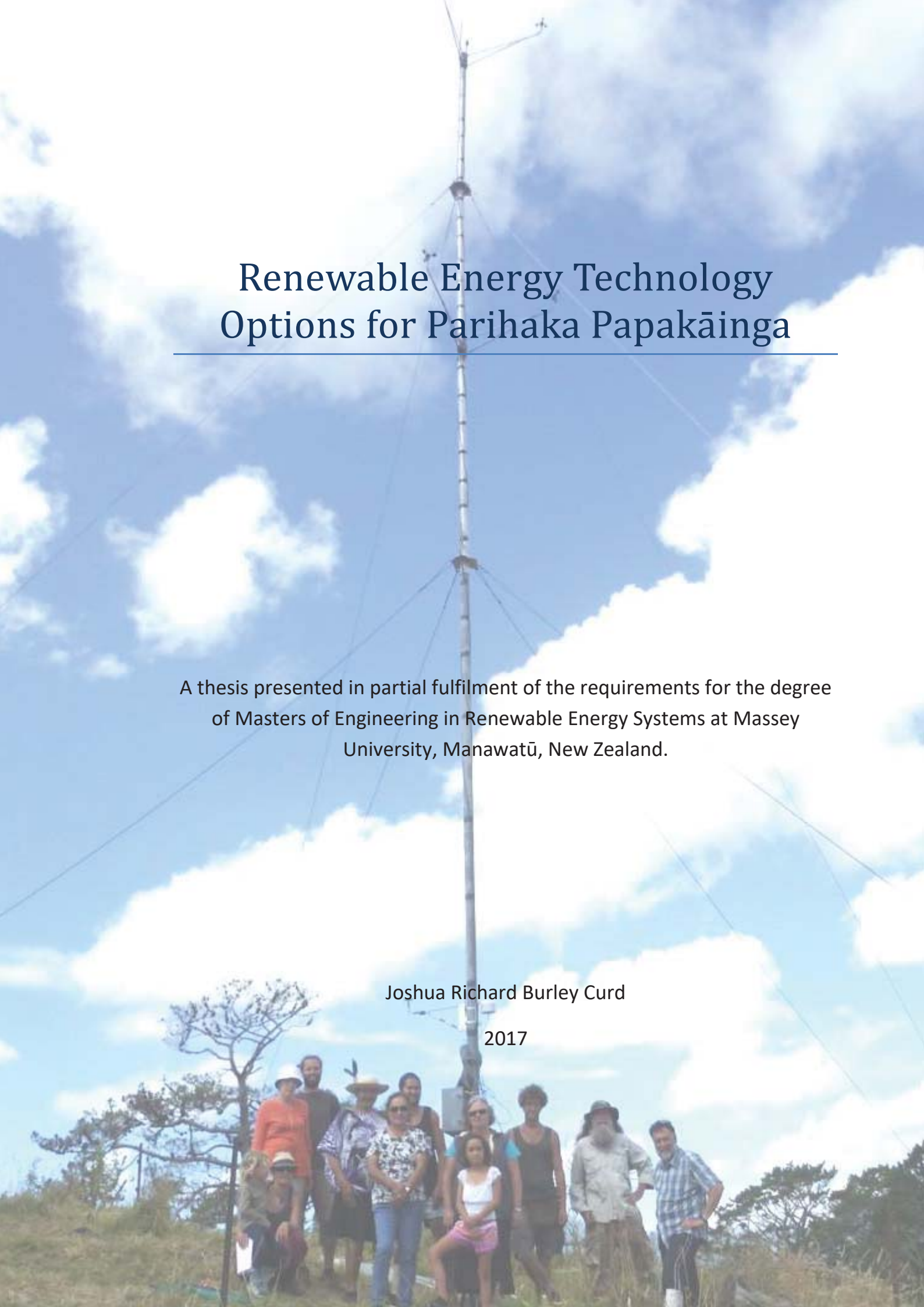
Renewable Energy Technology Options for Parihaka Papakāinga



A thesis presented in partial fulfilment of the requirements for the degree of Masters of Engineering in Renewable Energy Systems at Massey University, Manawatū, New Zealand.

Joshua Richard Burley Curd

2017

Abstract

The Parihaka Papakāinga Trust - the administering body of communally owned Māori land at Parihaka, Aotearoa New Zealand - initiated university research into sustainable energy practices and technologies within a context of community and infrastructure development. As one part of this wider research topic, various renewable energy conversion technologies were compared in terms of cost, effect on increasing the energy independence of the papakāinga (excluding transport, covered elsewhere), and reducing papakāinga greenhouse gas (GHG) emissions.

