The impact of PV and EVs on Network Charges

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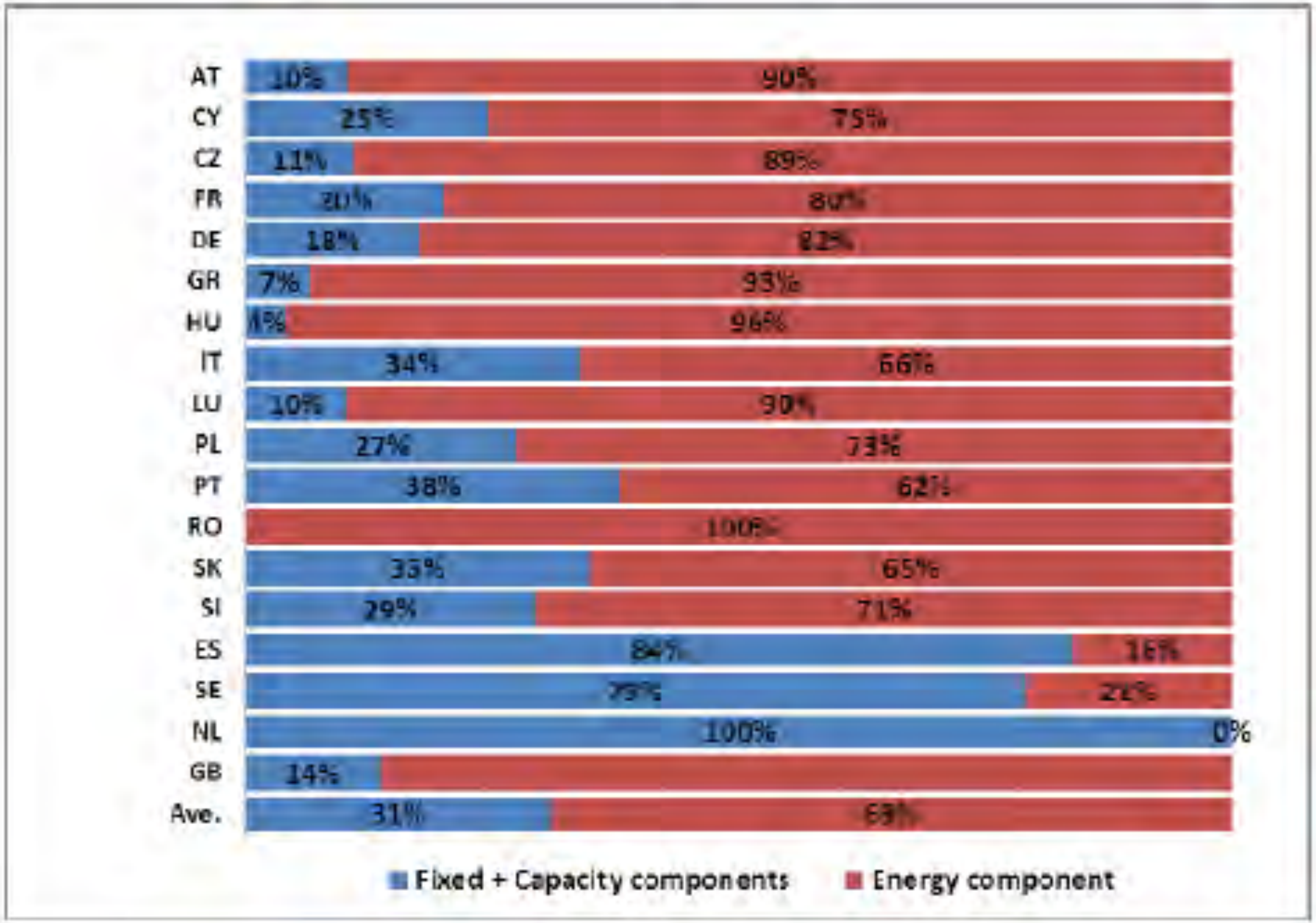
Overview

- We examine the potential impact of PV and EV uptake on network charges.
- However kWh charges were introduced to essential recover network fixed costs (and other policy costs) by an income related charge (tax).
- Recovering network fixed costs is an issue and has been linked to the potential 'death spiral' of the utility.
- While the network will still be valuable to most users as a source of intraday balancing and seasonal storage, how the costs will be recovered may need to change.
- A fixed network fee, unrelated to kWh is one answer, or a per kW peak fee would be closer to transmission charges. However with domestic PV, EV and storage uptake interacting it is by no means obvious which is best.

