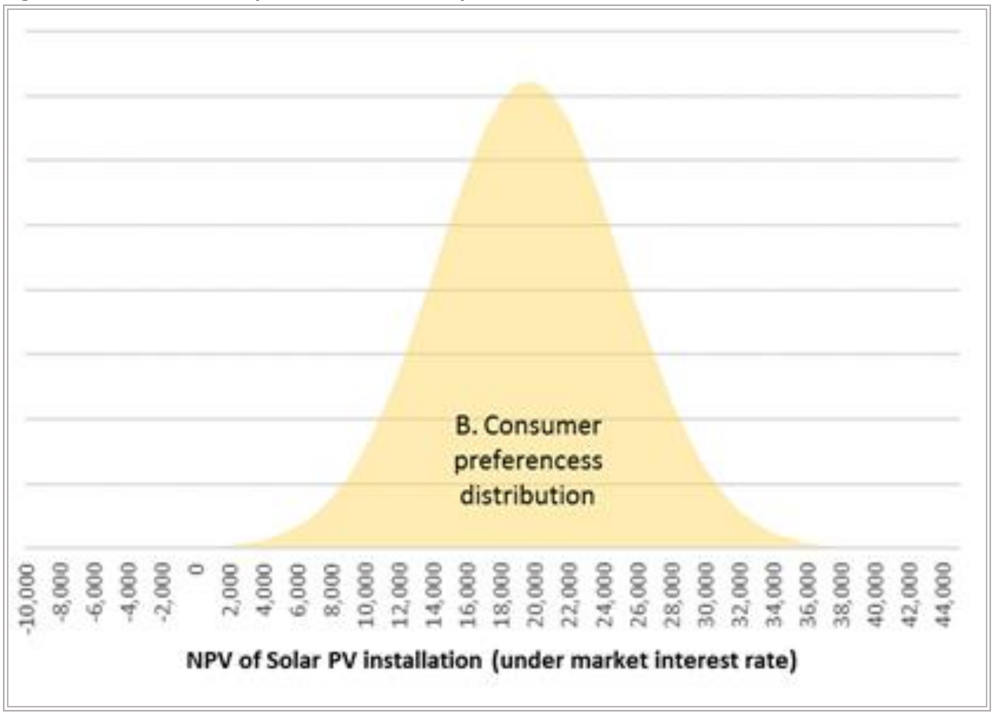
The 'consumer preferences' distribution is based on results from a review of literature on willingness to pay and the expected rate of return on solar PV investment. These factors vary among households depending on their own perceptions about solar PV and the barriers and non-financial costs and benefits associated with installation. Based on estimates in Parsons Brinkerhoff (2015) and NERA

[12] Feed in Tariffs are paid for 20 years; income from Feed-in-Tariffs is exempt from income tax; tariff rates are adjusted annually in line with the retail price index (RPI). Export tariff applied for up to 50% of excess power fed into the grid.

(2015), we assume that the mean household in the EU requires a 6.2% rate of return on investment to incentivise take-up of the technology[13].

Figure 4 shows an illustrative example of the distribution of consumer preferences in the UK. In this example, the mean prosumer would require the NPV of a solar PV installation to be £20,000 (under market interest rates), equivalent to a 6.2% annual rate of return. Households in the right-hand tail of the distribution require a much higher rate of return to incentivise investment (for example, because they face higher non-financial barriers, do not like the aesthetics of solar PV or attribute a higher cost to the inconvenience and hassle of arranging for solar PV to be installed).

Figure 4 Illustrative example of the consumer preferences distribution



2.4.1 Combining information on cost-effectiveness and consumer preferences

After the distributions of cost-effectiveness and consumer preferences have been derived for each country, they are combined, as shown in Figure 5. The area, 'C', is the overlapping area of the two distributions. A larger area C indicates that solar PV investment is an attractive option for a larger proportion of households. By combining the cost-effectiveness and consumer preference distributions, the proportion of households for which a solar PV investment is both cost-effective and desirable can be derived.

