Applied Energy 225 (2018) 221–232

Contents lists available at ScienceDirect

Applied Energy

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

Solar energy justice: A case-study analysis of Saskatchewan, Canada

Brett D. Dolter[a,*], Martin Boucher[b]

[a] Institute of the Environment, University of Ottawa, Canada
[b] School of Environment and Sustainability, University of Saskatchewan, Canada

HIGHLIGHTS

- Case study of solar energy justice in Saskatchewan Canada.
- Deliberative dialogue methodology used to design solar programs.
- Cross-subsidization is a key challenge to solar energy program designs.
- Centering due process as a core element of the energy justice decision-making tool can help to achieve energy justice.

ARTICLE INFO

Keywords:
Energy justice
Solar energy
Decision making
Deliberative dialogue
Due process

ABSTRACT

Our study investigates solar energy justice in the province of Saskatchewan, Canada. In 2017, we were engaged by the Saskatchewan Power Corporation (SaskPower), a government owned electric utility, to conduct stakeholder engagement workshops for the development of new solar energy programs in Saskatchewan. In coordination with SaskPower we developed a deliberative dialogue approach to the consultation process. Select stakeholders were invited to participate in a half-day workshop. In this workshop participants were asked for input on the principles that would guide SaskPower's solar energy strategy, the barriers that prevent solar energy from being installed in the province, and their ideas for effective solar energy programs. Participants worked in small groups to design solar energy programs, creating opportunities for mutual learning and deliberation. This research is the first application of deliberative dialogue to the design of solar energy programs of which we are aware and offers an example of due process in the program design stage of energy planning. We use an energy justice decision-making (Sovacool et al., 2014) tool to evaluate the process of designing SaskPower's solar energy strategy and the content of recommendations made by participants to answer the question, can due process help to achieve energy justice? Participants in our deliberative dialogue suggested guiding principles that were similar to the dimensions of the energy justice decision-making tool. The deliberative process also highlighted tensions between dimensions of the energy justice decision-making tool. In this paper, we suggest avenues to improve the deliberative dialogue process and conclude that centering due process as a core element of the energy justice decision-making tool can help to achieve energy justice. Our results contribute to the growing field of study on how deliberative dialogue can allow for better decisions in complex fields such as energy policy.

1. Introduction

Renewable energy installations have significantly outpaced expectations by notable forecasters [1]. To advance a more sustainable future it will be important to incorporate energy technologies that are more environmentally benign. However, technological innovations within the electricity system have significant societal impacts [2,3]. Traditional approaches to analyzing renewable energy have often focused on engineering and economics. A focus on the energy justice implications of technologies like solar panels will likely improve social outcomes as these novel technologies are incorporated into the electricity system [4,5]. In this vein, our study applies an energy justice framework to a case study of solar energy program design. The aim of our paper is twofold: first, we provide a case study of a solar energy program design that embodies the energy justice principle of *due process*; and second, we assess the value of Sovacool and Dworkin's energy justice framework by applying it in a real-world policy-making context [6].

In January of 2017 we were engaged by SaskPower to conduct stakeholder engagement workshops for the development of new solar energy programs in Saskatchewan. In coordination with SaskPower we

* Corresponding author.
E-mail address: brett.dolter@uregina.ca (B.D. Dolter).

https://doi.org/10.1016/j.apenergy.2018.04.088
Received 2 October 2017; Received in revised form 14 April 2018; Accepted 27 April 2018

developed a deliberative dialogue approach to consultation. Select stakeholders were invited to participate in a half-day workshop. Participants were asked for input on the principles that would guide SaskPower's solar energy strategy, the barriers to solar energy, and their ideas for effective solar energy programs. Participants worked in small groups to design solar energy programs, creating opportunities for mutual learning amongst themselves. This deliberative approach was novel in the Saskatchewan context. In the past, public consultations in the province have been top-down and, "typically one-way communication with minimal deliberation" [5, p. 20]. Our deliberative dialogic approach offers an example of due process in the program design stage of energy planning. We use the energy justice decision-making tool [7] to evaluate the process of designing SaskPower's solar energy strategy and the content of recommendations made by participants to answer the question, can due process help to achieve energy justice? We then suggest areas where the energy justice framework could be improved.

1.1. Growing interest in solar energy

Solar photovoltaic (PV) technology promises energy independence, income generation, community development, and reductions in greenhouse gas (GHG) emissions [8]. As a result, this energy source has seen significant uptake globally. The International Energy Agency (IEA) reported that 75 GW of new solar PV capacity was installed globally in 2016—the highest level of annual investment ever [9]. What's more, solar PV technology is continually improving and has reached a record efficiency of over 26% as of 2017 [10].

