The case for an incentive scheme for rooftop solar PV

Analysis by Joseph Curtin for Friends of the Earth, August 2017

Executive Summary

1. This paper provides evidence for the introduction of a support scheme for residential solar photovoltaic (PV) electricity, and addresses arguments that have been put forward against a tariff. Underpinned by financial modelling, it makes specific design proposals to Government.
2. Along with commercial and ground-mounted solar, residential rooftop solar PV offers many advantages for the grid, bill-payers and citizens, and enhances social buy-in for decarbonisation.
3. Our findings suggest that a generation tariff of 9 to 10 cent combined with an export tariff of 6.6 cent would be sufficient to incentivise deployment of rooftop solar, particularly for early adopters.
4. If restricted to 50,000 rooftops by 2030, the additional cost to the Public Services Obligation (PSO) would be relatively insignificant (€12.5- €13.8 million per annum).
5. Our proposed design is cost-effective, based on international best practice, and future proofed by offering a marginal incentive for home consumption. Cost effectiveness could be further safeguarded, however, by ongoing monitoring or through a built-in digression mechanism.
6. Arguments that this scheme could cross subsidise wealthy households lack empirical support. International evidence suggests that poor, average and wealthy households all choose to invest, and evidence from Ireland (from up-take of grants) suggests that the schemes would be attractive to a broad cross section of society.
7. The net costs and benefits to the overall energy system of domestic generation require future evaluation. Where detailed analysis of these costs and benefits has been undertaken (e.g. the UK) the grid services provided by domestic generations (e.g. peak shaving) are found to be substantial. We recommend further analysis on this point, but that in the interim, unsupported arguments that posit large overall systems costs should be avoided.
8. Rooftop solar PV, especially combined with battery storage technologies, are potentially disruptive to business models in the energy system. Over the medium to longer term this may necessitate a rethink of how the costs of the energy system are shared between users.
9. Blocking citizens from generating energy, however, is not the answer. Ireland should be preparing for a flexible modern networked grid of the future, which offers many potential benefits as well as risks that need to be managed.

Background

The Department of Communications, Climate Action and Environment (DCCAE) are considering a new renewable electricity support scheme to replace the existing REFIT regime.

Several issues are currently under deliberation in relation to the design of the incentive regime for Solar PV. Friends of the Earth are concerned that the scheme proposed by DCCAE may not cover micro/roof top installations, and may not adequately address barriers to citizen participation in the deployment of Solar PV. This contribution to the debate, therefore, focuses exclusively on the case for the introduction of a subsidy for rooftop solar PV, which we argue is vital for development of the type of grid and energy system that can deliver national decarbonisation at least cost and maximum benefit over the coming decades. While solar PV is a potentially disruptive technology to incumbent business models, it must be embraced not blocked, because it offers many benefits for citizens, and is a potentially vital component of the flexible and responsive energy system of the future.

In addition to making the argument for a rooftop scheme we address some of the arguments made against supporting rooftop Solar PV. These arguments include the following:

1. The cost of solar PV in Ireland;
2. The cost of small-scale PV compared to larger-scale ground mounted and commercial rooftop systems; and
3. The potential for cross-subsidisation of rich to poor households.

The response is structured as follows:

1. We first set out the importance of Solar PV in Ireland in the medium and long-term;
2. Second, we make a proposal for the design of support scheme for rooftop solar PV, and demonstrate that this is cost-effective for all bill payers (who are affected via the PSO), and attractive for householders;
3. Third, we consider the myth that solar PV involves poor households subsidising rich households;
4. Fourth, we deal with the grid costs and benefits, another reason often cited for inaction;
5. Fifth, we consider in brief some of the wider societal benefits of mobilising householders;
6. Finally, we consider what kind of energy system that might emerge in the future and how it can be planned for.

1. The role of Solar PV in Ireland's energy transition

Ireland has several objectives relevant to the transition to a low-carbon economy. The key relevant targets and objectives for 2020, 2030 and 2050 are given in Table 1. As can be seen, Ireland is not on target to meet these 2020 objectives.