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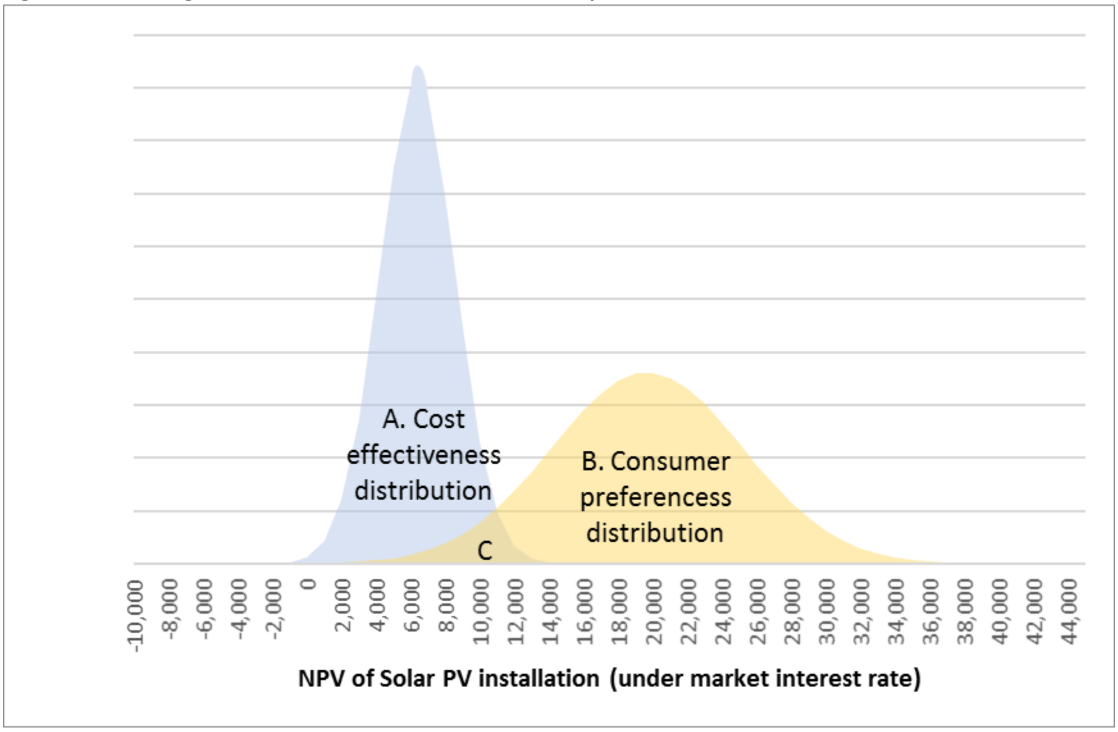
[13] Parsons Brinkerhoff (2015), 'Small-Scale Generation Costs Update'; NERA (2015), 'Electricity Generation Costs and Hurdle Rates'

Figure 5 Combining the 'cost-effectiveness' and 'consumer preference' distributions



2.5 Calibration

The final stage involves calibrating the results, to correct for error in our estimates due to factors that are not accounted for in the model.

The calibration factor is calculated as the share of investment that does take place (based on observed data) relative to the share that is considered attractive (based on model calculations). Calibration is used to account for factors that are not captured within the model, such as imperfect information and unobserved barriers to investment across households. The calibration factor is used to adjust the investment shares in all future years. The calibrated investment shares are then applied to estimates of total technical potential for solar PV, to derive take-up in each year.

The calibration factor was calculated based on new residential solar PV capacity in the most recent year of data available and the same calibration factor was then applied to every year in the projection period[14].

[14] By using a fixed calibration factor over the projection period, we implicitly assume that the likelihood that a seemingly attractive investment does take place, remains the same over time. It could be argued that the share of attractive investments that do take place would increase over time, as people become more familiar with the technology, which is part of the diffusion.

2.6 Key modelling assumptions

The starting point for the 2018 modelling input assumptions are summarised below:

- Capex cost: 1,688 £/kW
- Load factor: 9.4%
- Size of average residential Solar PV installation: 3.25 kWp
- Average interest rate: 2.5%
- Average required real rate of return on investment: 6.0%
- Electricity price: 16.5 p/kWh

To project baseline take-up of solar PV over the period 2018-2030, these modelling assumptions are assumed to evolve as follows:

