Energy Research & Social Science xxx (xxxx) xxx–xxx

Contents lists available at ScienceDirect

Energy Research & Social Science

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

Original research article

Rural laboratories and experiment at the fringes: A case study of a smart grid on Bruny Island, Australia

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ARTICLE INFO

Keywords:
Experiments
Living labs
Rural innovation
Battery storage
Smart grid

ABSTRACT

This paper examines the possibilities for significant energy innovation in rural locations in developed countries. It thereby questions the dominant framing of energy experiments and 'living labs' as urban. We discuss findings from empirical research with a rural community on Bruny Island, Australia, where a 3-year research project (2016–19) – CONSORT – funded by the Australian Renewable Energy Agency (ARENA), is underway with approximately 35 householders trialing a new residential battery storage and photovoltaic energy system. Bruny Island has a problem of peak demand for electricity during tourist periods, and a back-up diesel generator is currently used to supply electricity during peaks. An alternative solution is being trialled through CONSORT: household-level battery storage, which can be drawn upon by the utility to supply the grid as required. In this paper we explore two energy geography issues: first, how global and national energy challenges are manifesting on Bruny Island through the CONSORT project, and, second, the ways in which the particular sociotechnical context of Bruny Island has influenced the CONSORT project, creating tensions as well as opening up opportunities for energy innovation.

1. Introduction

Change is underway in energy production and use, particularly with regard to electricity [1]. The need for innovation is being driven by a range of problems: for instance climate change is increasing air conditioning requirements as temperatures increase, and aging energy infrastructures require expensive investments, pushing up electricity prices which particularly affects low income households, exacerbating fuel poverty. With these pressures on existing energy infrastructure, policy debate about energy is likewise on the increase, as well as experimentation with new energy sector policies [2,1,3,4]. One solution widely promoted by government and industry is 'smart grid' infrastructure development: the use of digital communication technologies alongside new energy technologies such as solar photovoltaics (PV) and batteries to improve and modernize energy infrastructure ([5]: iii, [6], [7]: 30–51, [8]). This paper is about how current global energy problems and smart grid solutions have manifested in one particular place – Bruny Island, Australia. Bruny Island is a rural island, lying just off the south-eastern coast of the island state of Tasmania, in southern Australia (see Fig. 1). The island is accessed by a short ferry ride and is divided into a north and a south island by a narrow isthmus.

In 2016 a 3-year smart grid research project commenced on Bruny Island, called 'CONSORT' (*CONsumer energy systems providing cost-effective grid suppORT*), involving approximately 35 Bruny Island householders trialing a new residential battery storage and photovoltaic energy system with a 'smart' digital controller. The technology installed in each trial participant's home is as follows: a solar photovoltaic (PV) array; an advanced but commercially available lithium battery; an inverter; and a Reposit 'box' or controller positioned at the interface of the battery and the grid, comprising internet-enabled monitoring software. The Reposit controller in effect acts as an energy broker that trades electricity on behalf of the householder, charging the battery from the grid and/or solar PV at off-peak times when it is cheap, and selling electricity back to the grid at peak, expensive times. The households' battery storage and solar PV are managed in aggregate across the distribution network by power system algorithms developed by the CONSORT team, known as Network Aware Coordination (NAC). The NAC algorithms – developed by CONSORT researchers at Australia National University (ANU) – also take into account economics and pricing, and coordinate the distributed fleet of Reposit controllers according to the lowest cost of meeting customer energy needs, while managing network constraints. The NAC algorithms have hitherto been demonstrated successfully in virtual trials on simulated electrical networks [9], but this Bruny Island project will provide the first 'real world' test.

Funded by the Australian Federal Government through the

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http://dx.doi.org/10.1016/j.erss.2017.09.031
Received 16 March 2017; Received in revised form 21 September 2017; Accepted 22 September 2017