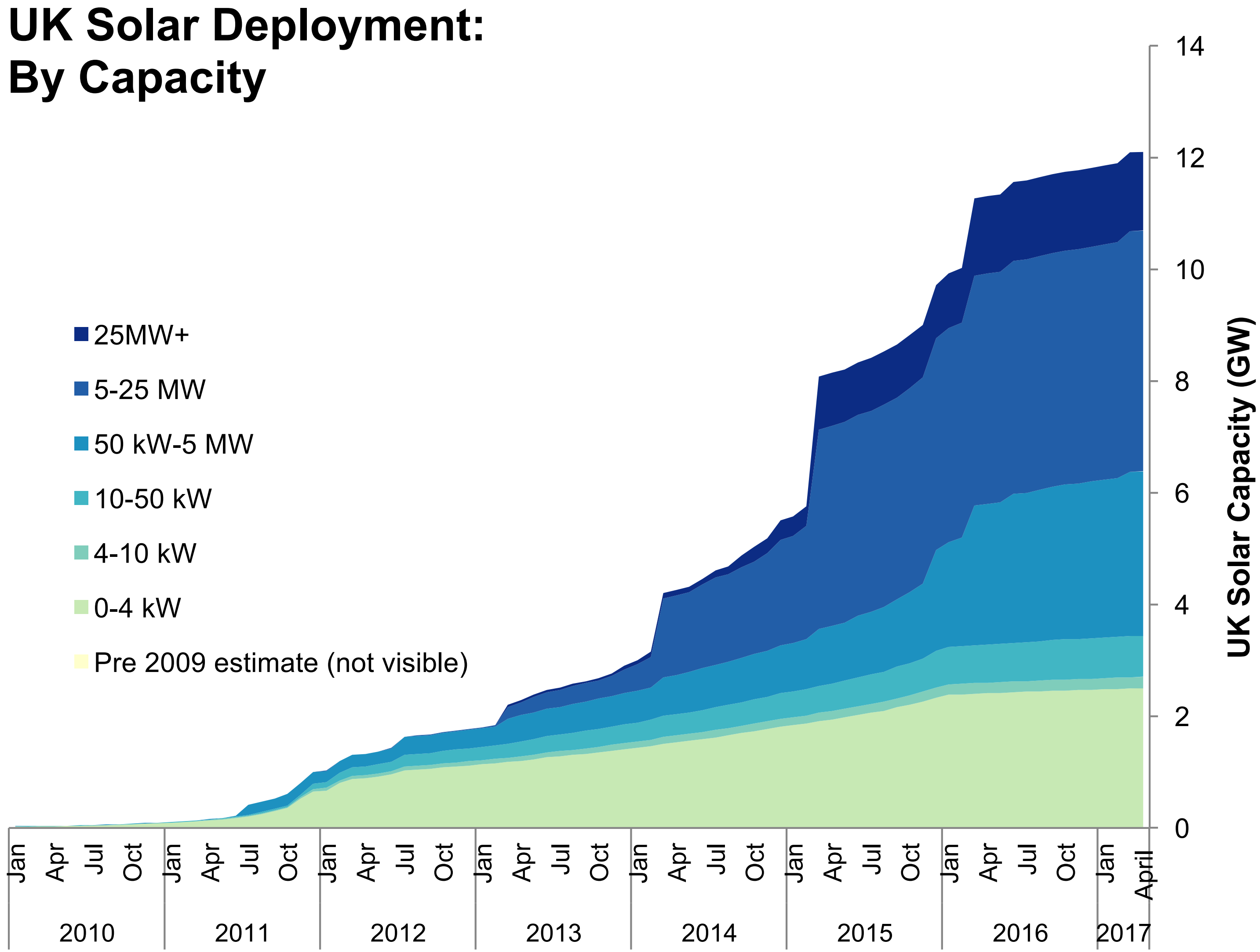
Recovery of distribution network costs



3500 kWh consumption

Source: Study on Tariff Design for