Energy Policy 122 (2018) 506–517

Contents lists available at ScienceDirect

Energy Policy

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

Improving the energy efficiency of the New Zealand economy: A policy comparison with other renewable-rich countries

Piyush Verma[a,*], Nitish Patel[a], Nirmal-Kumar C. Nair[a], Alan C. Brent[b]

[a] Department of Electrical & Computer Engineering, University of Auckland, New Zealand
[b] Sustainable Energy Systems, School of Engineering and Computer Science, Victoria University of Wellington, New Zealand

ARTICLE INFO

Keywords:
New Zealand
Energy policy
Energy efficiency
Energy intensity
Climate change

ABSTRACT

The relevance of energy efficiency policy measures for renewable-rich countries could be different from those countries that have a limited share of renewables in their electricity generation mix, and are therefore likely to focus on low-carbon energy generation policies. This paper presents a comparative analysis of the energy efficiency initiatives of the three highest renewable-rich OECD countries, namely: Iceland, Norway and New Zealand. The paper then focuses on a comprehensive review of New Zealand's energy efficiency policies since a formal "Energy Efficiency and Conservation Act" came into force. This paper then highlights the future challenges for New Zealand and offers some policy recommendations, which may also be applicable for other renewable-rich countries.

1. Introduction

The energy sector is currently experiencing a multifaceted challenge, whereby energy decision-makers are dealing with energy access, energy security, and environmental concerns altogether (Omer, 2009; Van den Bergh, 2011). Energy specialists have identified energy efficiency as a multipronged approach to address these concerns (Tanaka, 2008). The significance of energy efficiency towards achieving increasing self-sufficiency and energy security is ever increasing, and promoting both energy efficiency and energy conservation amongst different sectors are impactful instruments to extract additional benefits beyond energy cost savings (Dixon et al., 2010; Zhou et al., 2010). The importance of energy efficiency is thus being recognized globally (Omer, 2009; Tanaka, 2008; Dixon et al., 2010; Zhou et al., 2010) with energy agencies of different countries working actively to introduce and implement a variety of energy efficiency policies to promote and address the issues towards establishing a sustainable energy mix.

On the other hand, the level of interest and importance of the energy efficiency varies greatly with the countries' existing electricity generation mix. When countries have abundant renewable energy sources, their approach to energy is distinctly different from the countries that have a lack of such resources, or are still struggling with the integration of renewable sources into their electric grid. For example, countries like New Zealand differ in many ways from other countries, and one of the important distinctions is a high renewable generation portfolio. New Zealand is the country that has the third highest share of renewable energy in the total primary energy supply in OECD countries, and currently it is generating around 81% of its electricity from renewable sources (Ministry of Business, Innovation & Employment, 2016). Moreover, New Zealand retains the ambition of achieving 90% renewable-based electricity generation by 2025 (Ministry of Economic Development, 2011) without any direct subsidy, such as a feed-in-tariff. Iceland and Norway are two countries in the OECD that are ahead of New Zealand in terms of the proportion of renewable energy in their total primary energy supply. Fig. 1 shows the map of these three countries, their land area, population, and the share of renewable energy in total primary energy supply. There is a common tendency towards increased extraction of renewable sources in these

Abbreviations: ACEEE, American Council for Energy Efficient Economy; BRANZ, Building Research Association of New Zealand; CO_2, Carbon-di-oxide; EECA, Energy Efficiency and Conservation Authority, New Zealand; GDP, Gross Domestic Product; GWH, Gigawatt hours; HSBC, Hong Kong and Shanghai Banking Corporation; IPCC, Intergovernmental Panel on Climate Change; IEA, International Energy Agency; Ktoe, Kiloton of oil equivalent; MBIE, Ministry of Business, Innovation and Employment, New Zealand; MEPS, Minimum Energy Performance Standard; M&V, Measurement & Verification; NZD, New Zealand Dollar; NZGBC, New Zealand Green Building Council; OECD, Organization for Economic Cooperation and Development; PJ, Petajoule; PPP, Purchasing Power Parity; TPES, Total Primary Energy Supply; TFC, Total Final Consumption; TWH, Terawatt hours; toe, ton of oil equivalent; USD, United States Dollar; WEC, World Energy Council; WRI, World Resources Institute