Table 1. Ireland's compliance objectives for 2020

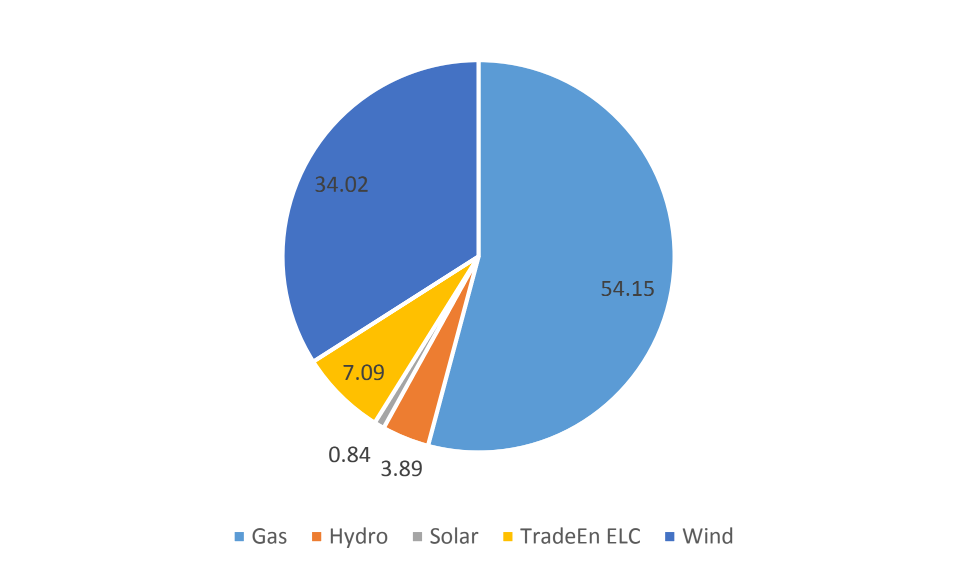
Objective	Time Period	Legal nature	WM projections	WAM projections
EU Effort Sharing Decisions (No 406/2009/EC)[1]: 20% reduction on non-ETS emissions on 2005 levels	2020	Legally binding	13.7 Mt shortfall	11.5 Mt shortfall
EU Renewable Energy Directive (2009/28/EC)[2]: 16% share of renewables in gross final energy consumption by 2020	2020	Legally binding	7.7% shortfall	2.8% Shortfall
European Commission Proposal (July 2016): Reduce emissions from buildings, transport and agriculture 39% on 2005 levels (non-ETS)	2030	Will be legally binding	113MT[3]	113MT[4]
National Policy Position on Climate Change: Reduce energy emissions 80% and achieve "carbon neutrality" in agriculture (Energy White Paper commitment to a reduction in energy emissions of 80-95% by 2050)	2050	National commit-ment	N/A	N/A

The most recent EPA data[5] demonstrates that Ireland's emissions are increasing in line with a recovering economy, and that the distance to target is again growing. To meet Ireland's 2050 objective for the energy sector, DCCAE has estimated that an average annual reduction of 0.75Mt CO_2 from relevant energy-related emissions would be required between now and 2050.[6]

Modelling work undertaken in Environmental Research Institute (UCC), published by DCCAE, demonstrates that solar PV is a very important technology for meeting these decarbonisation objectives in the medium (2030) and longer (2050) term.

In the medium-term, in a least-cost compliance scenario (where 2030 and 2050 objectives described in Table 1 are being met), solar PV delivers almost 1% of Ireland's total electricity production by 2030 (Fig 1).