Distribution Systems, Final Report (2015, p.114).

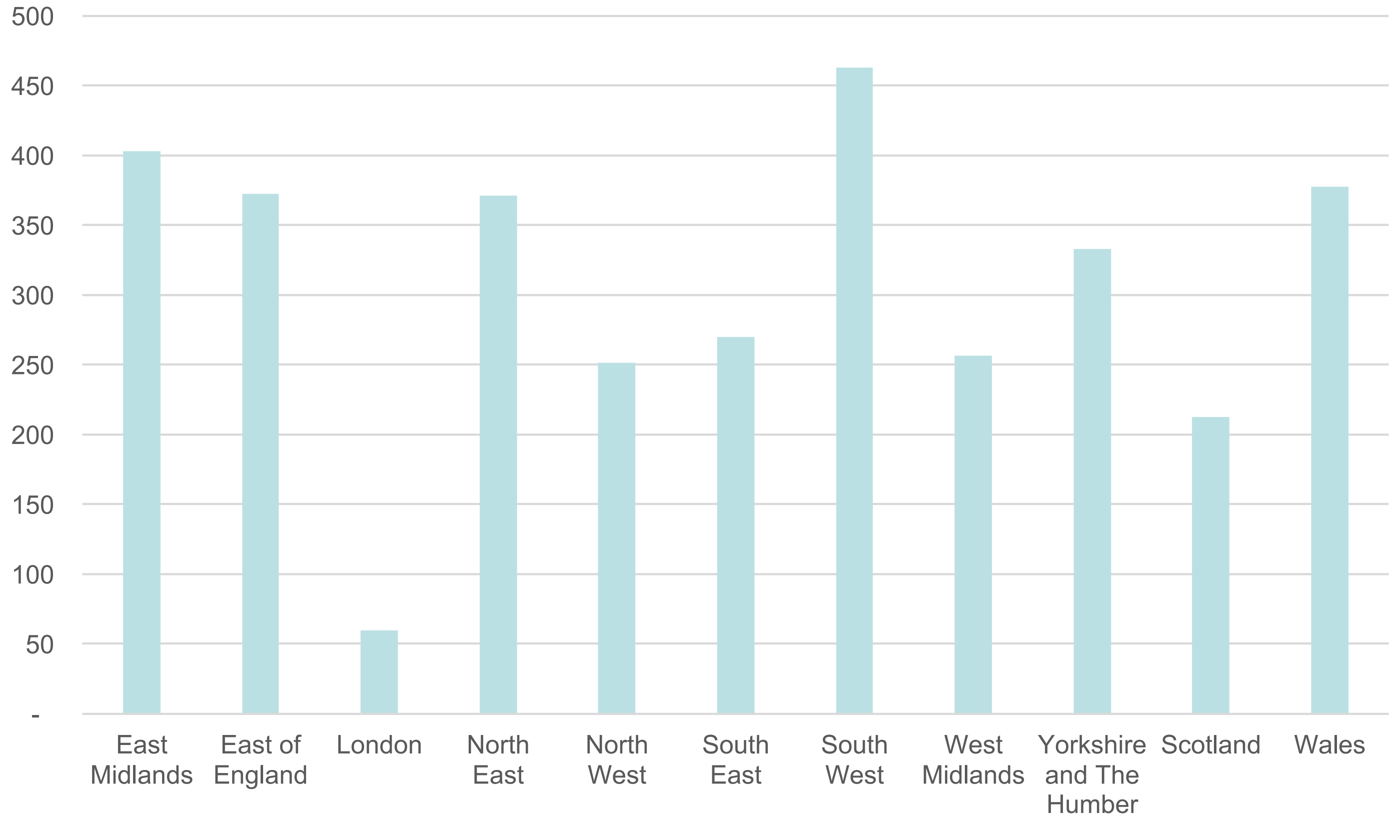
Solar PV deployment in the UK



Source: DECC (2017)