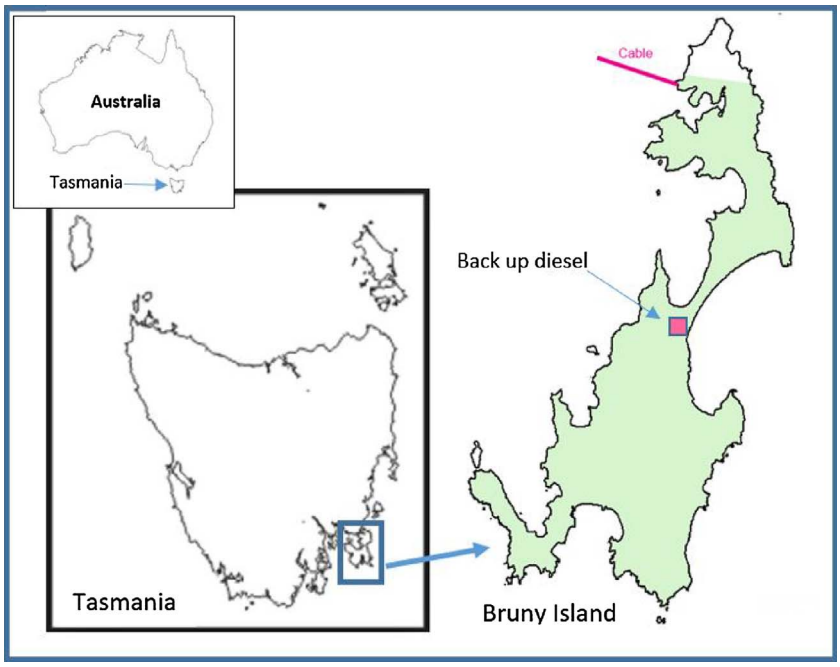

Fig. 1. Location of Bruny Island in the Tasman Sea, just off the south-eastern coast of Tasmania, Australia.

Australian Renewable Energy Agency (ARENA), the research project can be seen as both a policy and technology experiment, seeking to explore and better understand ways of managing and governing the electricity sector, as well as investigating the technical possibilities for, and constraints on, new decentralized smart grids comprising household level renewable energy and battery storage. The project team for CONSORT includes the local utility company (TasNetworks), a battery 'start up' ICT company (Reposit Power), and computer science, engineering and social science university researchers from ANU, the University of Sydney and the University of Tasmania.

The smart grid solution being tested through CONSORT is seen as highly innovative within the electricity sector in Australia, and has been promoted by ARENA and others as 'a world first', which Australia and other countries can learn from ([10,11],[12]: 5,8, [13]). The CONSORT project thus provides a useful lens through which to examine the spatial dimensions and characteristics of global energy challenges and transitions. This is particularly the case because of its location in Australia. Australia is being positioned (and is positioning itself) at the forefront of global energy infrastructure innovation, especially in relation to smart grids [14,15,4]. There are a range of reasons for this, which include three critical issues: first, Australia is a large country where it is difficult and expensive to install and operate a centralised electricity grid across its whole territory; second, Australia currently has the highest penetration (21%) of household-embedded solar generation worldwide [16], achieved through rapid growth (a 38% increase in households with rooftop solar between 2002–03 and 2013–14) [17]; third, electricity prices are high in Australia and rising [18], prompting customers to investigate leaving the centralised electricity grid, and with some evidence of this already occuring [19,20].

The location of the Bruny Island CONSORT project within the Australian national context of rapid and pioneering energy sector innovation provides an instructive test case for exploring how global, national and local sociotechnical dimensions interact. This paper focuses on two issues in particular: first, how global and national energy challenges are manifesting on Bruny Island through the CONSORT project, and, second, the ways in which the particular sociotechnical context of Bruny Island is influencing the CONSORT project, and the wider implications of this in relation to its potential for replication elsewhere. Using the case of the CONSORT project to explore these issues, we examine the possibilities for significant energy innovation in rural locations in developed countries. Conceptually, the empirical case is situated within scholarship on governance by experiment, innovation and 'living laboratories (labs)'. We position CONSORT as a rural experiment, and in the process question the overly urban focus of the majority of scholarship to date in this field, i.e. the dominant framing of energy experiments and 'living labs' as urban, typically located within in large global cities [21–24].

The paper is structured as follows: first, we briefly outline our method; second, we present a review of relevant literature on governance by experiment and innovation in urban laboratories, as well as rural areas; third, we provide a rich empirical description of the rural environment in which the CONSORT project is being conducted, including key characteristics of Bruny Island that have had influence on the adoption and operation of the CONSORT project; fourth, in discussion and conclusion, we reflect on our findings and their implications for energy geography scholars and energy practitioners.

2. Method

The overarching research question for the CONSORT project is 'Can consumers and the [electricity] network combine cost-effectively to meet their needs?'. The social science research is investigating how householders are responding to the new technology, including any changes in their energy practices in the home, using a qualitative research approach. We are also undertaking inductive action-research with the CONSORT project industry partners (Reposit and TasNetworks) and the interdisciplinary CONSORT research team (comprising computer scientists, economists and engineers).

CONSORT households were recruited by TasNetworks during late 2016 and early 2017 on the basis of two criteria: first, a reliable, continuous internet service to their home in order that the battery remains connected to the Reposit controller; and, second, that the household is serviced by the constrained undersea cable to Bruny Island from mainland Tasmania (one of two cables to the island). Further, preference was given to permanent residents of Bruny Island, rather than 'shack' or holiday residence owners.

Our analysis in this paper draws on primary data from a number of sources, including: semi-structured interviews with householders (45, pre and post installation); the original project proposal and vision for the CONSORT project developed by the team; contextual observations