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The power of buildings in climate change mitigation: The case of Norway

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ABSTRACT

Centralized power production mainly from fossil fuels is increasingly challenged by decentralized power production from renewables. This is a trend caused by the greening of the European power grid which is to be carbon neutral by 2050. As a part of this trend, the number of power-producing buildings is growing. Even in Norway, which has a highly centralized power production based on hydropower, buildings are increasingly equipped with solar power panels. The introduction of cross-sectoral innovations like power producing buildings is likely to encounter resistance, as the conventional system and its powerful actors are challenged. The strategies to either promote or block the growth of power producing buildings in Norway have been explored employing the Strategic Niche Management framework.

For this paper, 32 interviews were conducted with decision-makers and experts, both advocates and opponents of power-producing buildings. It has been found that narratives have the potential to work as a *bridging device* between the niche and the regime. If the narrative supporting power-producing buildings should become a bridging device, it would have to address challenges as defined by the regime incumbents. In Norway, this would be equivalent to addressing the challenge of peak load.

1. When buildings become power stations

"Make it, dammit. It is not exactly rocket science. It demands something from the power industry, of course, but they think differently and that is probably some of the problem". [1] Entrepreneur

Europe is greening its power system which is due to be carbon-free by 2050 (The European Climate Foundation, 2010). Buildings in Europe are responsible for about 40% of total final energy use and 36% of its CO_2 emissions (European Commission, 2016), and the challenges, in particular, are to increase energy efficiency and to decarbonize the power system (The European Climate Foundation, 2010). The decarbonization of the power system is part of an even larger transition towards a low-carbon society. Power-producing buildings, mainly utilizing solar power, are part of this trend towards more renewable production and also more local, small-scale production. As buildings are major energy consumers, it is a great energy potential in the building stock if less energy is used, or produced locally. Buildings tend to have a fairly predictable energy profile and in cold climates, peak power demand is related to low temperatures and household activities like for example cooking. Solar power production is low during winter which means buildings will rely on power from the grid. In addition, the development of energy efficient equipment does not necessarily focus on reducing peak load which is a main issue when optimizing the grid capacity. These are issues that are challenging to the electric utilities and add to other concerns, such as loss of income due to lower demand. Resistance is a likely reaction.

This study explores the introduction of power-producing buildings in Norway. A recent White Paper on energy (Olje- og Energidepartementet, 2015–2016), the first major policy document on the topic in 17 years, did not lay out any solar power policy. The solar power potential was discussed but seems to have been downplayed. At the same time, Norway's construction related policies aim at the imminent market break-through of zero energy/emission buildings – which in most cases implies local renewable energy production on the building.

1.1. The Norwegian case

Nearly all Norwegian electricity production is based on hydropower (Olje- og Energidepartementet, 2015), and electricity is therefore perceived as clean. However, since the late 1980s, there has been a general consensus in the Norwegian Parliament that the period of great

Abbreviations: EPBD, Energy Performance in Buildings Directive; NVE, The Norwegian Water Resources and Energy Directorate; RED, Renewable Energy Directive; ZEB, The Research Centre on Zero Emission Buildings; ZEN, The Research Centre on Zero Emission Neighbourhood

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[1] All quotes from the interviews have been translated by the author.

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hydropower development projects is over, due to the demands of nature conservation. Norwegian households are world-leading in their use of clean energy, as electricity – predominantly hydropower – amounts to 80% of domestic energy use, a large portion of which is used for heating (Bøeng, 2014). Since electricity is inexpensive, there is low economic motivation for energy efficiency projects and other sources of renewable energy production that struggle to compete without support schemes. However, electricity demand is increasing as electricity is replacing other and more polluting energy sources, for instance in the transport sector. Norway has the largest fleet of electric vehicles (EVs) per capita in the world, achieved through extensive use of incentives (Holtsmark and Skonhoft, 2014).

The implications of the European objective to decarbonize the power sector are less obvious for Norway than to most other countries, since nearly all electricity is renewable already. The formal reasons for advocating building concepts that include power production are found in particular in two EU directives: the Renewable Energy Directive (RED) and the Energy Performance in Buildings Directive (EPBD) (The European Parliament and the Council, 2010). The EPBD is still not fully adopted into Norwegian legislation, and it is vital that the concept of 'nearly zero energy' and the 'renewable sources produced on-site or nearby' objective in the EPBD are defined in the Norwegian context. Building concepts that include power production are normally also particularly energy efficient and will therefore contribute to additional available power by using less energy. This makes it beneficial to the requirement in the RED of an increased *share* of renewable energy. Excess power could be used to electrify the sectors that are responsible for Norway's per capita CO_2 emissions that are on a par with the rest of Europe. However, the increased electrification in Norway as well as in other countries leads to increased strain to the power distribution grid.