https://www.gov.uk/government/statistics/solar-photovoltaics-deployment

Solar installations by region by households



Installations per 10000 households

Source: Department for Business, Energy and Industrial Strategy (March 2017). Available at: https://www.gov.uk/government/statistical-data-sets/sub-regional-feed-in-tariffs-confirmed-on-the-cfr-statistics

Further potential for household PV

Back-of-the envelope calculations:

- 23.4 million habitable homes in England
- 27 million residential electricity customers
- 61% of homes are in suburban areas
- 21% are located in city or urban centres
- 63% are owner occupied
- 20% are private rented

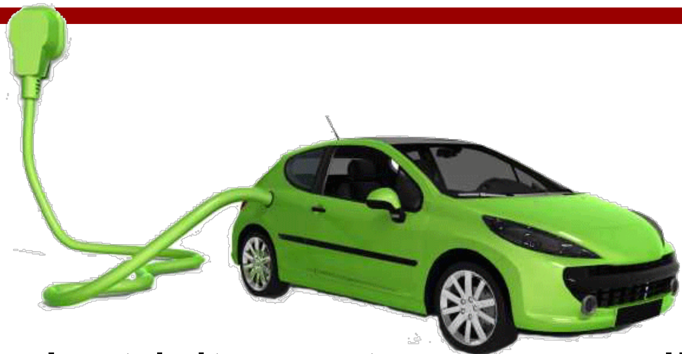
23400000 (habitable homes in the UK) * 82% (suburban areas or urban centres) * 63% (owner-occupied) = 12 088 400 (potential for household PVs in the UK)

23400000 (habitable homes in the UK) * 82% (located in suburban areas or urban centres) * 83% (owner-occupied **and rented**) = 15 926 040 (maximum potential for PVs in the UK)

27 000 000 (residential electricity customers) * 63% (live in owner-occupied houses) = 17 010 000

Source: National Statistics (2016).
Available at: https://www.gov.uk/government/statistics/english-housing-survey-2014-to-2015-headline-report

Potential for electric vehicles (EV)



- Less than 50% of electricity customers are likely to have the EV. The question is: How many are going to buy an EV?

- In 2016, there were 30,850,000 private cars in the UK (Department of Transport, 2017)
- About 77% of UK households have at least one car (81% have access to a car), about 33% households have 2 cars (National Travel Survey Statistics, 2016)
- By the end of 2016, around 350 000 plug-in EVs/EVs had been registered in the UK. EVs constitute around 1.3 per cent of the total new car market in the country (SMMT, 2016).

Sources: Department of Transport (2016, 17); National Travel Survey Statistics (2016)
Available at: https://www.gov.uk/government/statistical-data-sets/veh02-licensed-cars
SMMT (2016). Available at: https://www.smmt.co.uk/2017/01/december-2016-ev-registrations/

Issues

- Solar PV deployment in the UK has grown almost 10-fold the last 5 years with about 3% of UK households benefiting from self-consumption.

- Energy consumption per household does vary by region in Great Britain as does solar radiation.

- An increase in the solar PV in the UK results in a transfer of wealth and costs between customer groups under the current network cost recovery regime, which is mostly made up of a kWh charge.

Modelling Assumptions

We have four types of customers:

No EV, no PV

PV, no EV

No PV, EV

EV and PV

We assume that probability of having EV and PV is independently distributed and vary uptake rates EV and PV.

EV customers use 3000 kWh at home to charge their cars.

