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Assessing the system and investor value of utility-scale solar PV

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ABSTRACT

With pressure to reduce greenhouse gas emissions from the energy and other sectors, policymakers are increasingly seeking to mobilise investment in renewable electricity with support mechanisms. The objective of this paper is to assess the value of utility-scale solar PV using a multidisciplinary approach. In many cases renewable energy strategies are developed by investors and policymakers on the basis of a relatively narrow analysis of costs. However, as policies should be designed to maximise societal welfare, a wider paradigm is needed in decision-making. This paper argues for an impact assessment of renewable electricity generation that integrates its value from investor, utility, policy maker and end-user perspectives. We propose a multidisciplinary approach to the assessment, combining engineering production cost estimation with financial and market analysis of utility-scale solar PV in Ireland. The results show that while from an investor's perspective solar PV generation is, and will likely remain so for the foreseeable future, relatively expensive in a country with low solar irradiation such as Ireland, there are benefits for the electricity system in terms of reduced wind curtailment and, to a lesser extent, CO_2 emissions. This demonstrates why the wider costs and benefits of integrating a renewable electricity technology to the system need to be considered in assessment of renewable policy support mechanism. Policy makers can then seek to maximise the system benefits while minimising the cost of any policy supports.

Contents

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1. Introduction

Countries around the world are seeking to encourage higher shares of renewable energy in electricity generation and other energy sectors in order to reduce both greenhouse gas emissions and reliance on imported fossil fuels. The IEA estimates that annual investment in renewables needs to reach $400 billion in 2025 and continue to increase over 2026-2040 to an average of $470 billion per year to constrain the temperature rise to 2 C. Total installed renewables-based capacity would more than triple from existing levels to reach 6200 GW in 2040, almost 60% of total installed capacity at that time [1].

Increasing the share of renewable electricity implicates policy makers, energy users, energy providers, and investors and presents a number of uncertainties and potential challenges. Globally, the main sources of renewable electricity, after hydropower, are onshore wind and solar photovoltaic energy [2]. While the costs of wind and solar energy generation have fallen in recent years, in many countries they remain higher than conventional thermal generation. As a result, policy makers face decisions on the design of effective support strategies that address market failures in the electricity market[1] and the choice of which renewable electricity technologies to support.

The goal of renewable electricity policies, as with all policies, should be to maximize societal welfare. In designing support mechanisms for renewable electricity it is important to carry out analysis that considers the perspectives of stakeholders such as utility companies, energy users, and communities and individuals affected by energy infrastructure. Policy decision-making tools may be used, such as cost-benefit analysis, life cycle analysis, or multicriteria decision-making analysis. Regardless of the method, it is important to include the wider costs and benefits from the plethora of stakeholders given above in the assessment of impacts of renewable policy support mechanisms. This paper shows one approach to assess the impacts of a renewable electricity technology that takes into account a range of different stakeholder perspectives, namely investor, utility, and policy maker, of the value of investment in current and future utility-scale ground-mounted solar PV in a solar resource-poor location.

Solar PV energy was selected as the technology for analysis in this paper, as its swift transformation from a high-cost, experimental technology to a mature, competitive energy source across the globe over the last five years implies its deployment is likely to continue to grow. Worldwide deployment of solar photovoltaics (PV) increased 360% from 2010 to 2014, and installed costs have fallen by more than half in some regions during the same period [3]. Bloomberg New Energy Finance (BNEF) forecasts that costs will continue to fall, making utility-scale solar generation competitive with conventional sources in most of the world by 2026, and attract $3.7 trillion in investments through 2040 [4]. From an investor's perspective, financing costs for solar PV have fallen in many countries as experience with solar PV projects has grown and the perceived financial risk reduced [5]. As costs of solar PV have decreased, there is renewed interest in solar PV in locations with lower solar irradiance, where previously solar PV generation was considered financially unviable.

From a policy perspective, solar energy can be valuable as a means of diversifying a country's fuel mix, increasing the renewable electricity portfolio, reducing greenhouse gas emissions, and bolstering indigenous energy production. Estimates of the system costs and benefits of solar PV electricity generation are important in particular to policy makers for the purposes of investment planning and deciding whether there is economic and political justification for subsidy of solar PV. Without interconnection, an electricity system is constrained by the amount of non-synchronous generation of wind or solar PV power it can accommodate. Therefore, countries with an already significant share of intermittent, non-synchronous power generation and little interconnection with other electricity markets may face challenges integrating solar PV power in the system. In addition, high instantaneous shares of intermittent generation may pose other flexibility and capacity pressures on the system. The policy impacts, such as the impact on renewable or CO_2 emissions targets, curtailment of other renewable sources (such as wind energy), and the longer-term energy strategy should be assessed and compared with the cost of any policy supports under consideration and potential electricity system upgrades that might be incurred.

On the other side of the decision-making process are investors who need to consider whether it is worth investing in solar PV generation. One of the most important roles a company undertakes is to identify potential projects that will add value to a company. While there is increasing pressure to switch to renewable energy sources to reduce CO_2 emissions, it is unlikely that investors and firms will invest heavily in these areas unless doing so also coincides with the ultimate goal of maximizing wealth. In particular, what electricity price would be needed for a profitable return on their investment? The most frequently applied investment evaluation technique is Net Present Value Analysis, which sets the capital and ongoing costs, and the cost of finance, against the revenue over the lifetime of the project.

There has been much published on the impact of renewable support policies from either economic, technical and social perspectives ([6–18]) but few studies combine methods from several disciplines as we do here.

The research is novel, as it combines estimates of both project-level costs and system impacts in an assessment of solar PV generation and then examines the policy implications in a country with lower solar potential in light of these estimates. This, to our knowledge, has not previously investigated. The next section provides some context for the analysis, Section 3 describes the methodology, Section 4 presents the results and discussion; Section 5 comprises conclusions drawn from the analysis, and Section 6 includes some recommendations for future work.

2. Context

This paper combines analyses from several disciplines to examine whether the recent advances in solar PV technology have sufficiently altered the financial proposition for ground-mounted utility scale solar PV generation. We have chosen Ireland as the

[1] Market failures leading to underinvestment in renewable electricity such as: (i) the existence of unpriced externalities such as CO_2 emissions, and (ii) the underinvestment by private companies in renewable energy R&D due to spillover effects and the risks and benefits associated with ambitious energy projects [12].