- Current policy measures (including the FiT) are assumed to remain unchanged over the projection period
- Financial and non-financial consumer preferences, proxied by expected return on investment, are assumed to remain unchanged over the projection period
- The cost of equipment and installation (CAPEX costs) are assumed to fall by 1.4% pa
- The cost of maintenance (OPEX costs) are assumed to fall by 0.2% pa
- Electricity prices are set to grow in line with projections from the PRIMES reference scenario15
- A 0.1% degradation rate pa is assumed

The baseline assumption for CAPEX costs is a conservative estimate, which assumes a considerably lower year-on-year reduction in CAPEX costs compared to that observed over 2007-2013. The impact of a more rapid fall in CAPEX costs is explored in the scenario analysis section, where it is assumed that EU anti-dumping legislation on Chinese solar panel imports is withdrawn.

Historical OPEX costs are based on the assumption that the inverter will need to be replaced once every ten years. The cost of the inverter is assumed to be £800, based on figures in Parson Brinkerhoff (2015) and Fraunhofer ISE (2016)[16]. OPEX costs are assumed to decline by 0.2% pa over the projection period, based on Parsons Brinkerhoff (2015).

Baseline electricity prices are assumed to grow at 0.5% p.a. in line with the *Average price of electricity in final demand sectors* from the EU PRIMES reference scenario.

To take account of the range of consumer preferences with respect to Solar PV required translating subjective information (i.e. consumers perceptions about the aesthetics of Solar PV and the hassle and administrative barriers of investment) into a metric that could be used for the quantitative modelling. A literature review was used to inform our assumption on the hurdle rate for investment in residential Solar PV. The hurdle rate reflects consumers' willingness to invest, with lower hurdle rates indicating a perception of lower non-financial barriers (and therefore willingness to accept a lower rate of return on investment) and higher hurdle rates indicating a perception of higher non-financial barriers (and therefore a higher rate of return is required to incentivize investment).

Consumer preferences are proxied by the expected return of investment and are assumed to remain unchanged over the projection period. Our assumptions about the effect of non-financial barriers on the required rate of return of investment were informed by a literature review. One of

[15] 'EU Reference Scenario 2016: Energy, transport and GHG emissions Trends to 2050'. Available online at: https://ec.europa.eu/energy/sites/ener/files/documents/20160713%20draft_publication_REF2016_v13.pdf

[16] Fraunhofer ISE (2016) 'Photovoltaics Report'. Available at https://www.ise.fraunhofer.de/content/dam/ise/de/documents/publications/studies/Photovoltaics-Report.pdf

the studies by Parsons Brinckerhoff and Ricardo-AEA[17] used a homeowner survey to calculate the required rate of return on investment, asking homeowners: "What is the maximum payback time you would be willing to accept for this installation (years)?". The results from the survey show that, on average, a 6.2% rate of return is required to incentivise take-up of the technology. This rate of return is broadly consistent with findings from the other studies and is used as our central assumption[18]. To take account of non-financial barriers, we used results from a survey of legal barriers to investment in solar PV

The interest rate used was the borrowing cost faced by households (for house purchases), taken from the Bank of England 2-year mortgage rate. This assumes that households could remortgage their house to finance their Solar PV project.

The load factor represents the average quantity of electricity generated per hour relative to the maximum possible amount that could be generated for a given capacity. It is affected by the weather, air particulates and the efficiency of the solar modules. The load factor was assumed to be 9.4%, based on recent data from the Department for Business, Innovation and Skills (BEIS). The model assumes that the load factor is constant over the projection period as, when making their investment decision, it is likely that consumers would expect the weather to be relatively constant year-on-year.

Assumptions about the degradation rate of solar panels and expected lifetime were based on a study by Fraunhofer ISE (2015)[19]. The degradation rate (0.1% p.a.) is the average rate across 14 solar plants in Germany fitted with multicrystalline and monocrystalline panels. In line with Fraunhofer ISE (2015), we assume that solar panels have a lifetime of 20 years.

There is considerable uncertainty in estimating precisely how much electricity prosumers are likely to consume and how much they will export under different policy regimes, which is likely to be dependent on number of factors such as the size of the house and ownership of technologies such as electric vehicles. Based on a review of recent literature[20], we assume that 47% of electricity generated is self-consumed and the remaining 53% of electricity is exported to the grid.

A literature review was used to assess the range of costs faced by different households, so as to derive the variance of the cost-effectiveness distribution.