PV customers have lowered metered import, due to using half their generation at home.

This allows us to calculate total kWh in each region relative to a baseline.

We assume revenue requirement remains fixed.

We fix daily use charge at initial level.

We then solve for the required per unit charge to recover fixed revenue.

Comparison of tariffs in 2 UK regions

- The choice of the regions is pre-determined by the values of the variable cots: we selected the regions where the costs are the lowest and the highest

- Highest costs region – Scottish Power Distribution (SP Manweb) and lowest distribution cost – Western Power Distribution (East Midlands) region in the UK

	Variable rate	*Fixed charge*	*Annual averages*					
	(p/kWh)	*(p/customer/day)*	*Consumption (kWh)*	*Variable costs (£)*	*Fixed costs (£)*	*Total costs (£)*	*% Variable costs*	*% Fixed costs*
Scottish Power Distribution								
SP Manweb	4.114	3.730	3.200	131.65	13.61	145.26	90.6%	9.4%
Western Power Distribution								
East Midlands	2.266	1.470	3.200	72.51	5.37	77.88	93.1%	6.9%

A comparison of 2 regions distribution charge

Average bill: £577 @ 3800 kWh in 2013

Non-solar households:

SP Manweb: 365*£0.0373 + 3800*£0.04114 = £13.61 + £156.33 = £169.94
East Midlands: 365*£0.0147 + 3900*£0.02266 = £5.36 + £88.37 = £93.73

Solar households:

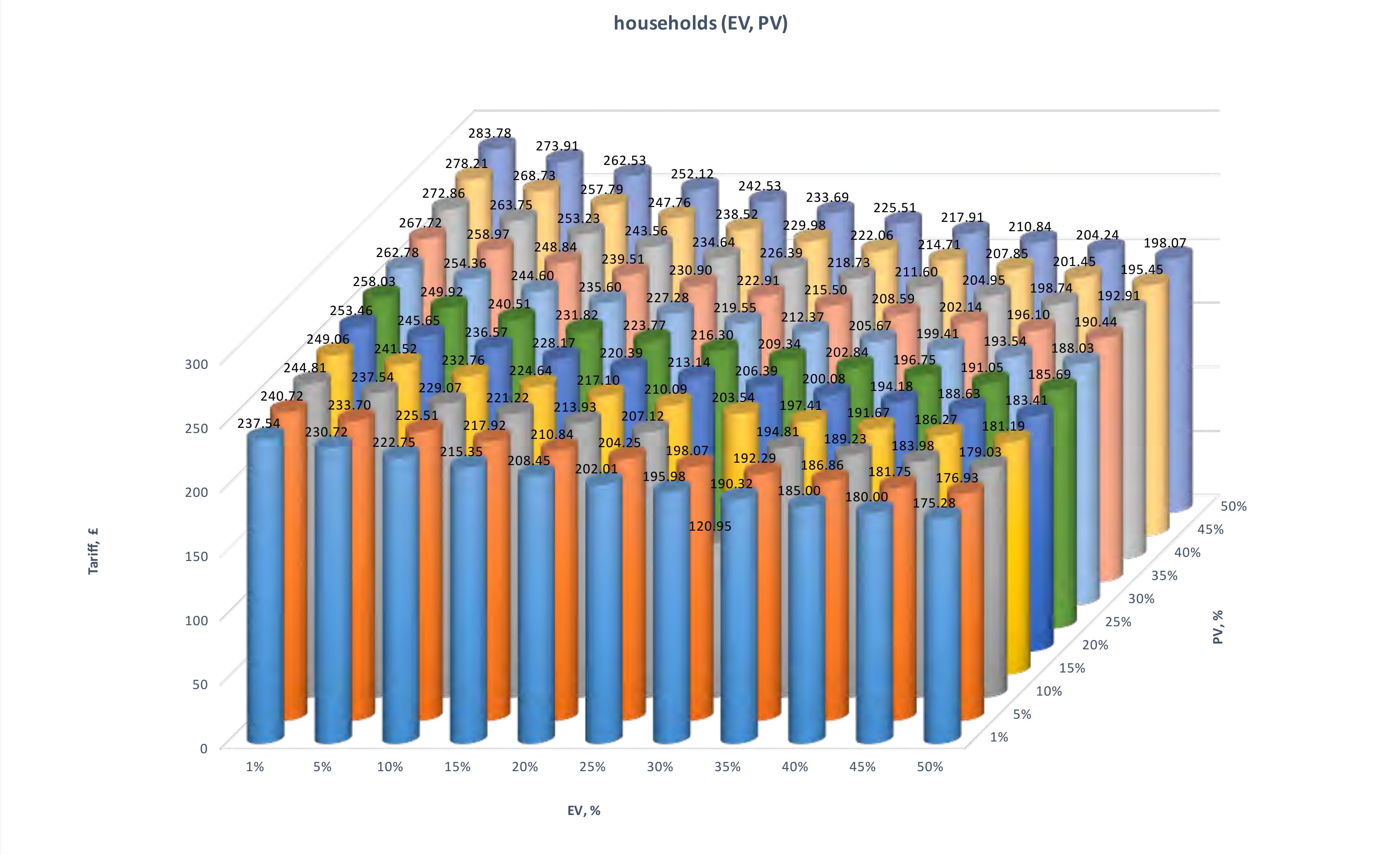
SP Manweb: 365*£0.0373 + 2594*£0.04114 = £13.61 + £106.71 = £120.32
East Midlands: 365*£0.0147 + 2567*£0.02266 = £5.36 + £58.16 = £63.52

