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Determining commercially viable two-way and one-way 'Contract-for-Difference' strike prices and revenue receipts

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ABSTRACT

In this article, we investigate the role that a Contract-for-Difference (CFD) might play in increasing investment in renewable energy in Australia. Two CFD schemes are investigated: two-way and one-way CFD. A financial model is developed that determines commercially viable CFD strike prices. Account is taken of revenue from wholesale electricity market and renewable energy certificate sales. Capital and operational costs of the project including distribution of funds to holders of equity and debt are also included. Findings based on analysis of the solar array located at the University of Queensland Gatton Campus in Australia is presented, employing a typical meteorological year framework. The major finding was that Government will prefer a two-way CFD scheme and Single-Axis tracking solar PV array technology. In contrast, project proponents will strongly prefer a one-way CFD design.

1. Introduction

Government support for investment in renewable energy have been based on key policy mechanisms including: (1) tax concession instruments such as the U.S. Federal Business Energy Investment Tax Credit (DOE, 2017); (2) renewable energy obligation or target schemes such as the UK Renewable Obligation (RO) (OFGEM, 2017), the Australian Large Scale Renewable Energy Target (LRET) (Nelson et al., 2013; CER, 2016) and U.S. Renewable Energy Portfolio Standards (Schelly, 2014); and (3) feed-in tariffs which have been widely implemented in continental Europe, often based on estimates of Levelised Cost of Electricity (LCOE). Of these policy mechanisms, Ouyang and Lin (2014) concluded that feed-in tariffs were the most effective in promoting investment in renewable energy, citing evidence in Lesser and Su (2008), Couture and Gagnon (2010), and Thiam (2011). Overviews of feed-in tariff design and implementation are presented in del Rio and Gual (2007), Klein et al. (2008), Cory et al. (2009), Couture et al. (2010), Mabee et al. (2012), Jenner et al. (2013), Moore et al. (2013) and Wang et al. (2016).

However, Hirth (2013), Ueckerdt et al. (2013), Hirth et al. (2016) and Simshauser (2017) identify potential complications and limitations associated with using the conventional LCOE measure for projects built around intermittent renewable energy sources if the costs of integration are not included. Integrations costs are likely to be higher in the short-run because of fixed capacity than in the longer run when the power system has had time to adapt. The market value of intermittent renewables is likely to decline as integration costs increase with penetration of variable renewables. Factors linked to power system adaptation capable of significantly reducing integration costs and improving market value include greater demand-side management, electricity storage and greater transmission inter-connectedness.

More recently, interest in reverse auction 'Contract-for-Difference' (CFD) mechanism has gained prominence, in terms of public policy (UK Government, 2015; Victoria, 2015; ACT, 2016; CCA, 2016; QRET Expert Panel, 2016) and academically (Kozlov, 2014; Bunn and Yusupov, 2015; Onifade, 2016; Pollitt and Anaya, 2016). CFD pricing has been employed previously in energy applications relating to transmission congestion contracts (Hogan, 1992) and the Nordic market (Kristiansen, 2004).

A CFD mechanism does not require a reverse auction process for its successful implementation. However, the reverse auction CFD mechanism has garnered the particular attention of jurisdictions investigating its potential use as a policy support mechanism for renewable energy. This is particularly the case in Australia, building upon the experience of the ACT scheme (ACT, 2016). In general, a reverse auction CFD requires that renewable energy project proponents bid a strike

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Abbreviations: c/kWh, Cents per kilowatt hour; $/kW, Dollars per Kilowatt; $/kW-yr, Dollars per Kilowatt per year; $/MWh, Dollars per Megawatt hour; $m, Million of Dollars; $pa, Million of Dollars Per Annum; ACT, Australian Capital Territiory; AEMO, Australian Energy Market Operator; ARENA, Australian Renewable Energy Agency; CCA, Australian Climate Change Authority; CER, Australian Government Clean Energy Regulator; DOE, United States of America Department of Energy; EBITA, Earnings before Interest, Taxes, and Amortization; EBIT, Earnings before Interest and Taxes; EBT, Earnings before Tax; kW, Kilowatt; kWh, Kilowatt hour; LGC, Large-scale Generation Certificate; Module, An Alternative Name for a Solar PV Panel; MW, Megawatt; MWh, Megawatt hour; OFGEM, United Kingdom Office of Gas and Electricity Markets; QRET, Queensland Renewable Energy Target Expert Panel

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price as part of a reverse auction process. Strike prices are ranked in ascending order and projects with the lowest bid price chosen, moving up the ascending-order ranking until the desired renewable energy capacity of the auction round has been achieved.

The policy objectives that the CFD policy is trying to achieve will influence how it is implemented. It can be used as a policy lever to promote investment in newly emerging renewable technologies that are at significant competitive disadvantage to more mature technologies. In this case, the auction round would target specific emerging technologies with the expectation of higher levels of Government support because project proponents would have to bid higher CFD strike prices to ensure commercial viability. Policy focus would be directed towards determining the size of the aggregate capacity of the programme and how that is split between different auction rounds to maintain a strict cap on Government financial liability whilst locking in cost reductions as the technology matures.

If the objective of policy is to promote rapid expansion in renewable energy capacity at least cost, then the eligible renewable energy base will be broader in scope, linked to a requirement of technology neutrality. Successful applicants within reverse auction rounds would most likely be more mature renewable technologies such as wind and solar PV.

