Energy Research & Social Science 46 (2018) 103–113

Contents lists available at ScienceDirect

Energy Research & Social Science

journal homepage: www.elsevier.com/locate/erss

Original research article

The politics of energy scenarios: Are International Energy Agency and other conservative projections hampering the renewable energy transition?

Gerry Carrington, Janet Stephenson*

Centre for Sustainability, University of Otago, P.O. Box 56, Dunedin 9054, New Zealand

ARTICLE INFO

Keywords:
Solar PV
Scenario
Growth projection
Energy transition

ABSTRACT

Scenario-building assists commissioning organisations to understand the multiple forces that shape their future. Governments and investors use the scenario projections of authoritative organisations to help drive their planning and decision-making. But what if scenarios consistently fail to represent a credibly established technology trajectory, particularly for a topic as critical as the world's future energy systems? We examine solar PV projections in 26 recent global energy scenarios, contrasting them with academic studies and other analyses, and find that they all fail to account fully for technology developments and recognise plausible upper levels of solar PV growth. Drilling deeper into the influential World Energy Outlook scenarios of the International Energy Agency, which are amongst the more conservative of the 26 scenarios, we explore possible reasons for, and the implications of, their projections for solar PV growth. We conclude that low scenario projections such as the IEA's are likely to deter investments in innovation and development that would otherwise occur. If authoritative scenarios fully acknowledge the possibility of continuing rapid growth of solar PV, investors, governments and the energy sector will be encouraged to take a more optimistic view of the market potential, thus creating positive feedback loops of belief, investment, and growth.

1. Introduction

If the expectations and ambitions of investors and policy makers for the future of energy systems are shaped by scenarios that are unnecessarily pessimistic about the potential rate of change, might this in itself become a self-fulfilling prophesy, as suggested by the International Renewable Energy Agency [1]? In this paper we explore the proposition that estimates of the rate at which the global energy system could plausibly become low-carbon have implications for investment decisions as well as for energy policy.

The predominant view in the academic literature is that energy transitions are inevitably long protracted affairs [2]. On the other hand Sovacool [3] suggests that the evidence does not consistently support this position. A brisk debate [2,4–8] was stimulated when Sovacool [3] posed the questions: “What does the mainstream academic literature suggest about the time scale of energy transitions?” and “What does some of the more recent empirical data related to transitions say, or challenge, about the mainstream view?” (p202). In this paper we aim to advance this debate by reviewing global energy scenarios and associated literature on solar photovoltaic (solar PV) growth, and considering the implications for policy and investment decision-makers. Solar PV is likely to be a key technology in a low-carbon energy system because of its rapid historic growth and because solar energy has more potential for electricity generation than other renewable resources [9]. Global solar PV capacity has increased by 34% per annum on average over 57 years to 2017 (Fig. 1). We review studies which indicate that continued growth at a similar rate until 2030 is a reasonable possibility. We also explore the implications of scenarios that promulgate more conservative projections.

Projections for the future growth of solar PV cover a wide range. At one extreme Seba [10] argues that solar PV is an exponential technology for which historic growth rates will be maintained at least until the 2030’s, as part of a wider technological transition in energy and transport. If this eventuates, solar PV would provide more than half of global electricity production by 2030. Although Seba is arguably the most prominent advocate for a transition of this speed and scale, it is also considered to be plausible by others in the research community [11–16]. In this paper we will refer to an outcome in which solar PV generates more than 50% of global electricity as a “Seba-like” transition.

Seba’s view contrasts with those of Kramer and Haigh [17], Höök et al. [18], Bezdek and Wendling [19] and Smil [20]. Kramer and Haigh [17] propose two “laws of energy technology deployment” based on the concept of “materiality” – the time at which a new energy technology

* Corresponding author.
E-mail addresses: gerald.carrington@otago.ac.nz (G. Carrington), janet.stephenson@otago.ac.nz (J. Stephenson).

https://doi.org/10.1016/j.erss.2018.07.011
Received 15 September 2017; Received in revised form 2 July 2018; Accepted 6 July 2018

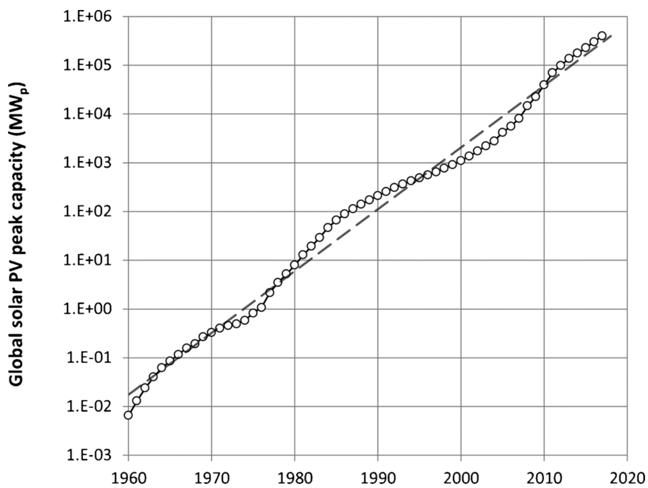

Fig. 1. The open circles show the cumulative global solar PV peak generation capacity (MW_p) at the end of each year, 1960–2017. The dashed line is a fitted exponential growth curve with a compound annual average growth rate of 34% pa.

produces or consumes between 1% and 10% of world energy supply. Prior to materiality they claim that the rate of deployment of a new energy technology may grow exponentially. But subsequently the rate of growth reduces due to existing infrastructure lock-in, the time needed to establish large-scale technology supply capacity, and the time required to adapt to it. The position of Kramer and Haigh is broadly consistent with what Sovacool [3] calls "the mainstream view that energy transitions all take time" (p205).