Households solar export:

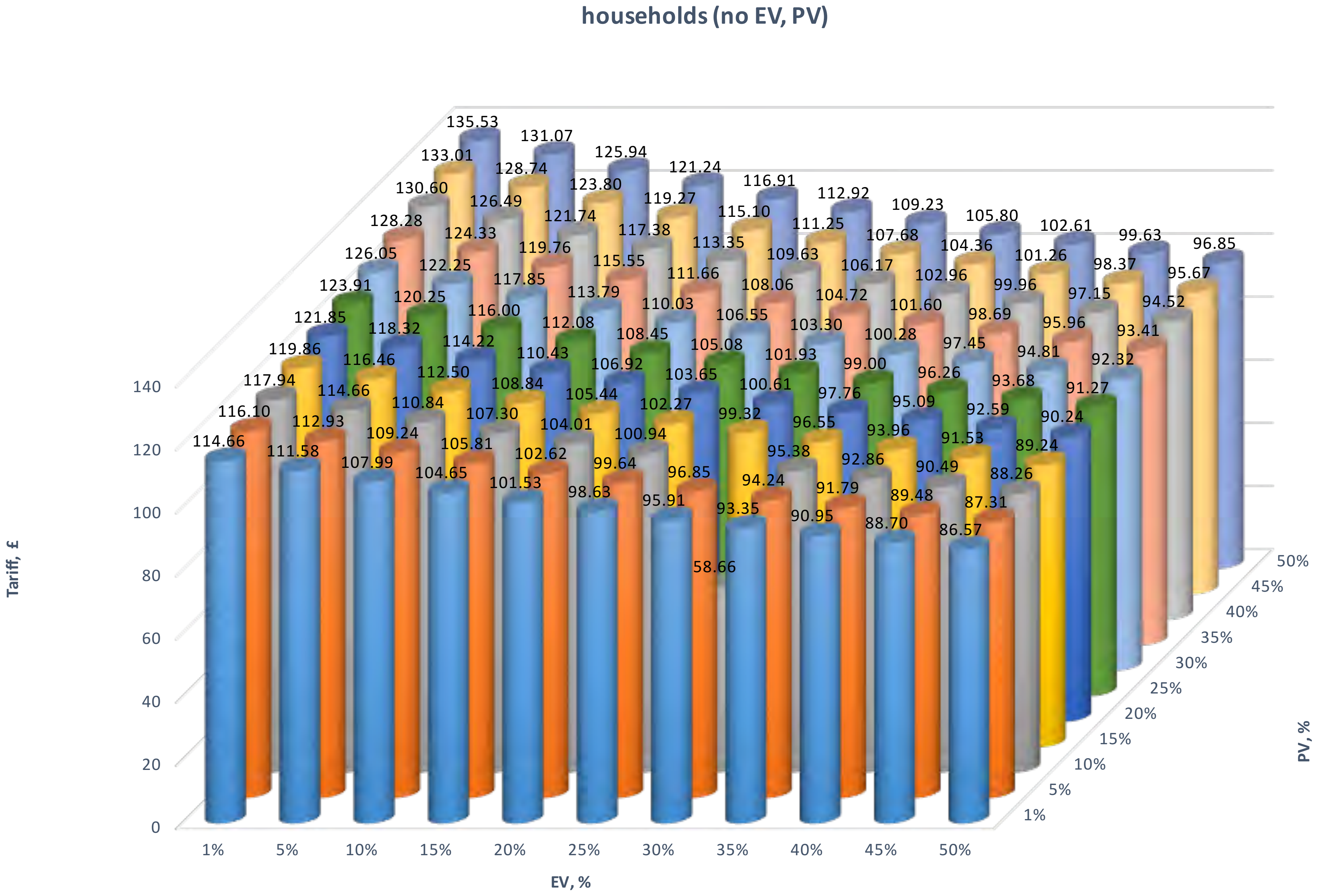
SP Manweb: 1206 kWh * £0.1292 (FIT in 2013) = £155.81
East Midlands: 1333 kWh * £0.1292 = £172.22