[17] Parsons Brinkerhoff (2015), 'Small-Scale Generation Costs Update'
[18] NERA (2015), 'Electricity Generation Costs and Hurdle Rates'
[19] Fraunhofer ISE (2015), 'Recent facts about Photovoltaics in Germany'
[20] Parsons Brinkerhoff (2015), 'Small-Scale Generation Costs Update'; V. Bermudez (2017), 'Electricity storage supporting PV competitiveness in a reliable and sustainable electric network'.

3 Results

Our baseline projections, which assume that Feed-in Tariffs for residential Solar PV are maintained at the current level, are summarised in Table 2, below. The results show that, under the assumption of a continuation of current Feed-in Tariff rates, residential solar PV capacity could reach 3.5GW by 2030, with over 1 million prosumers in the UK (around 3.5% of all households).

Table 2 Baseline projections for residential solar PV in the UK (based on an assumed continuation of current FiT rates)

	2015	2020	2025	2030
Residential Solar PV capacity (MW)	2,499	2,681	2,983	3,540
Share of technical potential for residential Solar PV	6.6%	6.9%	7.4%	8.5%
Number of residential Solar PV prosumers (000s)	755	825	918	1,089
Share of households that invest in residential Solar PV	2.7%	2.8%	3.0%	3.5%
Mean payback period for residential Solar PV (years)	11.4	17.3	16.0	14.8

However, the baseline results do not take account of recent policy announcements or new technologies that could affect the attractiveness of residential solar investments in the UK in the future. To take account of these effects and to allow modelling of different cost and consumer preference scenarios, the take-up curves have been parameterised. Along with a baseline scenario, where the current FiT rates were assumed to be continued, three additional scenarios were modelled, as outlined in the table below. The EV growth scenario is a technology driven scenario that affects consumer preferences in favour of solar PV. The other two scenarios both affect the cost-effectiveness of solar PV installation. The cost-effectiveness of investment in solar PV is reduced in the scenario involving a phase-out of existing policy support but the cost-effectiveness is increased in the scenario that assumes relaxation of EU anti-dumping legislation. The scenarios are further described in Table 3 and the projected take-up of residential solar PV under each scenario is presented in Figure 2.