To establish an understanding of expectations for solar PV growth we examine 26 global energy scenarios that are by well-recognised organisations, broadly read, accessible and widely referenced. We compare the scenario projections with analysis in the academic and grey literatures, including reputable commercial reports. Throughout we accept the definition of the IPCC [21] that a scenario is "a coherent, internally consistent and plausible description of a possible future state of the world. It is not a forecast; rather, each scenario is one alternative image of how the future can unfold." Scenario development is undertaken for many reasons including to systematically analyse possible future pathways, to examine technology potentials, to elucidate strategic options and more generally "to capture the richness and range of possibilities, stimulating decision makers to consider changes they would otherwise ignore" ([22]:38). In this context we use the verb "project" and noun "projection" in the same way as the IEA [23]: a projection is an estimate of a possible future state under specific assumptions. It is not a prediction.

Energy scenarios produced by influential global organisations matter because they "affect what may actually happen. They are performative." ([24]:465). They shape the beliefs and expectations of decision-makers in their sector and beyond [25]. They have a pervasive influence on the unfolding energy transition because "[t]he language we use to describe transitions serves as more than a mere analytical tool—it can shape how energy system users, investors, operators, builders and financiers frame energy problems and also envision future pathways for change" ([8]:236). Scenarios establish expectations that can become "taken-for-granted assumptions of what is going to happen, thus falling into a deterministic lock-in, where future states become not just a promise but an inevitability" ([24]:469). Widely-shared expectations and visions about the future can underpin unconscious biases, or become hard-wired into analytical tools and models [26]. Organisations themselves may be constrained by their own beliefs and norms that support a particular energy culture [27] which makes it difficult to examine a future that is beyond the scope of those beliefs. For these reasons the projections that organisations declare in their scenarios are not only shaped by their own world-views, but they also shape the world-views of others.

In this paper we question the messages scenarios convey to others, and examine "what they can reveal about current agendas, motivations, and existing social orders" ([24]: 482). This is particularly significant given that expectations "play a central role in mobilizing resources both at the macro level, for example in national policy […] and at the meso level of sectors and innovation networks" ([26]:286). Critically, they also underpin the decisions of investors [28]. Consequently, scenarios that promulgate a limited-scope vision may have the effect of constraining the "cognitive aspects" of investors ([29]:6).

To examine our title question, "Are International Energy Agency and other conservative projections hampering the renewable energy transition?" we consider three subsidiary questions: Is there evidence that the International Energy Agency and other scenarios are conservative? What evidence is there that solar PV could continue to grow at historic rates? From a public-good perspective, should global energy scenarios explore rapid (Seba-like) solar PV uptake as a plausible future?

The paper is structured as follows: in Section 2 we describe the methods used to analyse global energy scenarios and in Section 3 we examine data on the deployment of solar PV in the past and consider the implications of different growth rates in the future. We examine the results of the scenario analysis in Section 4, compare them with other evidence on the future growth of solar PV, and consider the implications of conservative scenarios. In Section 5 we present our conclusions.

2. Methods

We examined 26 well-known global energy scenarios, all but one published between 2013 and 2017. The slightly earlier World Wide Fund for Nature scenario [30] was also included for contrast because it projected a faster rate of reduction in global CO_2 emissions than the others. Six of the scenarios are by fossil-fuel companies (Statoil 3; Shell 2, ExxonMobil 1). Nine are by the International Energy Agency, an intergovernmental agency established by the OECD, and five are by the World Energy Council, a global network of energy organisations. Three are by Greenpeace. There is one scenario each by Carbon Tracker (a think tank based in the UK), the World Wide Fund for Nature and the USA's Energy Information Administration.

Table 1 lists the scenarios in order of increasing projected CO_2 emissions in 2040 (top to bottom), showing source details, the letter codes used to identify them in Fig. 4, and the projected global CO_2 emissions due to energy use in 2040. We recognise that the scenarios may have been produced for a range of reasons and may use different methodologies, but their findings cover a similar range of topics and are thus empirically comparable. The Appendix A lists numerical data for each scenario.

As a basis for comparing the scenarios we used eight global indicators for 2040, the last year for many of the scenarios. These were selected as indicators of projected changes in the global energy system in response to global climate change: CO_2 emissions due to fossil-fuel combustion, total primary energy demand (TPED), natural gas use, oil use, coal use, total electricity generation, solar PV generation and wind generation. The projected quantity of CO_2 emissions in 2040 was expressed in units of GT of CO_2. TPED includes all energy sources before being converted into the form used by consumers. TPED and fuels are measured here in units of EJ (10^{18} J). Total electricity generation is the energy supplied as electricity which is measured in units of PWh (10^{15} Wh). Where the scenarios used other units, we applied the following conversion factors, selected for consistency between the IEA [32] and the WEC [35] scenarios: primary energy 0.0417 EJ/MTOE; natural gas 0.0342 EJ/bcm; oil 1.95 EJ pa/mb per day; coal 0.0287 EJ/Mtce; heat 1.055 EJ/quad; electricity 3.6 EJ/PWh.

Most of the scenarios provided the required data in the form of tables, but for the ExxonMobil [38] and WWF [30] scenarios some data