Households with EV:
Hypothetical EV consumption of 3000 kWh per kW for all two regions.

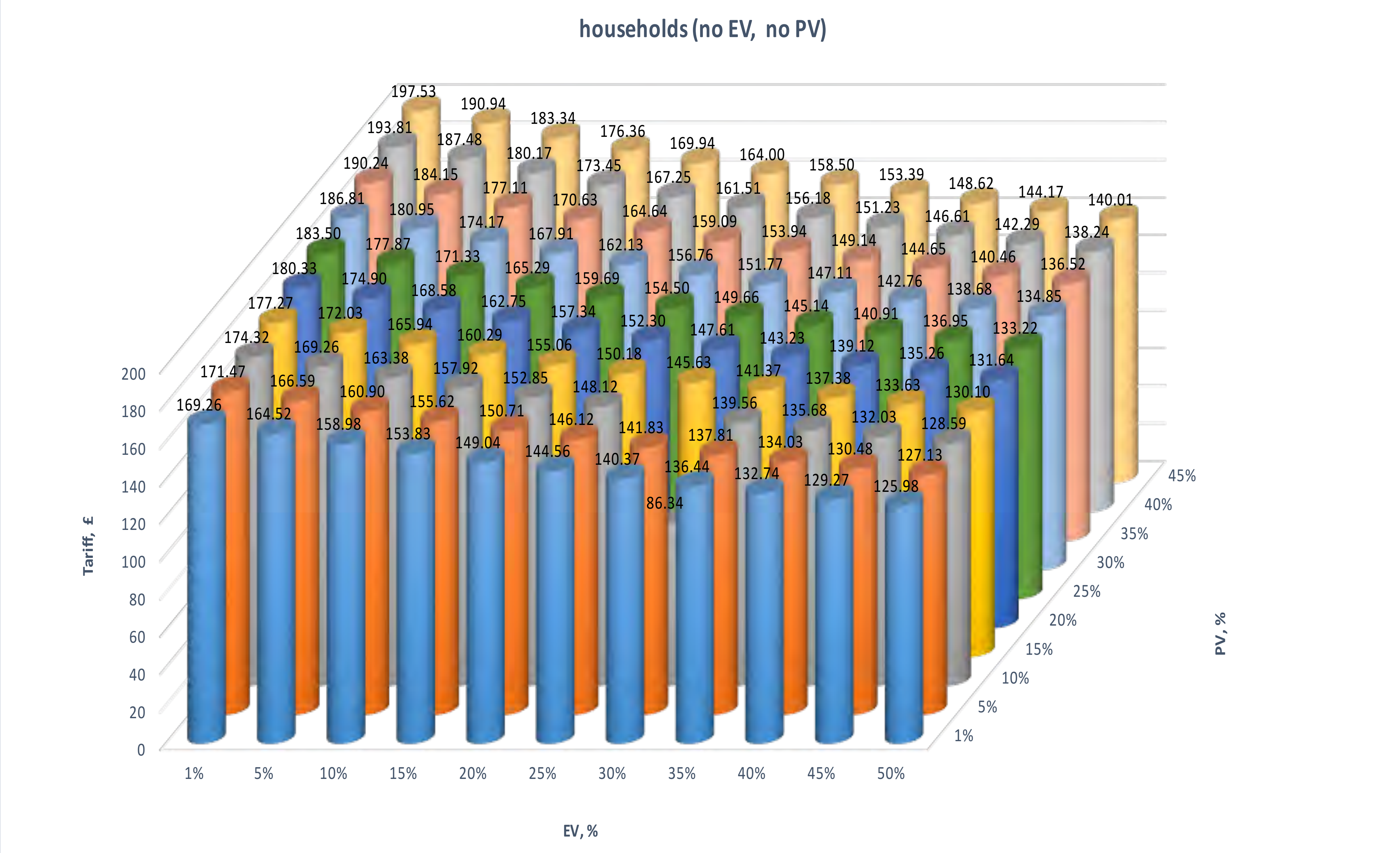
SP Manweb – EV and PV households



SP Manweb – PV, No EV households



SP Manweb – No EV, No PV households



Implications

- For SP Manweb customers:
  - No EV - No PV households pay £50 more than PV households now.
  - At 50% PV penetration their charges go up another £27.
  - However home charging of EVs can reduce charges for non-EV owners. At 50% penetration of EVs, No EV – No PV households save £44.
- For East Midlands customers, the comparable figures are:
  - pay £30 more, go up another £15, save £24.

When existing network charges become a problem: a case of solar PV in South Queensland, Australia

	Household A	*Household B*	*Household C*	*Household D*
	No air-con	*Air con*	*No air-con*	*Air-con*
	No Solar PV	*No Solar PV*	*Solar PV*	*Solar PV*
Maximum Demand (kW)	1.41	2.14	1.50	2.09
Metered import (kWh)	6253.4	7560.6	3820.1	4707.1
Solar Export (kWh)	0	0	2259.1	1838.8
Gross Demand (kWh)	6253.4	7560.6	6253.4	7560.6
Number of customers	283849	694643	26151	235357
% of customers	23%	56%	2%	19%
Base Network Tariff	$1006.14	$1171.37	$698.57	$810.69
Differences	A-C	B-D		
	$307.57	$360.68		

Note: Solar PV took off in 2009; 22% of households with solar PV in 2014. charging basis 20% fixed, 80% per kWh import. 1 AUD = 0.53 GBP.

Source: Simshauser (2014), p.22, Table 3. Modeled impact for 2014.

Clearly there is a case for regulatory action to change charging basis!

Conclusions

- Need for more modelling of who pays for future network costs as connection of PV, EV and storage continues (n.b. we assumed fixed total cost).

- Increase in the solar PV (and EV) lead to the redistribution of wealth and costs among existing customers. The numbers are small at the moment, but a significant share of the bill (up to 8% in the UK).

- What to do is not clear as per kWh charging is bad under PV uptake, but good under EV uptake.

- Per kW peak charging is an obvious way forward but with domestic storage it too may be an unfair, if efficient way to charge for the network, especially if total network usage begins to fall.

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