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Consumer solar distributed generation (DG): net metering and some competition issues

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Introduction

Electricity service involves the delivery of power (kW), energy (kWh) and power quality (e.g. voltage, frequency, or interruptions) at a particular location. The final consumers value each of these attributes directly and it is, in theory, possible to charge for each of these dimensions of service. However, the electricity pricing typically represents bundled service where delivery costs and commodity costs are bundled up by the retailer, who handles the contractual relationship with the wholesale power market and the transmission and distribution companies. Final consumers mostly prefer such bundling and value the transaction benefits of a single service provider contract and the insurance element that non-exposure to individual cost elements brings. These arrangements have traditionally been common to all network industries. By contrast producers, who sell across networks, often face costs (or price reductions) that reflect the costs they impose on the network. Generators, generating at less favourable times, in less favourable locations, or with lower power quality realize lower prices.

Network charges for the provision of transmission and distribution system services are part of the bundled price that customers pay. These charges recover the largely fixed costs of the transmission and distribution system and can be thought as paying for access to power for final electricity consumers. Electricity generators also need access to the transmission and distribution networks to allow them to service their customers. Domestic prosumers (i.e. owners of PV) use the distribution system for balancing their supply and demand even if their net demand is zero over the year.

Part I: Net Metering: Pricing Solar DG at Retail

- **Is net metering good policy? At the retail rate? At a different rate?**

No, net metering is not a good policy.

Traditionally electricity distribution and transmission systems have largely been paid for via unit electricity charges based on metered imports, with some contribution being made via fixed payments for most customers. Net metering implies that a customer who exports the same quantity of electricity as they import pays for no electricity net and makes no contribution to the fixed costs of distribution and transmission networks via variable charges. This is true even though they are making more real time use of those networks than a customer with no installed generation.

The evolution of net metering and the potential for this situation to arise is easy to explain in terms of political economy but it is difficult to justify on the grounds of economic rationality. Net metering conflates two issues that can be logically separated: (1) the desire of society to pay extra for certain types of distributed generation on the grounds of reaching renewable and decarbonisation targets; and (2) public utility pricing principles for the recovery of network costs, which balance fairness and efficiency in network pricing (Bonbright, 1961). It also, wrongly, assumes that a customer who generates electricity should be treated in the same unsophisticated way as a customer who only consumes electricity. It is difficult to think of any other industry that does this: in other industries consumers who sell own production (most obviously agriculture) must adhere by sophisticated market pricing rules or sell to wholesalers (or privately) at a discount.

Indeed one can go further and say that net metering introduces a fundamental conflict between these two issues that can be avoided. Historically, issue (2) has been an important concern for economic regulators and policy makers. Network charges should reflect costs and should be fair. This implies that those who use the network more should pay more and there should be a concern to protect poorer network users. Net metering runs completely counter to these principles of network pricing. Richer consumers, who can afford to install PV, and who make more use of the network make less of a contribution to the costs of the network.

If society wants to pay for distributed PV then it should pay for it at a premium that reflects the value of a unit of electricity to society and in a way, which does not distort other incentives in the energy system. The intention of PV subsidies was not to cause such distortions. This implies that there needs to be a separation of the charges for the transmission and distribution system and the payments for distributed PV, as is the case for renewable generation connected at higher voltages.

- **Does retail net metering result in cross-subsidization? For example, if the fixed costs associated with building and maintaining the electricity grid are incorporated into the price per kilowatt hour (volumetric pricing), do non-solar customers end up cross-subsidizing solar DG customers because the latter do not pay a full share of fixed costs when they choose to rely on self-generation?**

Yes, net metering does result in cross-subsidisation in situations where electricity service fixed charges do not recover all of the attributable network fixed costs.

Consumers with PV make less of a contribution to the fixed costs of the network. In doing so they raise the network costs for other users and provide additional (and arguably unintended) incentives to connect more PV, making the avoidance of network charges a significant benefit for new installers of PV. This does not exactly result in a ‘death’ spiral but it does result in a significant shift in charges among customer groups.

Some utilities have recognized the growing impact of DG and have begun trying to implement reforms to existing programs in a bid to raise some of the financial concerns associated with DG. In Arizona, the Arizona Public Service (APS) filed with the Arizona Corporation Commission (ACC) making two policy proposals. They suggested that under the first policy option, existing net metering customers would be charged higher on the basis of their electricity usage with the demand charge ranging from $45 to $80 per month. Another option would involve the establishment of a credit system for new DG customers in which the distributed generators would acquire compensation for electricity sold to the grid at a rate set by the ACC with the amount appearing as a credit on the customer's monthly bill. The first proposal reduced the residential solar customers' monthly savings from 14-16 cents per KWh to 6-10 cents per kWh while the second proposal reduced savings to nearly 4 cents per kWh per month. The APS tried to justify this by stating that the total subsidization of rooftop solar customers' amounts to nearly $18 million per year for their customers and that solar rooftop generation hardly saves utility money. They argued that had these sources not been available, the utility would have purchased that electricity on the wholesale market at a cheaper price as compared to the current system, in which rooftop generators are compensated at the full retail rate (APPA, 2013)[1].

