Energy Policy 87 (2015) 573–583

Contents lists available at ScienceDirect

Energy Policy

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

Public acceptance of the expansion and modification of high-voltage power lines in the context of the energy transition

Pascal Lienert*, Bernadette Suetterlin, Michael Siegrist

ETH Zurich, Institute for Environmental Decisions (IED), Consumer Behavior, Universitaetsstrasse 22 CHN J 75.1, 8092 Zurich, Switzerland

HIGHLIGHTS

- People do not link the energy transition and necessary grid expansions.
- The acceptance of grid expansion is higher in the context of the energy transition.
- It is important to distinguish between different types of grid expansion.
- Perceived benefit and affect predict the acceptance of grid expansions.
- Affect is especially important for local acceptance of grid expansions.

ARTICLE INFO

Article history:
Received 9 June 2015
Received in revised form
16 September 2015
Accepted 18 September 2015

Keywords:
Energy transition
Public acceptance
Risk perception
Grid expansion and modification
High-voltage power lines

ABSTRACT

The expansion and modification of high-voltage power lines (HVPLs) constitutes a key element of the successful implementation of the energy transition. While HVPLs often face public opposition, the energy transition and renewables are generally perceived positively. Drawing on the importance of benefit perception and affective responses for the acceptance of technologies, the present study investigated whether the perception of HVPLs changes when they are seen as a necessary measure for the successful energy transition. The results show that HVPLs are associated with more positive feelings, higher perceived benefit, lower perceived risk, and higher general and local acceptance when they are linked to the energy transition. However, numerous people believed that the energy transition renders further grid expansions unnecessary. This belief proved to be resistant to the provision of contrary information. Furthermore, the results underline the effect of visual impacts on the acceptance of HVPLs. Changes to the electricity grid that are accompanied by less visual impacts (e.g., technological modification) are more accepted than more visually disruptive changes (e.g., new construction). Finally, the findings emphasize the importance of affective response for the acceptance of HVPLs, especially for local acceptance. The results have several important implications for energy policy makers.

1. Introduction

In an attempt to lower greenhouse gas emissions and counteract climate change, governments worldwide are increasing the share of renewable power in their electricity portfolios (UN, 2010). As a result, energy systems are undergoing substantial changes that are often accompanied by increased infrastructural demands. This not only applies to the introduction of renewable energy sources like solar and wind power, but also to related infrastructure such as electricity grids (Pidgeon and Demski, 2012). Switzerland, which provides the setting for the current study, is no exception to these developments.

1.1. Swiss energy policy

Thanks to Switzerland's many lakes and rivers and its high precipitation levels, the Swiss electricity supply can rely to a large extent on renewable hydroelectric power. About 55–60% of the country's power production is provided in that manner. Nuclear power also plays a key role and accounts for 35–40% of the electricity supply. Other energy sources (including fossil fuels, waste incineration, and renewables) only account for about 5%, with new renewable energy sources playing a marginal role with a share of 0.8% solar power and 0.1% wind power (BFE, 2013).

The importance of nuclear power was unchallenged until March 2011, when the nuclear accident at Fukushima triggered a discussion about the risks and benefits of nuclear power plants. As in many other countries, people's acceptance of nuclear power decreased in Switzerland (Kim et al., 2013; Siegrist and Visschers,

* Corresponding author.
E-mail address: pascal.lienert@hest.ethz.ch (P. Lienert).

http://dx.doi.org/10.1016/j.enpol.2015.09.023
0301-4215/

2013). Subsequently, in 2011 the Swiss federal council and the parliament decided to gradually phase out nuclear power until 2050 (Bundesrat, 2011). This will lead to a massive gap in the electricity supply and therefore constitutes a major challenge for the Swiss energy system.

To address this challenge, a new energy strategy was formulated. Measures to close the resulting electricity gap include the increase of energy efficiency, the further promotion of renewable energy technologies and, if necessary, additional imports and the inclusion of combined-cycle gas power plants into the energy system.

This move away from nuclear power and fossil fuels toward a more sustainable energy future based on renewables is commonly referred to as "the energy transition" in German-speaking countries. The implementation of this energy transition poses several challenges to the electricity network, which plays an essential role in the new energy strategy (Bundesrat, 2013). For instance, the promotion of renewables leads to the decentralization of the energy system due to the transition from a few large-scale nuclear power plants to many small-scale renewable energy sources. The integration of these renewables into the existing energy infrastructure creates a need for additional power lines. Furthermore, additional power lines are necessary to connect new electricity storage sites to the existing electricity grid. These electricity storage sites are needed to compensate for the fluctuating power production of renewables such as wind and solar power. In addition, the close connection of the transmission network to the European network is necessary to ensure increased international exchange and energy imports in the form of wind power from the northern sea and solar power from the Mediterranean area. Simultaneously, the exchange between the national transmission network and the regional distribution networks becomes more important due to the fluctuating power production of renewable energy sources and the introduction of new technological systems like smart grids. Combined with the increased demand for electricity over the past few decades, these factors demand higher flexibility and capacities from the entire Swiss electricity infrastructure (Bundesrat, 2013; Swissgrid, 2012).