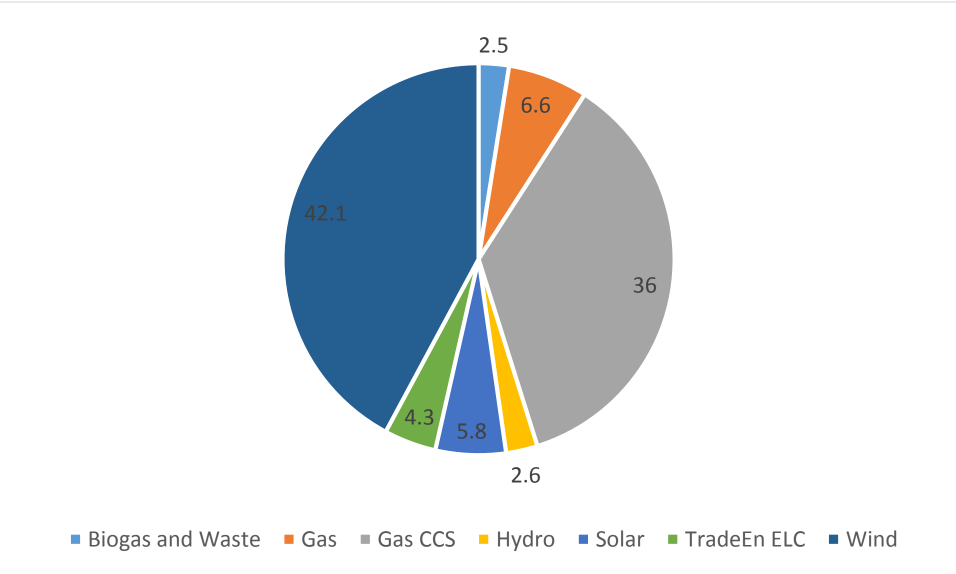
Fig. 1. Electricity Production by Fuel (% 2030)



Source: Derived from UCC (2017)[7]

In the longer–term (2050), the deployment of solar PV becomes a key aspect of Ireland's electric production, accounting for nearly 6% of electricity production by 2050 in a scenario where national and EU objectives are met at least cost.

Fig. 2. Electricity Production by Fuel (% 2050)



Source: Derived from UCC (2017)[8]

Solar PV will be among the first renewable technologies to achieve "grid parity"[9] in the UK (were conditions are similar to Ireland's), where it is projected to be the least-cost electricity generation technology in the coming five or so years. [10] UK energy system planners are projecting the deployment of 10GW of small-scale subsidy-free solar by 2030.[11]

It is vital, therefore, that measures are taken to support Solar PV under the renewable energy support scheme currently under consideration in Ireland. The initial period of support is necessary so that the technology matures in the Irish market, and to ensure that Ireland can benefit from dramatic technology cost reductions anticipated over the coming decades. Supporting the industry at this early stage will ensure that a qualified cadre of project developers and technology experts emerges, and a technology supply chain is developed.

2. The cost-effectives of rooftop solar PV in Ireland

While the argument for the importance of solar PV (above) is commonly accepted in Ireland, there is less certainty about supporting rooftop solar PV. A perception has taken hold that rooftop is too expensive to support, or that supporting it can have other negative unintended consequences. These positions, however, do not appear to be supported by the data, and are perhaps a reflection of the potentially disruptive nature of small-scale solar PV.

It is true that smaller installations offer lower economies of scale and higher transaction costs, and are therefore are less-cost effective compared to larger commercial rooftop or ground mounted developments. Some estimates suggest that, on a Levelized Cost of Energy (LCOE) basis, small-scale rooftop developments may be in the region of 50% more expensive compared to commercial rooftop and twice as expensive as ground mounted projects in the UK.[12]

While it is true that larger schemes offer these economies of scale and lower transaction costs, the argument in favour of household rooftop solar is based on the fact that householders save energy which would otherwise be paid for at the rate of the peak electricity tariff for residential customers. This fact is underappreciated, and improves the economics considerably, dramatically reducing the need for Government subsidy. Despite the fact that the current Irish tariff structure is arguably outdated for the type of energy system that is now emerging, and does not reflect the marginal cost of electricity (a point we take up in greater detail below), it still allows for solar PV to be attractive to householders at a reasonable cost to Government.

To illustrate the case for rooftop solar PV, the level of support required by Government, and the types of support options available, we have modelled the potential attractiveness of rooftop solar schemes under different support scenarios. Further to a literature review, review of market data from the UK, and interviews with experienced project developers in Ireland, we used the assumptions given in Table 2 for this purpose.