Another motivation of policy-makers to adopt a CFD policy could be budgetary constraints. CFD's have the ability to leverage against revenue earnt from wholesale market operations. This means the overall size of Government financial support needed would be significantly reduced under a CFD policy compared with conventional feed-in tariff policy. Furthermore, the lower financial risk profile of Government under-writing CFDs through their ability to access tax revenue or attract favourable long-term debt financing terms could convey additional advantage. Specifically, shorter tenured CFD under-written by Government might more readily satisfy project financiers than similarly tenured CFDs under-written by commercial organisations. The lower tenure on Government backed CFDs would reduce the risk to taxpayers or electricity consumers if the Government's liability was funded from consolidated revenue or charges levied on electricity consumers.

When developing the policy framework for CFDs, Government will need to monitor potential short- and long-term consequences that these financial instruments might have on existing hedging instruments and contracts. Currently, most hedge instruments are *firm* products linked to the output of thermal generation. Hedging of intermittent renewables, however, is based on different *non-firm* instruments linked to commercial Power Purchase Agreements (PPA) (Simshauser, 2017). If higher penetration of renewables leads to the exit of thermal generation, then the role of non-firm instruments will gain more prominence as the volume of firm hedging instruments declines. Careful monitoring of the stability and liquidity of the hedging market would be needed to ensure that requirements of all market participants continue to be met and hedge supply contract shortages are avoided. To facilitate this, CFDs should be developed so they can be traded in secondary markets thereby improving the prospects of both longer term liquidity and stability of markets for hedge contracts (Simshauser, 2017).

Governmental costs associated with administering and monitoring a reverse auction CFD scheme will be linked to due diligence to protect its revenue base while also pursuing the objectives behind the policy. If the cost of the CFD policy is financed through levies on electricity consumption, due diligence by responsible Government would extend also to managing the impacts of any cost imposts on lower income households or trade-exposed high electricity consuming industries.

Within a broader context, two key effects have been identified in the literature that could potentially mitigate desired outcomes associated with the CFD policy. The first relates to higher capital costs of renewable energy projects potentially inducing an upwards shift in average costs and electricity tariffs over the longer term, reversing any initial downward movement in wholesale electricity prices achieved over the short-term (Felder, 2011; Nelson et al., 2012). However, evidence also shows that capital costs of renewable energy projects have themselves declined (sometimes quite sharply) under renewable energy policy support programmes. This would moderate the extent of any upward shift in average costs over time.

The second is the rebound effect whereby reductions in wholesale electricity prices associated with renewable energy support would stimulate the demand for electricity, increasing electricity consumption and carbon emissions if the electricity supply has a high degree of carbon intensity (Frondel and Vance, 2013). However, they key issue driving this outcome is the carbon intensity of electricity supply which would be expected to decline as renewable energy penetration rates increase. Moreover, the key policy objective of CFD and other renewable energy support mechanisms is not to reduce demand but instead to de-carbonise electricity supply. In fact, longer run carbon mitigation strategies often envisage increased electrification of key industries such as transport to reduce carbon emission associated with oil, gas and petroleum consumption. Finally, in assessing costs and benefits of renewable energy policy proposals, benefits of mitigating the longer term costs of climate change under Business-As-Usual are usually not included in the analysis. Specifically, low income groups will also be the least able to adapt to severe climate change impacts linked to extreme weather, increased food and water insecurity or adverse health impacts. More generally, very useful lessons can be drawn from the European experience of administering and implementing feed-in tariff schemes that are directly relevant to CFD policy. These lessons relate to ensuring that support levels remain cost reflective within design parameters aimed at protecting the financial position of Government. Comprehensive surveys of these lessons are reported in Cory et al. (2009) and especially Couture et al. (2010).

Two CFD structures are investigated in this article (QRET Expert Panel, 2016):

- *Two-way CFD*: A set level of revenue is guaranteed based on revenue collected through the wholesale market and revenue provided under the CFD up to an agreed strike price. If wholesale revenue exceeds that associated with the CFD strike price, the project proponent is required to pay back the difference to the CFD counter-party.
- *One-way CFD*: Project proponents are guaranteed a minimum level of revenue, but maintain additional levels of revenue if wholesale market prices exceed the CFD strike price.

In the case of a two-way CFD scheme, the need to get the bid price right gains more prominence because project proponents must pay back to the CFD counter-party, the amount of incremental revenue when wholesale market prices exceed the CFD strike price. As such, and in contrast with one-way CFD, it is not possible under two-way CFD to utilise super-normal economic profits associated with high wholesale electricity price events.

To determine CFD strike prices, account needs to be taken of expected wholesale electricity price trends, expected solar PV yield, other eligible renewable energy revenue streams as well as capital and operational costs of the solar PV project. In the case of solar PV yield, project proponents often base solar PV output assessment on average solar PV yield, typically utilising a Typical Metrological Year (TMY) framework. In this paper three key metrics will be investigated. These are: (1) the amount of financial support provided to the project proponent by the CFD counter-party; (2) the overall profitability of the project; and (3) the market value of the solar project.

Novel contributions of the article include: (1) using financial modelling and solar PV output of the utility-scale University of Queensland (UQ) Gatton Solar Research Facility (GSRF); (2) determining commercially viable CFD strike prices under both CFD schemes; (3) calculating revenue payable to GSRF by a CFD counter-party under both CFD schemes; (4) examining the underlying profitability of GSRF under both CFD schemes; and (5) applying the modelling to different solar PV array tracking technologies installed at GSRF. To the author's knowledge,