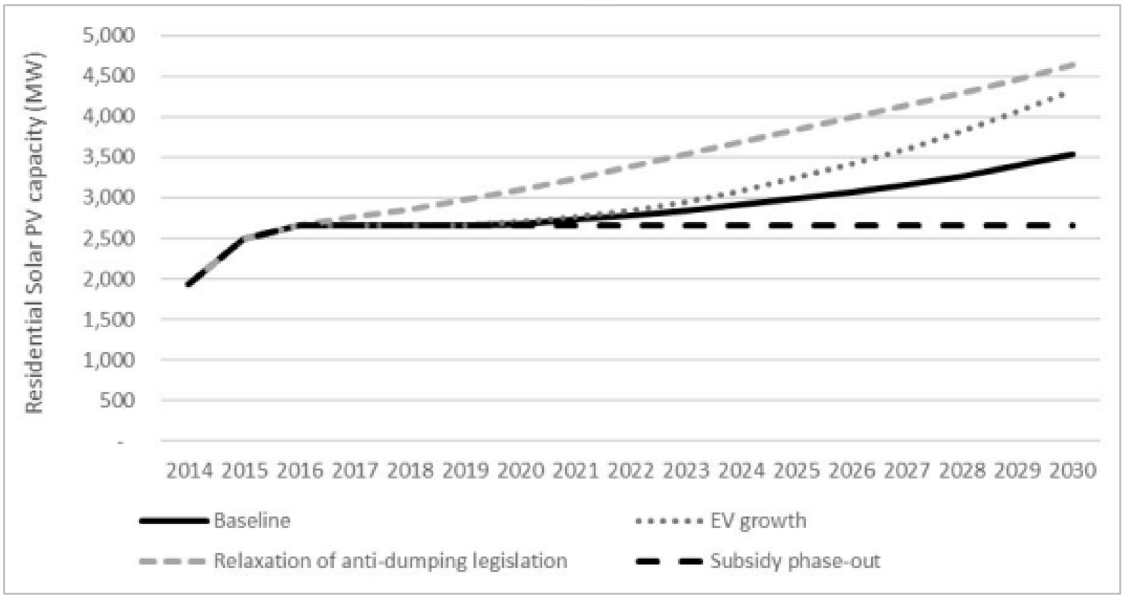
Table 3 Overview of modelling scenarios

Scenario name	Description
Subsidy phase-out	In this scenario, Feed-in Tariffs are phased-out in 2019, in line with recently announced government policy. Thus, under this scenario, new prosumers are only able to benefit from lower electricity bills due to self-consumption and they receive no compensation for surplus electricity fed into the grid.
Relaxation of anti-dumping legislation	EU anti-dumping legislation imposed a 47.7% tariff on Solar PV panels and cells imported from China[21]. In line with recent announcements, this scenario assumes that these import duties are revoked and that all Solar PV installations in the EU use Chinese panels, free from the 47.7% duties. This leads to an initial 15% fall in CAPEX costs (installation costs are not affected)[22]. CAPEX costs are then assumed to fall by 1.4% pa, in line with our baseline assumptions.
Electric vehicle (EV) growth	This scenario assumes a rapid increase in electric vehicles with smart charging and battery storage technologies so that, by 2030, the average self-consumption ratio for residential Solar PV reaches 70%.

[21] European Commission (2013) Press release, available at: http://europa.eu/rapid/press-release_IP-13-1190_en.htm

[22] Based on Parsons Brinkerhoff (2015), 'Small-scale Generation Cost Update'

Figure 6 Projections for cumulative residential Solar PV capacity in the UK



The scenario results highlight the uncertainties in the baseline estimates of take-up of residential Solar PV.

The subsidy phase-out scenario assumes that Feed-in Tariffs are phased out in 2019, in line with recent announcements by the UK government. This scenario leads to a complete freeze in residential solar PV capacity over the period to 2030. By 2030, cumulative installed Solar PV capacity is nearly 1GW lower than in the baseline (where it is assumed that existing policy support is continued).

In September 2019, the EU announced an end to EU anti-dumping legislation, which artificially inflated the CAPEX cost of Solar PV. By reducing CAPEX costs, the relaxation of anti-dumping legislation scenario drives an improvement in the cost-effectiveness of investment, and an estimated 1GW increase in take-up by 2030.

The EV growth scenario also has a positive impact on residential Solar PV capacity installed. The effect is relatively small over the period to 2030, because take-up of EVs is very gradual and, in many countries, the proportion of 'attractive' investments that do take place, are very low. By 2030, cumulative installed capacity in the EV growth scenario is around 750 MW higher than under baseline projections.

4 Conclusions

- Following rapid growth over the period 2011-2012, growth in residential solar PV capacity in the UK slowed over the period 2012-2015. Since 2015, the cut to Feed-in tariffs has resulted in flat-lining of residential Solar PV capacity.
- Our baseline projections suggest that, if the current Feed-in Tariff rate was maintained, the huge slump in new investments in solar technologies among households will continue until a point is reached in the early-2020s, at which point CAPEX costs are sufficiently low and electricity prices are sufficiently high to incentivize new investments.
- These baseline projections capture the balance of two offsetting effects: an improvement in the cost-effectiveness of solar PV investments over time (due to higher electricity prices and lower CAPEX costs) balanced against a smaller pool of potential investors (as those with most favourable preferences towards solar PV, for which investment is most cost effective, have already installed).
- However, there are two recent policy developments that will have an important impact on future residential solar PV investments in the UK in the short to medium terms:
  - Firstly, in September 2018, the European Commission ended the anti-dumping legislation on imports of solar panels from China.
  - Secondly, the UK government has recently announced a phase out of the Feed-in Tariff in April 2019.
- Through its impact on reducing CAPEX costs, relaxation of EU anti-dumping legislation against imports of solar PV from China would have a positive impact on the investment rate, leading to an estimated 1GW increase in installed solar PV capacity by 2030 (relative to the 'current policy' baseline scenario).
- However, the anti-dumping legislation has been brought in at around the same time as a planned phase out of Feed-in Tariff and export payments for new solar projects in April 2019. Our results suggest that this phase-out of the Feed-in Tariff and export payments will lead to a freeze in residential solar PV capacity in the medium term (to 2030), even in light of the recent relaxation of EU anti-dumping legislation that is expected to significantly reduce the CAPEX costs of solar PV.
- There is some uncertainty in our solar PV projections, which are dependent on key assumptions about the future development of CAPEX and OPEX costs, electricity prices, interest rates, self-consumption ratios and consumer preferences, as well as the development of new, complementary technologies.
- An increase in the number of households with an electric vehicle, for example, could incentivize new investments, due to technology synergies which could increase self-consumption shares (e.g. in cases where electric vehicles were charged at home during the day).