Consumption of electricity, LPG and firewood was assessed in 14 study buildings over 12 months. Energy demands both now and also for hypothetical scenarios 20 years in the future were proposed, taking into account energy efficiency opportunities, low energy housing design and potential electric vehicle charging loads from parallel research.

The local solar, wind and hydro potentials were assessed over 12 months, and estimations of the long-term resources were made using long-term reference data from the region. An estimation was also made of land area requirements to support a short rotation coppicing (SRC) fuelwood plantation.

The technical and economic performance of a range of electricity and heat generation technologies was modelled, both on an individual building basis and on a community-wide basis.

The technologies with the largest expected economic benefits (after energy efficiency and building design) were a grid-connected community solar PV array with output available for consumption by as much of the papakāinga as possible, and wood-burners for space and water heating in new homes. However further study is required into the design and costs of a feasible metering and billing solution to allocate the benefits of community owned distributed electricity generation.

The technologies with the largest expected effect on energy independence include combining solar water heaters with wood-burners and wetbacks for space and water heating, and producing firewood locally with an SRC plantation.

Based on the household study, transport behaviours or technologies are expected to have a larger effect on GHG emissions than papakāinga infrastructure.

Recommendations include a billing/metering feasibility study potentially followed by a community PV array, an SRC trial, and solar water heaters and wood-burners with water heating for new homes.

Acknowledgements

I would like to acknowledge and thank the following:

The Parihaka community who welcomed me so warmly and kindly, and accommodated and supported the research activities. Many of the community contributed in many different ways, too many to list here, and I am grateful to you all.

The three houses of the marae at Parihaka, who facilitated and supported the research from the beginning.

The families who welcomed us into their homes to collect household energy use data, including Turoa who passed away.

Taiepa Tiketike research assistant Tihikura Hohaia, not only for all the mahi and guidance, but also for the valued friendship which developed.

The Parihaka Papakāinga Trust and Te Whare Whakaruru for facilitating the research.

Those who gave their time to participate in the Punanga Ngi workshops.

Eve Kawana-Brown and Amokura Panoho for visualising and creating the project, and the Ministry of Business, Innovation and Employment for providing the funding to enable it.

My supervisors Dr Phil Murray, Professor Ralph Sims and Dr Nick Roskruge. Also the valued friendship and leadership of Phil.

Powerco for funding the installation of electricity monitoring devices, and Janet Stephenson and Rebecca Ford at the University of Otago for enabling the electricity monitoring within their *100 Homes* research.

Leith Robertson and Darren Barrett of Wells Engineering, who installed and removed the electricity monitoring devices.

Jamie Silk, Elizabeth Chisholm and Daniel Gnoth at Powerco for the advice on the issues and possibilities surrounding connecting distributed generation sources to the local electricity network.

Barry Waugh at NIWA for the river monitoring advice, and Kathy Walter for providing long term river flow data in the region.

Andrew Cotter and Warrick Johnston at Taranaki Regional Council for the advice in establishing river monitoring at Parihaka (including a valuable site visit), and Fiona Jansma for providing long term river and wind environmental data in the region.

Ian Fuller and Ranvir Singh from the geography department at Massey University for the river flow monitoring course and the loan of the velocity meter.

Andrew Pollard at BRANZ for the advice on monitoring LPG consumption, including the kind offer of gas flow meters and data loggers.

Peter McComb and Dr Séverin Thiébau of Metocean Solutions for providing long term modelled wind speed data in the region.

Brett Gawn and Paul Vautier of Calibre Consulting for providing the high quality topographical survey of Parihaka, and background information.

Tobias Heine at Solarcity for the advice on solar PV installations and costs.

The work put in by Ana Hernandez, Jonathan Quinn, Ingrid Lambert and Ray Mohan which helped form this research.

The support, tolerance and love of my fiancée Fiona Gordon.

Many thanks to all those who have assisted, including those who I forgot to include and to whom I apologise.

I would also like to acknowledge that the conclusions and recommendations here fall far short of the vision of self-sufficiency at Parihaka, but hope that they inform some initial practical steps as part of a larger journey in that direction.

Table of Contents

List of Figures

List of Tables