Arizona Public Service Company estimates that if the prevailing speed of rooftop-solar establishment proceeds through mid-2017, its non-solar consumers will give roughly $800 million in raised charges to support rooftop solar customers over the next 20 years (Pool, 2012). The entire expenses nationwide are unknown. Nonetheless, an interdisciplinary association of professors and researchers at MIT published research about the prospect of solar energy and presumed that net metering is ineffective and should be redesigned (MIT, 2015)[2].

Thus, passing on additional costs or revenue losses attributed to DG onto the balance of other utility customers is likely to be a wealth transfer from the less affluent to the more affluent. This generally means that utility companies will set high fixed charges that will be shared by all the customers. Low income customers consuming less electricity than others will therefore be subject to higher electric bills. Payment of DG at full retail price or compensation for excess generation at full retail price will force the inclusion of distribution costs even though DG customers do not aid the utility companies in saving on distribution costs. This will result in higher fixed distribution charges and will slow down the long run energy efficiency efforts (APPA, 2013).

- **Does cross-subsidization of one form or another always occur when retail rates are based only on volumetric charges and are time-invariant? Does cross-subsidization caused by net metering differ in any way from other forms of cross-subsidization inherent in regulated retail rates?**

In order to reflect on this question, let us consider a case study of how network charging regimes can rapidly become unfit for purpose in the presence of a big uptake of a solar DG. South Queensland in Australia has one of the highest penetration rates of domestic solar rooftop PV in the world. In total, 22% of households had PV in 2014 and 75% have air-

[1] https://www.publicpower.org/files/PDFs/Distributed%20Generation-Nov2013.pdf
[2] http://energy.mit.edu/wp-content/uploads/2015/05/MITEI-The-Future-of-Solar-Energy.pdf

conditioning (Simshauser, 2014)[3]. Distribution charges in South Queensland are charged on the basis of 20% fixed cost and 80% per kWh. The massive increase in solar PV (from close to zero at the start of 2009) has resulted in a huge transfer of wealth and costs between customer groups. Solar PV consumers have lower metered consumption due to own production (a form of net metering). This significantly reduces their share of the per kWh costs of the distribution system. Meanwhile, the revenue cap regulation of the distribution charges means that the same revenue has been recovered as the number of units has fallen, thus per unit charges have risen and the distribution of their payment between different types of households has dramatically changed.

Table 1: Differences in Network Charges for Residential Consumers in South Queensland

	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	A$1006.14	A$1171.37	A$698.57	A$810.69
Differences	A-C	B-D		
	A$307.57	A$360.68		

Source: Simshauser (2014)

Simshauser (2014) analyses four types of household in this new situation: households with no PV and no air-conditioning (this is the poorest group); households with air-conditioning and no PV; households with PV and no air-conditioning; and households with PV and air-conditioning. He looks at how the charging mechanism has shifted the payments and considers a more cost reflective charging regime where each household pays a fixed charge, a per kW peak charge and a variable per kWh charge which better reflects underlying costs. What he finds is that households with PV and air-conditioning have only a fractionally lower peak per kW usage relative to those with no PV but air-conditioning. Meanwhile households with air-conditioning and no PV currently pay less than they should towards distribution charges, given their relative cost of service. The impact is striking the poorest group without PV and air-conditioning currently pay 307 Australian dollars p.a. more (or USD 211, i.e. around 40% more) than those with PV and no air-conditioning (see Table 1). This reveals that the starting point of charging is already unfairly subsidizing peaky users with air-conditioning AND that the system has rapidly become much more unfair with the high take-up of PV. A more cost reflective three-part tariff schemes sees those with PV and air-conditioning paying 28% more than at the moment and those without both paying 15% less (with the result that the poorer households pay around 180 AUD (USD 124) less). Simply put: the relationship between kWhs and kW peak observed prior to the arrival of PV has fundamentally changed, such that kWhs are a poor proxy for kW peak demand.

Is this situation is different from other types of cross-subsidy inherent in network pricing? All networks average costs across location and time of day for residential consumers. This has

[3] https://www.researchgate.net/profile/Paul_Simshauser/publication/276415820_Demand_Tariffs_resolving_rate_instability_and_hidden_subsidies/links/55597ff308aeaaff3bf99e70.pdf

traditionally been done on the grounds of societal preferences for simplicity (for the consumers and for the utility), fairness and because there would be little price response to introducing differential pricing in many cases. The situation with net metering is different in that it is simply the outcome of the way we chose subsidise renewables interacting with existing network charging methodologies. It can simply be addressed, it is unfair and it could be leading to price responses whereby some households are investing in PV (at the margin) to avoid contributing to network fixed costs.