In this context, leading actors in the building industry, supported by generous governmental R & D funding, are advocating building concepts that are power-producing entities, most notably with the use of distributed generation of solar power (photovoltaics/PVs) or in some cases local cogeneration in combined heat and power (CHP). To achieve this, the relevant concepts demand innovative solutions that are challenging to the industry, but they represent incremental rather than radical change (Slaughter, 1998). The notion of power-producing buildings is an opportunity for the building industry to contribute to climate change mitigation and at the same time position for new business domains.

Energy-generating buildings have been part of Norwegian energy and climate policy for more than a decade; they have been assisted through investment support schemes on selected technologies like heat pumps, which recently have been extended to include solar power among other technologies (Enova, 2016a). There are a few examples of investment support for buildings that generate an intermittent power surplus, such as the Powerhouse Kjørbo pilot project (Enova, 2016b). The absence of an explicit inclusion of renewable local power production in energy policy, as described above, stands in contrast to the existence of state-supported projects. There is ambivalence on the policy level towards power-producing buildings and the distributed energy production they represent. This is a common situation when new technologies are introduced (Kemp et al., 1998).

1.2. Perspective and previous research

The potential for solar power production, or lack thereof, is frequently given as an explanation as to why authorities in Norway are reluctant to advise households and other building owners and developers to invest. The allegedly limited potential is due to the geography of Norway, where it is generally colder and darker than most of Europe, and where solar power production would be highest in summer although energy needs peaks in the winter. However, any prospects for solar power are highly dependent on assumptions regarding prices of electricity, solar panels and installations, in addition to lifetime costs, solar panel efficiency, storage technology and more. According to the aforementioned White Paper (Olje- og Energidepartementet, 2015–2016), the calculated solar power potential is 1.5 TWh by 2020 and 3.8 TWh by 2030, if suitable roof area is utilized when buildings are erected or renovated. In relation to the total power production in Norway,[2] this is rather insignificant. However, there has been substantial growth in installations on *existing* roofing in 2016,[3] but existing roofing and detached production sites are not included in the calculated potential. Furthermore, even though Norway extends through 13 degrees of latitude, the majority of the population lives in eastern and southern Norway, areas that have the same solar irradiance as for example Northern Germany (Andresen, 2008). The potential is thus bigger than suggested by the government, yet how big is not known.

A payback time of between 18 and 23 years for installations in 2016 was calculated, sinking to between 8 and 15 years in 2030, disregarding any subsidies (Zaitsev et al., 2016). Depending on further development and cost reductions regarding solar panels, in the foreseeable future they could make a cost-effective contribution to the Norwegian energy system.

Little research has been done on the societal implications of the transformation of the Norwegian energy system so far, with some exceptions, (e.g. (Christiansen, 2002; Gullberg et al., 2014; Skjølsvold et al., 2013)). Transformation of the building sector has been studied in Nykamp as well as in Ørstavik (Nykamp, 2016; Orstavik, 2014). Studies on transformation in other national frameworks may also be relevant (e.g. (Geels et al., 2016; Hess, 2013; Konrad et al., 2008; Smith et al., 2005; Verbong and Geels, 2010)). This article extends the literature, in particular by focusing on narratives and anti-narratives in the latter phase of the development of a niche (Raven et al., 2016). Linking the niche of power-producing buildings to a regime environment also illustrates that niche empowerment is a highly political process involving power and antagonism. The transformation of power systems is about to take place all over Europe, and issues of decentralized power production are therefore also relevant in other settings.

In this article, in order to limit the extent of the discussion to politics and strategies located within and around the niche of power-producing buildings, a boundary has been drawn around the supply side including the policy measures for implementation, thus excluding the demand-side issues, which should be given attention in a subsequent article.

The rest of the paper is structured as follows: the next section summarizes the conceptual foundations in this paper as well as the methodology. Section 3 presents empirical findings which primarily enlighten the arguments and actions by advocates and opponents of power-producing buildings. In Section 4, the empirical results are analysed and discussed. This section also looks at how power-producing buildings could develop to become an essential part of the sustainable transition that lies ahead. Finally, conclusions and policy implications are drawn.

2. Conceptual framework and method

2.1. The regime and its incumbents

The regime concept has been cultivated in particular by Geels through the Multi-Level Perspective (e.g. in Fuenfschilling and Truffer (2014), Geels and Schot (2007), Geels (2011), Geels (2002)) as well as within the Strategic Niche Management framework (Schot and Geels, 2008; Raven et al., 2010; Kemp et al., 1998). A regime is understood as a dynamically stable structure consisting of actors, networks and institutions.

[2] In 2015, the total power production in Norway was 145 TWh, according to Statistics Norway.

[3] According to an interview with Otovo in October 2016, around 500 solar power installations on existing household roofs had either been installed or were planned to be installed during 2016.