DYNAMIC MODEL APPROACH TO ASSESS FEED-IN TARIFFS FOR RESIDENTIAL PV SYSTEMS

Sebastián Oliva (s.olivahenriquez@student.unsw.edu.au) and Iain MacGill (i.macgill@unsw.edu.au)
School of Electrical Engineering and Telecommunications and Centre for Energy and Environmental Markets
The University of New South Wales, Sydney, Australia, Tel.: +61 449978022

Overview

A brief period of significant PV policy support that occurred concurrently with major PV system cost reductions has led to an explosive deployment of distributed PV systems in the Australian state of NSW. At the same time there has been a lack of a long term economic assessment of these policies in Australia, from both a social and a private perspective, which has ended up in unsustainable and economically inefficient programs. In this paper we assess a range of different feed-in tariff (FiT) options that have been used or proposed within NSW using a dynamic model that estimates longer term PV deployment; consequent impacts on key stakeholders including electricity retailers and distribution network service providers (DNSPs), as well as electricity tariffs; and the social benefits and costs of particular scheme designs and settings. We find that for the majority of the PV policy options we have assessed, their public costs fall within the range of social benefits of avoided carbon emissions using either (lower) control cost or (higher) damage cost estimates. Moreover, commercial returns of PV deployment vary considerably for system owners, retailers and DNSPs for different scheme designs with notably adverse impacts on DNSPs under net metering (NM). Finally, we suggest a possible approach to choose the most appropriate scheme design for different policy objectives.

Methods

Our approach first estimates future PV installations based on a system dynamic model presented by Hsu (2012). This model uses the willingness of householders to invest in PV systems based on the annual returns of such systems under different PV policy options and projected PV costs. Such PV installations impact financially on retailers and DNSPs and hence impact on future electricity tariffs which change, in turn, future returns for customers and new installations. In particular, reductions to the income of DNSPs with PV deployment can be significant under NM arrangements. In the longer term, with significant PV deployment and potentially little reduction in required network expenditure, network tariffs would need to be increased. This will have the effect of increasing retail tariffs hence making PV more attractive.

Financial impacts on these industry participants are obtained from a model developed in (Oliva and MacGill, 2012) based on commercial arrangements in NSW; in this case using averaged results from a sample of 61 residential PV systems over a year of actual hourly PV production and wholesale electricity costs in NSW.

To assess policies we compare their environmental social benefits and net costs (total public cost of FiTs minus the cost of electricity at the retail tariff). We use the projected PV deployment to estimate avoided emissions benefits and publicly funded PV FiT costs. To estimate avoided emissions benefits we use both a 'damages' carbon cost (Hope, 2011) and a 'control' carbon cost approach (Australian Treasury, 2011).

The different FiT designs and settings are based on actual and proposed FiT implementations in NSW over recent years. Table I describes the PV commercial arrangements and policies we assess in this paper for a total period of 7 years.

PV policy	Description
NM-0	NM arrangement[1] with no payment for exports from retailers to PV customers.
NM-7.7	NM arrangement with a payment of 7.7 ¢/kWh[2] for exports from retailers to PV customers.
FiT-2013	FiT payment to PV customers for the gross PV generation at 60 ¢/kWh in 2013.
FiT-2013-14	FiT payment to PV customers for the gross PV generation at 60 ¢/kWh in 2013 and 40 ¢/kWh in 2014.
4xFiTs	4 years of FiT payment to PV customers for the gross PV generation starting at 60 ¢/kWh and being reduced annually.
7xFiTs	7 years of FiT payment to PV customers for the gross PV generation starting at 60 ¢/kWh and being reduced annually.

Table 1. Description of PV Policies[3]

[1] Under NM the PV electricity is first used on-site while any excess of PV generation will be exported to the grid.

[2] All monetary valuations in this paper are shown in 2012 Australian dollars.

[3] FiT schemes consider a retailer contribution of 7.7 ¢/kWh of PV generation paid to the NSW government. Also we assume that after the FiT scheme closes PV customers will move to a *NM-7.7* arrangement.

Results

We test the performance of the different policy options with our dynamic model. Figures 1 and 2 show the resulting impact of these policy options on PV deployment and benefits and costs for society, retailers and DNSPs.

