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Review

The cost-effectiveness of household photovoltaic systems in reducing greenhouse gas emissions in Australia: Linking subsidies with emission reductions

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HIGHLIGHTS

- Payback period for Australian household PV fell to four years in 2011 and 2012.
- PV became attractive due to high feed-in tariffs and declining PV costs.
- Cost was AU$200/t CO_2e in 2010, expected to be AU$65 to AU$100/t CO_2e by 2020.
- PV resulted in greenhouse gas emissions reducing by 3.7 million t CO_2e in 2013.
- PV expected to reduce greenhouse gas emissions by 8 million t CO_2e in 2020.

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ABSTRACT

This paper examines the cost-effectiveness of subsidies (feed-in tariffs and renewable energy credits) paid for by electricity consumers to support the uptake of roof top photovoltaic (PV) systems by households in Australia. We estimate annual payback periods, and then regress these against the actual uptake of household PV and associated emission reductions, creating a relationship not apparent in other research. Sensitivity analysis reveals that the declining cost of PV panels had most impact on PV uptake followed by feed-in tariffs, renewable energy credits and the increasing cost of household electricity tariffs. Our modelling shows that feed-in tariffs were higher than necessary to achieve the resultant levels of PV uptake and that the low cost of PV panels and comparatively high electricity tariffs are likely to result in a continuing strong uptake of household PV in Australia. Our modelling shows that subsidies peaked in 2011 and 2012, with payback periods of three to four years, having since increased to five to six years. Emission reduction costs are expected to reduce from over AU$200 per t CO_2e in 2013 to between AU$65 and AU$100 per t CO_2e in 2020. Household PV reduced Australia's emissions by 3.7 million t CO_2e in 2013 (1.7% of Australia's total emissions) and is expected to reach eight million tonnes (3.7% of Australia's total emissions) by 2020.

Contents

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1. Introduction

In Australia, electricity consumers subsidise the development of household photovoltaic (PV) systems through two schemes: (1) feed-in tariffs (FITs) which are provided on a state by state basis, and vary in price, coverage and term for systems under 5 or 10 kW, depending on the state concerned [1]; and (2) through a renewable energy scheme that provides renewable energy credits for renewable energy output [2]. Costs of these schemes are recovered through a charge imposed on electricity retailers, who in turn recover those costs from electricity consumers (Fig. 1). In broad terms PV households experience an installation cost, being the installed PV cost discounted by the value of small-scale technology certificates (“STC price” and “STC multiplier”), and obtain revenue from FITs (“FIT export benefit”) plus benefiting from reduced imported electricity (“Reduced elec. consumption benefit”). In this paper we examine the cost-effectiveness of these subsidies as an emissions reduction initiative.[1] This is achieved through modelling that ultimately links the cost of subsidies to reductions in greenhouse gas (GHG) emissions, a link which does not appear to be replicated in any other research.

To provide some context, Australia’s emissions in the financial year ending June (FY) 2013 totalled 562.8 million t CO_2e, with stationary electricity generation contributing 193.1 million t CO_2e. Australia’s emissions reduction target for 2020 is 537 million t CO_2e, with 191 million targeted from stationary electricity generation [4]. Electricity sector GHG emissions are targeted to decrease only marginally to 2020, partly due to the impact household PV has already had on reducing GHG emission levels.

Australia implemented the world’s first national Mandatory Renewable Energy Target (MRET) in 2001 [5] which encouraged renewable energy schemes by crediting each megawatt hour of output, above a 1997 base output level, with a renewable energy certificate (REC), later re-classified as either a large-scale generation certificate (LGC) or a small-scale technology certificate (STC) [2]. In 2009 the MRET was renamed the renewable energy target (RET) and a REC multiplier was introduced providing extra “deemed” RECs (Renewable Energy (Electricity) Amendment Act, 2010). It is assumed existing RET legislation will continue even though some changes might occur as a result of the current RET review. At the time of writing there appears to be bipartisan support for smaller renewable energy schemes, including household PV [6].

Households with PV systems avoid going to go to the market to sell their STCs as the practice has been to assign their STCs to installers who discount PV installation prices by the market value of the STCs [7]. There is strong competition between installers to provide competitively priced PV panels which are mostly imported from Asia, particularly China. An oversupply in 2010, due largely to investment subsidies in China [8,9], at a time when the Australian dollar was strong, resulted in a substantial drop in the price of PV panels (Fig. 2). Attractive FITs were introduced on a state by state basis between 2008 and 2010 (Fig. 3), creating subsidies from two sources and fuelling the boom in PV installations.

Since 2010 PV panel prices have increased only marginally and even though FITs are lower than they were five years ago the demand for PV panels remains strong [10]. Nevertheless at some stage a saturation level will be reached whereby the non-PV household group will take an increasing level of enticement to be attracted to PV. In late 2013 the Australian states of Queensland and South Australia had household PV penetration rates of 22% and 25% respectively with a nation-wide average of 14% [11].

2. Literature review

2.1. World-wide subsidy support for household PV

An increasing number of countries has introduced renewable energy subsidies with a particular focus on household PV supported by FITs and less commonly by RECs. Honguaug et al. [8] determined that in 2014 there were 75 jurisdictions world-wide having solar energy FITs and 14 having renewable energy credit policies, having increased from 50 and ten respectively in 2010 [12]. Dusonchet et al. [13] provides a comprehensive review of FITs in EU countries. Australia’s household PV subsidies differ from those in other parts of the world in that RECs are a nation-wide scheme whereas FITs are state determined, covering differing time periods and with some FITs being on a gross (that is all PV output) basis and some on a net (that is exports only) basis. The relative merits of each of REC and FIT schemes are discussed in [14] concluding that it is difficult to show which is more effective while noting that Tamas et al. [15] concluded that the schemes would have identical effectiveness in perfectly competitive markets. Authorities in Australia, as in most countries, underestimated the uptake of PV which was driven mainly by the unexpected rapid decline in the price of PV panels [16]. This has resulted in many

[1] The quantitative analysis presented in the paper covers the period from year ending June 2005 to year ending June 2014 and is in Australian dollars; the Australian dollar having averaged US$0.9326 over this period. The full analysis is from FY 2000 to FY 2020 encompassing the period the Australia Commonwealth Government has committed to reducing GHG emissions by 5%, over 2000 levels, as well as seeking to have 20% of electricity generation from renewable energy sources [2].