Installations of solar PV panels have been increasing in the Canadian province of Saskatchewan. The Saskatchewan Power Corporation (SaskPower), a provincially owned electric utility, offers two main options for installing solar power projects less than 100 kW (kw) in size:

- *Net metering* allows customers to use the electricity generated by their solar PV installation for their own energy needs, and to send any extra solar electricity back to the electricity grid in exchange for credits on their electricity bill [11]. Enrollment in the net metering program grew from nine customers in 2010 to 578 in 2016 [12].
- The *small power producers* program allows solar energy proponents to develop solar energy projects and sell all or part of the electricity generated to SaskPower at a price of 10.83 cents/kWh, escalating at 2% per year [11].[1] At year end in 2016, 14 projects had been installed under the small power producers program, and another 25 were waiting in the queue [12].

1.2. Disruptive potential of solar energy

A growing interest in solar energy represents both an opportunity to expand the production of zero-emissions, renewable energy in the province, and a disruptive threat to the SaskPower business model. Solar PV technology is unique in that it can be installed at the point of electricity demand. The transmission lines created in the early years of SaskPower were necessary to transmit electricity from power plant to distant electrical loads. With a population of 1.17 million spread over a landmass of 650,000 km^2, Saskatchewan now possesses one of the most dispersed electricity service areas in the world. Billions are being spent to maintain and upgrade the transmission lines that transect the province [14]. Solar PV can be installed on homes, businesses, farms, and in fields on or near the site of energy demand. This distributed energy potential throws into question the need for a centralized grid controlled by a monopoly utility.[2]

Solar PV technology is also unique in that individual solar panels are small-scale and modular. This means they can be installed privately, without the need for expensive engineering expertise. The business case for solar energy self-generation has become more attractive in Saskatchewan in recent years, largely for two reasons. First, electricity rates in Saskatchewan have been increasing on average by 3% per year due to the need to expand supply, maintain and upgrade transmission lines, and lower greenhouse gas emissions. Second, the cost of installing solar PV technology has been falling. In the United States, the median total installed cost of solar PV panels has fallen from $12/$W_{DC}$ in 2000 to less than $4/$W_{DC}$ today [16]. As the economics shift, SaskPower's net metering and small power producer solar energy programs begin to look more desirable to customers (see Fig. 1).

Like other utilities across North America, SaskPower is aware of the financial implications of expanding solar energy self-generation. When customers install solar panels and "zero" their meter with the net metering program, they reduce SaskPower's revenue. The more customers install self-generation, the more SaskPower must raise rates on existing customers to pay for existing generation, transmission and distribution assets. These assets are still used by solar energy self-generators when solar energy is not available (*e.g.* at night) or is inadequate to meet self-generators' power needs. However, net metering allows customers to lower their electricity bills to near zero (only a moderate $22 administrative charge remains) and avoid paying for these back-up system costs. As it stands, the current net metering program is not financially sustainable. As more customers adopt solar PV technology and zero their bills, and SaskPower raises rates to cover the costs of its extensive transmission and distribution network and increasingly idle back-up generators, it risks entering the "utility death spiral", a process that ends in bankruptcy for the utility [17]. Knowledge of this risk is a key motivation for SaskPower to rethink its solar energy programs, and many utilities around North America are doing the same [18].

1.3. Solar energy potential in Saskatchewan

Adding to the desirability of solar energy is the high-quality of the solar resource in Saskatchewan. Southern Saskatchewan has the highest solar PV potential in Canada. Solar PV installations in communities such as Estevan and Coronach, home to the province's coal-fired power plants, generate nearly 1400 kWh of electricity per year for every 1 kw installed (1383 kWh/kw and 1379 kWh/kw respectively) [19]. For comparison, this solar energy potential is nearly as high as Mexico City (1425 kWh/kw) and Los Angeles (1485 kWh/kw) [19]. Solar PV output in the semi-arid southern part of the province is aided by clear skies throughout the year and cool temperatures in the fall, winter, and spring months that allow PV cells to convert solar insolation into electricity more efficiently.

1.4. The need for low-emissions electricity

In 2016–17 nearly half (49%) of all electricity in Saskatchewan was generated by coal-fired power plants [20]. The predominance of coal-fired power has meant Saskatchewan's electricity sector registers the second highest GHG emissions intensity in the country [21]. To reduce GHG emissions the Saskatchewan government has committed to expand renewable energy to comprise 50% of electricity capacity by 2030. With an anticipated capacity of 7000 MW, this promise means the province will soon contain up to 3500 MW of renewable capacity.

[1] This rate is lower than the residential retail rate of 13.74 cents/kWh and the business rate of 11.58 cents/kWh [13].

[2] The role that solar energy will play in local energy systems will depend on the nature of the other aspects of the local energy system. Solar energy production is variable and so a mix of energy storage, flexible demand response technologies, and dispatchable generation is required to respond to this variability. Solar PV panels also require 1 km^2 of available land or roof space per 32 MW installed capacity [15]. A high concentration of local energy demand will require a large area of land or roof space to accommodate the necessary solar generation infrastructure and distribution lines.