Table 2. Assumptions about domestic PV system

Capacity (KW)	3KW
System cost	€5700
Annual Output	2769KWh
Op ex per KW	€25
Peak electricity cost	0.135

Degradation (%)	0.50
Site usage (%)	50
Electricity cost inflation (%)	4

We modelled a number of scenarios with a view to making a proposal for the design of an incentive scheme. In selecting a final preferred design proposal, we considered the following factors:

- **Cost-effectiveness and the PSO:**
  - How the support scheme could be designed to make a minimal annual contribution to the overall PSO. This is a function of the level of support offered and amount of rooftop solar deployed (installed capacity of rooftop solar PV by 2030)
  - How much this costs in terms of tCO2/€ of PSO (useful for comparing the PSO support to other exchequer-funded programmes)
- **Householder perspective:**
  - We assume that the vast majority of householders will think primarily in terms of simple payback period, but that many will also consider lifetime savings (particular early adopters)
  - We also considered Net Present Value (NPV) and Internal Rate of Return (IRR) at different discount rates
- **Future proofing:**
  - We considered the importance of creating a marginal incentive for home consumption, which is a function of the relationship between the peak electricity price and the export tariff
- **International experience:**
  - The design of UK and German and other support schemes for renewables, which in general include an export and generation tariff

On this basis, and balancing the objectives described above, we propose that a support scheme for rooftop solar to be offered as per Table 3.

Table 3. Proposed Support Scheme for residential rooftop solar PV

Generation tariff	€0.09 -0.10
Export tariff	€0.066
Installed Capacity (MW, 2030)	150

This support scheme would be designed with international experience (particularly that of the UK) in mind, where a generation tariff (for all electricity generated) is offered to producers. This is the real subsidy involved, because the export tariff is set in line with the average spot price paid for electricity by suppliers (i.e. the export tariff is a sale of a product on the market). This design allows us to clearly determine the rate of the real subsidy (the generation tariff).

Cost-effectiveness can be managed by capping the overall quantity of support available at 150MW by 2030, which can be offered to homeowners on a first-come-first-served basis. As can be seen from Table 4, this is equivalent to roughly 50,000 houses with solar PV by 2030 (more ambitious schemes could be considered, see Table 4), at an annual cost of €12.5 - 13.8 million to the PSO. The subsidy is a very minor overall contribution to the PSO. It is also a reasonably cost-effective option when considered in terms of t/CO_2 at €213. In order to ensure an equitable share between households, the generation tariff might be restricted to 3 Kw per household. Restricting the support scheme to existing homes rather than new builds might also be considered so as to avoid subsidising what is already required under Part L of building regulations.

The technology is increasingly mature and we do not envisage rapid cost decreases of the types experienced in the UK, Germany, Italy etc. over the past decade. Nevertheless, the support levels should be reviewed every 2-5 years, or some form of digression mechanism could be considered to control costs, depending on rapidity of deployment, interest from householders etc.

Table 4. Cost-effectiveness for electricity users and the exchequer

Number of Homes	Annual Exchequer Cost €.09 cent	Annual Exchequer Cost €.10 cent	€/t for exchequer
1000	276900	249210	20
10,000	2769000	2492100	20
50,000	13845000	12460500	20
100,000	27690000	24921000	20
500,000	138450000	124605000	20

*added to PSO

Finally, it is necessary to consider if the level of support offered would be attractive to householders. We find that with a generation tariff of 10 cent, the scheme would offer roughly a 10-year simple payback for the householder. With reform to the tariff structure (see below) where fixed costs are restructured into a volumetric charge, the payback time is 7-8 years. After 25 years, the €5,700 investment will have netted an undiscounted return of €14,244 (assuming a 20-year generating tariff, and savings on bill and export tariff for 25 years), or a net undiscounted householder benefit of €8,544. We believe that this would be a highly attractive proposition for many householders, particularly early adopters. The investment has a positive NPV for discount rates of between 2-7% and has an internal rate of return of 7%.

Finally, with this design the export tariff (6.6 cent) is set at half the rate of the peak electricity tariff for household (13.5 cent), creating a marginal incentive to consumer domestically and invest in storage and other technologies as them become cost effective.

3. Cross-subsidisation of bill-payers

There is a narrative that, somehow, cross-subsidising householders to generate electricity is unfair to bill payers. It is true that government subsidies, by their very nature, have distributional impacts. The PSO as currently structured requires all bill payers to subsidise professional developers, utilities and private investors to build wind power. The PSO also subsidies the generation of peat, which is the most environmentally damaging fossil fuel. Because these are added as a fixed charge on all users' bills, they are regressive charges. It is important, however, to be very clear that this applies to the structure of the PSO as currently designed. It is unusual that the cross-subsidisation argument seems only to be used to argue against rooftop solar PV.