The implementation of these necessary changes to the electricity grid leads to several challenges for policy makers. One such challenge, namely the lack of public acceptance of the necessary modification and expansion of power lines, will be the focus of the present study.

1.2. Public acceptance of the modification and expansion of high-voltage power lines

High-voltage power lines (HVPLs) and the related infrastructure projects often face public opposition. Besides increasing costs, this resistance also leads to considerable delays in construction processes (Swissgrid, 2012). Many countries that aim to expand HVPLs in order to promote green energy and modernize their electricity grids are facing the same challenges (Cain and Nelson, 2013; Cotton and Devine-Wright, 2012; Vajjhala and Fischbeck, 2007). Thus, it is important to take a closer look at the determinants of the acceptance of HVPLs.

Research has shown that perceived risks and benefits play an important role when it comes to public acceptance of technologies (Huijts et al., 2012). In the context of HVPLs, several studies have investigated the factors that influence people's risk and benefit perception and therefore drive public opposition (Aas et al., 2014; Cain and Nelson, 2013; Cotton and Devine-Wright, 2013). Visual impacts on the appearance of the landscape (Elliott and Wadley, 2012; Furby et al., 1988), environmental hazards such as the endangerment of bird populations (Bevanger, 1998), noise emissions (Doukas et al., 2011), and the decrease of property values (Jackson and Pitts, 2010) are only some of the factors that play an important role in this context. Another crucial factor is health concerns related to electromagnetic fields (EMFs). There is no clear scientific evidence that electromagnetic fields are harmful to human health, although some studies have been published that relate EMF exposure to an increased prevalence of childhood leukemia (Ahlbom et al., 2001; Draper et al., 2005). Even though there is no underlying biological mechanism that explains this relation, claims of the possible negative health effects of EMFs have received considerable attention from the public and the media (Claassen et al., 2012).

Regardless of this focus on risk aspects in public discussions, several studies showed that perceived benefit outweighs perceived risk when it comes to predicting people's acceptance of energy-related technologies. For example, Visschers and Siegrist (2013) showed that perceived benefit of nuclear power was the most important predictor of people's acceptance, before as well as after the nuclear accident at Fukushima. Similarly, Bronfman et al. (2012) found that perceived benefit had the greatest effect on public acceptance of electricity generation sources like nuclear power, fossil fuels and hydropower.

1.3. The role of affective responses in the context of technology acceptance

The role of affective responses in judgment and decision-making has received increased attention over the last few decades. Before that, apart from a limited number of exceptions (e.g., Schwarz and Clore, 1983; Zajonc, 1980), theoretical models of judgment and decision-making mainly focused on cognitive aspects and feelings were merely regarded as epiphenomenal. Several authors have challenged this orientation and stated that the affective response can play an important role in people's decision-making (Loewenstein et al., 2001; Peters and Slovic, 1996; Slovic et al., 2007).

Slovic and colleagues (Finucane et al., 2000; Slovic et al., 2004; Slovic et al., 2007), for instance, emphasized the importance of affective responses for decision-making, introducing the affect heuristic to the literature. They define affect as the "goodness" or "badness" of a stimulus. Affect is experienced as a feeling state, which can happen consciously or unconsciously (Slovic et al., 2007). According to the affect heuristic, people use their affective responses as a cue when it comes to risk and benefit judgments, since this can be easier and more efficient than cognitively weighing all the pros and cons against each other. The affect heuristic postulates that if people feel good about a technology, they tend to judge the associated benefits as high and the risks as low, whereas if their feelings toward a technology are unfavorable, they tend to relate low benefits and high risks to this technology (Slovic et al., 2004).

1.4. Acceptance of the energy transition and renewables

These findings regarding the importance of perceived benefits and affect are of high relevance when it comes to determining the public acceptance of the necessary modification and expansion of the electricity grid in the context of the energy transition. In contrast to the lack of acceptance of HVPLs and the related infrastructure, the energy transition itself, and renewables in particular, are generally very well accepted by the public (Alhakami and Slovic, 1994; Visschers and Siegrist, 2014; Zoellner et al., 2008). For instance, Zoellner et al. (2008) conducted several case studies in Germany, showing that between 75% and 85% of the people agreed with the statement that renewable energy sources should play an important role in future power generation. In Switzerland, the proposed energy transition also meets with high acceptance. In