- **Does it make sense for PUCs to target net metering for reform, or should they focus on reforming retail rates more generally to better reflect the varying costs of supplying electric power?**

Net metering is the presenting issue. It is always the case that reforming retail rates to make them more cost reflective is economically desirable. Net metering is a big issue that can be addressed in one go, while the full cost reflectivity of final prices is something of a moving target and may not be what customers actually want. It is something of myth that electricity customers want prices that reflect their varying costs of supply – the residential electricity price is a combination of a price for the underlying product and a financial hedge against price fluctuations.

Net metering and network charging raise some important questions for discussion: First of all, is the current charging methodology in particular states efficient and fair? Second, does the apportionment of charges between fixed, per kW peak and per kWh use of system charges need to be changed? Third, does the advent of a significant new technology at a particular voltage level on the network mean that a new type of charge needs to be introduced at that voltage level (e.g. kW peak export tariff)? The three following case studies from Germany and the town of Belmont, MA shed some light on the problem.

The case of Germany shows that when the total subsidy cost is apportioned through per unit charges, then clearly recovering subsidies through metered consumption results in shift of subsidies towards households that have not taken them up. A new tax charge on own consumption of solar of 4.4 euro cents /kWh (70% of *Erneuerbare-Energien-Gesetz* (abbreviated as EEG or the *Renewable Energy Act*) charge) was proposed for industrial and commercial companies in Germany to partly correct the tax arbitrage incentive (under the EEG charge), but this was later introduced at 30% of EEG and deferred initially. This shows the difficulty of reversing historic charging concessions. However, in the US context state level efforts to adjust historic charging methodologies in the light of new realities should be supported by Federal authorities.

In September 2015, Belmont (MA) Municipal Light Board from the town of Belmont in Massachusetts commission the Temporary Net Metering Working Group to prepare a report that discussed the issue of net metering and the ways of dealing with it (Belmont Light, 2015). The Working Group recommended setting the facility solar capacity limit encompassing the solar interconnections with the facility of 250 kW or less (Belmont Light, 2015)[4]. Moreover, each solar PV household was recommended to be given a monthly "buyback" price ($0.11/kWh) that would be fixed until December 31, 2017 (i.e. not full retail price).

[4] http://www.belmontlight.com/about-us/pdf/2015.09.29_Final_Report_NMWAG.pdf

According to the recommendations of the Belmont Working Group, the amount due to the solar host would be the credit towards host bill (no payment if the resulting bill is negative). Moreover, it was decided that no new applications after the aggregate capacity of all solar distributed generation receiving new metering or buyback services exceeding 1,000 kW (1 megawatt) would be considered.

- **Is there a way to prioritize among various reforms? Potential reforms may include a "value of solar" tariff; dual metering/net metering at something other than the retail rate; fixed charge reforms; smart meters/time-variant pricing.**

There are various models and principles that can be used for designing network charges for electricity. Any charging methodology for an electricity network has to deal with fixed cost recovery that represents a tax, which needs to be levied on network users. The tax rate on an individual network user could be higher or lower, but network fixed costs need to be recovered in aggregate and this will lead to some clear incentives on heavily taxed users to make investments driven by tax avoidance advantages.

The rise of distributed energy resources (DERs) offers the stakeholders and policy-makers increased opportunities to exploit the existing system of network charges in ways not originally envisaged. It becomes obvious that a rapid uptake of PV, EVs, or distributed storage poses charging problems at either the household or business customer level. It seems likely that poorer customers would be disadvantaged by their inability to invest in the sort of investments that might be required of customers in the future to keep their bills down.

The bright side of all this is that new uses of the network creates opportunities for reallocating charges to new users and away from existing users who may be poor and vulnerable. It may also be that solutions as to how to change the charging basis are easily to hand, because we are simply seeing the extension of well-known issues from higher to lower voltages on the network. In many cases we simply see the extension of charging methodologies from higher to lower voltages on the network. Therefore, new dimensions to network charging (such as per maximum kW export or import tariffs) which already exist at the transmission level at lower voltages, can (and should) be introduced.

Part II: Competition Issues

- **Is solar DG a competitive threat to distribution utilities? Does this depend on whether the distribution utility owns generation assets?**

No, solar DG is not a threat. Distributed generation still needs to access the network for export and prosumers still need import capability. To the extent that DG can reduce losses and the need for system capacity upgrades this may reduce the size of the distribution system over time, but this is not likely to be material. There may be certain locations where combinations of batteries and PV may reduce the need for peak capacity and indeed encourage disconnection. However this is something that does not threaten the viability of distribution assets in the medium term. On the other hand the need for fast charging of electric vehicles may increase the demand for system capacity. However all this suggests is that regulators need to give clear incentives for smart solutions when it comes to network utility requests for upgrading (or indeed replacing) their existing capacity.

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