The subsidy regime currently under consideration will create further distributional issues, but we see no logic for demanding that bill-payers only subsidise professional developers. We do not see why rooftop generators are different to these other actors that are currently being subsidised, or those who will be subsidised in the next phase of renewables support.

If there were evidence to suggest that only rich householders invest in rooftop solar PV from other countries, perhaps this argument might hold water. We note, however, that there is no evidence to support the assertion. While some assertions to this affect have been made in newspapers, we do not find any literature, policy assessments or reports which support the argument.

For example, an Irish Times opinion piece argued in relation to a subsidy for solar PV in Australia that: *The Queensland subsidy was attractive to older and richer households who, by installing solar cells, have dramatically reduced their consumption of publicly-generated electricity"* and "*much of the cost for solar powered electricity is being paid for by poorer households*.[13]

We could not uncover a source for this assertion. Analysis of the initiative demonstrates that uptake of rooftop solar has in fact been highest in low-income areas among low income households.[14] Similarly, in the United States, the average household income of an investor in rooftop solar PV in the US was $57,000, only slightly above the national household income average. [15]

While no data is available for Irish households as there is no support scheme in place, we know for a fact that Irish grant schemes for home insulation have been popular with a wide demographic, from low- to high income households.[16]

We know of no data or analysis which supports the assertion that support for Solar PV subsidises richer households. The danger is further ameliorated by the entry into the market of new business models and types of financing that lessen the need for high levels of upfront capital or savings (sale and lease back etc.), and note also cheap capital entering the market (Bank of America, Credit Suisse and Citigroup etc. are providing bond financing) for rooftop solar systems in many countries with mature markets. Needless to say, the poorest households (in Ireland) also receive supplements and support with electricity bills, further minimising the supposed negative socio-economic consequences.

Nevertheless, it is important to consider how distributional impacts can be lessened. This can be achieved by introducing reforms to the tariff structure as well as ensuring that capital is available to interested householders.

4. Grid costs or benefits?

It has also been argued that solar PV users use the grid but do not contribute to its upkeep. But we also question this narrative. While solar PV households will undoubtedly need to draw from the grid, in the vast majority of cases (without a huge investment in battery storage), they also contribute to the grid at peak demand, during the day when the sun is shining. Solar PV installations can also, therefore, provide a grid service. In the future, households will have various storage solutions which can also potentially be of benefit to the optimal grid functioning.

There are therefore costs and benefits to consider. No analysis of these potential grid costs and grid benefits has been undertaken. We do not claim that rooftop solar PV would provide a net benefit to the system, but we argue that further independent analysis is required on this topic, rather than unsupported assertion or heuristics.

We note in jurisdictions where this analysis has been undertaken, such as in the UK, findings suggest in a system where low carbon generation located close to people's homes and businesses, combined with new technologies such as storage, could result in savings for consumers on their bills of up to £40bn over the coming decades. [17] Policy might be encouraging the emergence of a grid which benefits society and all citizens, even if this creates difficulty for typical business models in the energy system.

5. Wider social benefits

One of the headline objectives of the 2015 Energy White Paper was as follows:

The energy system will change from one that is almost exclusively Government and utility led, to one where citizens and communities will increasingly be participants in energy efficiency and in renewable energy generation and distribution.

This was to be achieved, inter alia, by:

Exploring the scope to provide market support for micro generation.[18]