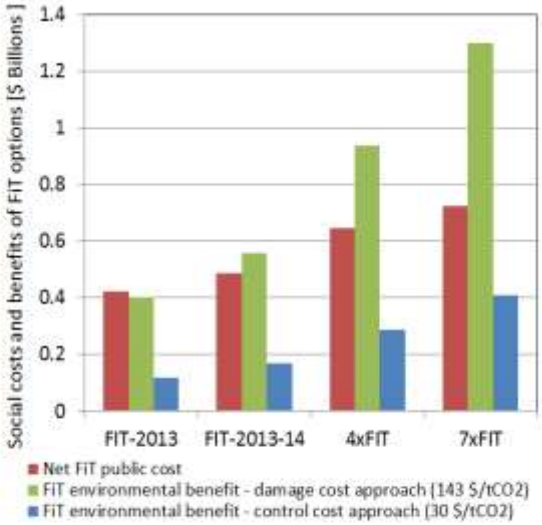

Fig 1. Long term environmental benefits and total net costs of FiTs options for society over 7 years[4].

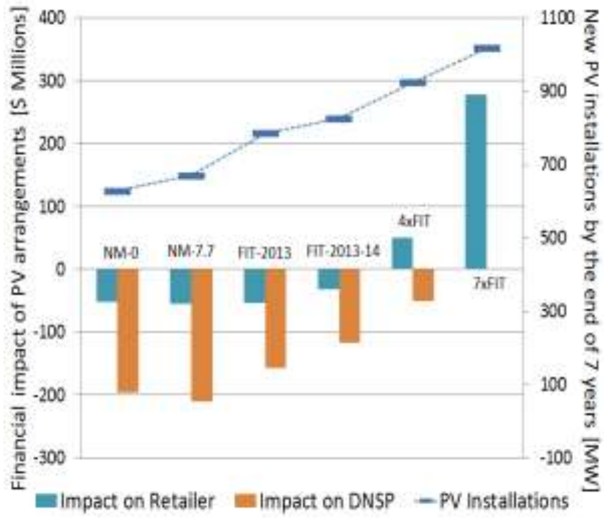

Fig 2. New PV installations and cumulative financial impact of PV arrangements on retailers and DNSPs by the end of the 7 years.

Fig. 1 shows how different policies offer different social costs and benefits. We see that FiT-2013-14, 4xFiT and 7xFiT net cost are in between the lowest and the highest value of FiT environmental benefits while such social benefits are largely driven by the value of the social costs of carbon (SCC). Also we see that FiT-2013, which would represent a FiT scheme as the 2010 NSW Solar Bonus Scheme in 2013, suggests that this scheme would not be socially beneficial since its net cost are always higher than benefits.

On the other hand, the total impact on retailers and DNSPs depend on the commercial arrangements in place. Fig. 2 shows that while retailers and DNSPs experience generally losses under NM arrangements; retailers experience financial gains under FiT schemes. However the overall impact is variable depending on how many years FiTs are available.

Conclusions

This article highlights the need of aligning FiT rates with the environmental PV benefits. However such benefits depend considerably on what are still highly variable and controversial estimations of the SCC. Using these two extreme SCC values and policy options suggests that a range for an optimal net FiT costs would be from 0.12 to 1.3 billion dollars.

Moreover, we see that considering a damage cost approach for the SCC the policy that maximizes the social PV value (benefits minus costs) is 7xFiT. The particular challenge of using estimated carbon ‘control’ costs, as seen in emissions trading schemes in the EU and Australia, is that current carbon prices are almost certainly well below the levels required to achieve the emission reductions goals that appear required to effectively address our climate challenges.

References

Australian Treasury, 2011. Strong Growth, Low Pollution: Modelling a Carbon Price. The Treasury.

Hope, C.W., 2011. The Social Cost of CO2 from the PAGE09 Model. Economics: The Open-Access, Open Assessment E-Journal 5.

Hsu, C.-W., 2012. Using a system dynamics model to assess the effects of capital subsidies and feed-in tariffs on solar PV installations. Applied Energy 100, 205-217.

Oliva, S.J., MacGill, I.F., 2012. Assessing the impact of household PV systems on the profits of all electricity industry participants, Power and Energy Society General Meeting, 2012 IEEE, pp. 1-7.

[4] Environmental benefits consider avoided CO_2 emissions for the whole life of the new PV installations (25 years) triggered by the FiTs.