References

- BEUC (2017), 'Tenants' Access to Solar Self-Consumption'. Available at: http://www.beuc.eu/publications/beuc-x-2017-020_jmu_iut_tenants_access_to_solar.pdf
- BEUC (2016), 'Current practices in consumer driven renewable electricity market'. Available at: http://www.beuc.eu/publications/beuc-x-2016-003_jmu_current_practices_in_consumer_driven_renewable_electricity_markets.pdf
- Energy Saving Trust (2015), 'Solar Energy Calculator Sizing Guide'. The 'average detached house'
- Eiffert, P. (2003). 'Non-Technical Barriers to the Commercialization of PV Power Systems in the Built Environment'
- European Commission (2016), 'EU Reference Scenario 2016: Energy, transport and GHG emissions Trends to 2050'. Available at: https://ec.europa.eu/energy/sites/ener/files/documents/20160713%20draft_publication_REF2016_v13.pdf
- European Commission (2015), 'Best practices on Renewable Energy Self-consumption'. Available at: http://ec.europa.eu/energy/sites/ener/files/documents/1_EN_autre_document_travail_service_part1_v6.pdf
- European Commission (2013), 'Press release: EU imposes definitive measures on Chinese solar panels, confirms undertaking with Chinese solar panel exporters'. Available at: http://europa.eu/rapid/press-release_IP-13-1190_en.htm
- Eurostat database (2017). Data extracted on 1.03.2017
- Lehman and Peter (2003), 'Assessment of Roof & Façade Potentials for Solar use in Europe'. Available at: http://susi-con.com/downloads/roofs.pdf
- NERA (2015), 'Electricity Generation Costs and Hurdle Rates. Lot 1: Hurdle Rates update for Generation Technologies'
- IEA (2017), IEA/IRENA Joint Policies and Measures database. Available at: https://www.iea.org/policiesandmeasures/renewableenergy/
- IEA-RETD (2014), 'Residential Prosumers - Drivers and Policy Options (Re-Prosumers)'. Available at: http://iea-retd.org/wp-content/uploads/2014/06/RE-PROSUMERS_IEA-RETD_2014.pdf
- IEA (2013-2016), 'National Survey Report of PV Power Applications' (reports for Austria, Belgium, Denmark, Finland, France, Germany, Italy, The Netherlands, Norway, Portugal, Spain, Sweden, United Kingdom covering the period 2012-2015)
- IEA (2001), 'Potential for Building Integrated Photovoltaics'
- JLL (2014), 'Solar PV: Shedding light on the opportunities'. Available online: http://www.jll.eu/emea/en-gb/Documents/Renewable-Energy-Documents/JLL%20-%20Shedding%20light%20on%20PV.pdf
- Masson, G., Briano, J.I., Baez, M. J. (2016) 'Review and Analysis of PV Self-Consumption Policies' IEA-PVPS.
- Nelson, D. (2011) 'The Role of Government Policy in the Development of Solar Photovoltaic Power' Climate Policy Initiative, San Francisco. Available at: https://climatepolicyinitiative.org/wp-content/uploads/2011/12/Role-of-Government-in-PV-Power-Development.pdf
- Ofgem (2017), 'Feed-In Tariff (FIT) rates'. Available at: https://www.ofgem.gov.uk/environmental-programmes/fit/fit-tariff-rates

- Parsons Brinkerhoff (2015), 'Small-Scale Generation Costs Update'
- Wiginton, L.K. et al. (2010), 'Quantifying Rooftop Solar Photovoltaic Potential for Regional Renewable Energy Policy'. Available at: http://solar.maps.umn.edu/assets/pdf/roof-libre.pdf
- World Energy Council (2016), 'Variable renewables integration in electricity systems: How to get it right', World Energy Perspectives 2016