This commitment was made because of the multiple benefits from galvanising citizens as investors in low-carbon transition. Many accounts of the successes and failures of low-carbon transition have identified community and societal acceptance as a potentially significant barrier, but also a key enabler of success (Shackley and Green, 2007; Sovacool and Lakshmi Ratan, 2012; Stokes, 2013; Szarka et al., 2012; B. J. A. Walker et al., 2014; G. Walker, 2011; Wolsink, 2007; Wüstenhagen et al., 2007). Mobilising citizens as investors, and offering them a stake in low carbon transition is a highly effective way of mobilising knowledge, understanding and support for low carbon technologies. Individual citizen investment in technologies such as solar panels can generate local income and contribute to understanding of climate and energy security issues, and create niches which positively interact with the wider regime in various ways (Bergman and Eyre, 2011; Bolton and Foxon, 2015; Devine-Wright, 2014; Devine-Wright, 2005; Dóci et al., 2015; Li et al., 2013; Palm and Tengvard, 2011; Parag et al., 2013; Rogers et al., 2008; Slee, 2015; Viardot, 2013; B. J. A. Walker et al., 2014; Wüstenhagen et al., 2007; Yildiz, 2014; Yildiz et al., 2015). Experience investing in a LCT can also positively dispose citizens to making future low-carbon investments (Boon and Dieperink, 2014; Dobbyn and Thomas, 2005; Keirstead, 2007).

There are, therefore, good reasons for mobilising citizen investment in solar PV that are not captured in analysis looking at least-cost pathways to low carbon transition.

6. Energy system in the future?

Predicting the future is highly challenging. However, we believe that there is a risk, and with it an opportunity, that solar PV and storage costs will continue to decrease exponentially, leading to a radically altered energy system in the future. Costs of battery storage, for example, continue to fall at 20% per annum – Aurora Energy Research find that battery storage capacity could reach up to 8GW in the UK by 2030.

This is a risk that Irish energy systems planners therefore need to be aware of as one possible future. It is a potentially disruptive future that threatens incumbent business models. We believe that Irish energy systems planners should be preparing for a flexible modern networked grid by removing barriers to micro-generation and smart storage technologies, by enable smart homes and businesses, and by making markets work for flexibility. Analysis from the UK and elsewhere shows that this is the type of energy system that will deliver optimally for bill payers.

Part of the way in which this is planned for is by enabling householders to become energy citizens, as detailed in the Energy White Paper. Amongst other things this involves bringing forward an export and generation tariff for rooftop solar and removing regulatory and other barriers which prevent deployment of rooftop solar PV.

This technological backdrop may require a reconsideration of the tariff structure for electricity in due course, and in particular the consideration of a volumetric charge to replace fixed costs, including the PSO.

[1] http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=uriserv:OJ.L_.2009.140.01.0136.01.ENG#page=12
[2] http://eur-lex.europa.eu/legal-content/EN/ALL/?uri=CELEX%3A32009L0028
[3] http://www.dccae.gov.ie/documents/National%20Mitigation%20Plan%202017.pdf
[4] http://www.dccae.gov.ie/documents/National%20Mitigation%20Plan%202017.pdf
[5] http://www.epa.ie/pubs/reports/air/airemissions/ghgprojections/EPA_2017_GHG_Emission_Projections_Summary_Report.pdf
[6] http://www.dccae.gov.ie/documents/National%20Mitigation%20Plan%202017.pdf
[7] http://dccae.gov.ie/documents/ESRI%20Energy%20Modelling%20Paper%20May%202017.pdf
[8] http://dccae.gov.ie/documents/ESRI%20Energy%20Modelling%20Paper%20May%202017.pdf
[9] Grid parity occurs when a new electricity source can generate power at a levelized cost of electricity (LCOE) that is less than or equal to the price of purchasing power from the electricity grid.
[10] http://www.r-e-a.net/upload/uk-solar-beyond-subsidy-the-transition.pdf
[11] https://www.gov.uk/government/publications/updated-energy-and-emissions-projections-2016
[12] http://www.r-e-a.net/upload/uk-solar-beyond-subsidy-the-transition.pdf
[13] https://www.irishtimes.com/business/economy/john-fitzgerald-early-adopters-can-pay-a-heavy-price-1.2492715
[14] http://reneweconomy.com.au/rooftop-solar-uptake-still-highest-in-low-income-australia-63263/
[15] https://www.google.com/search?q=average+household+income+usa&ie=utf-8&oe=utf-8&aq=t
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[17] https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/568982/An_analysis_of_electricity_flexibility_for_Great_Britain.pdf
[18] http://www.dccae.gov.ie/documents/Energy%20White%20Paper%20-%20Dec%202015.pdf