* Corresponding author.
E-mail address: piyush.verma@ierc.ie (P. Verma).

https://doi.org/10.1016/j.enpol.2018.08.002
Received 1 February 2018; Received in revised form 30 July 2018; Accepted 1 August 2018

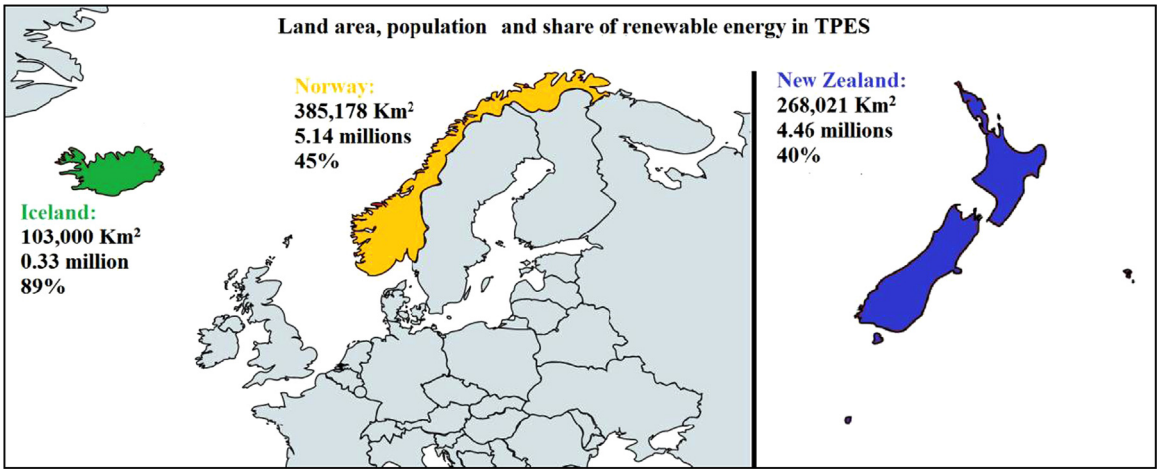

Fig. 1. OECD top three renewable-rich countries and share of renewable energy in TPES.

three countries. However, it is important to consider and understand their approach to energy efficiency at the same time.

The primary focus of this paper is thus to obtain an understanding of how these three countries (Iceland, Norway and New Zealand) are dealing with energy efficiency in their economies, given that they are also significantly rich in terms of renewable energy sources (for electricity generation). Furthermore, this article also presents a comprehensive analysis of New Zealand energy efficiency policies, and includes the challenges and concrete policy recommendations in implementing such energy efficiency policies. Notably, this paper helps energy efficiency researchers and policy-makers to understand the context of energy efficiency policies, and identify the future opportunities, specifically for countries that are progressing towards increased renewable generation in their electricity system.

2. New Zealand energy sector overview

In the last four decades, New Zealand's total primary energy supply[1] has increased from around 9000 ktoe (380 PJ) to 21,000 ktoe (903 PJ) and the energy mix has also changed significantly (Ministry of Business, Innovation & Employment, 2015). Currently, significant changes and challenges to the particular electricity sector are also being experienced (Nair and Zhang, 2009), in the context of ensuring security alongside highly distributed renewable generation.

Figs. 2 and 3 indicate the growth in total primary energy supply since 1974, and the mix of different energy sources in total primary energy supply in the year 2015 respectively. In the year 2015, the total primary energy supply was 906.87 PJ and oil accounted for around 32% the total primary energy supply. Oil continues to dominate New Zealand's overall energy mix (Ministry of Business, Innovation & Employment, 2016), and this makes the country's energy security situation vulnerable, in terms of supply disruptions and international price spikes, which can make the energy market unstable in a short-term as well as long-term. In the year 2015, 335.53 PJ of oil was imported, which is 25.44% higher than it was imported in 2000 (Energy Statistics, 2015).

With around 40% of the total primary energy supply from renewable resources, New Zealand is the third highest country in the OECD, shown in Table 1. There was a rapid increase of renewable energy in the energy mix of New Zealand in recent years, which is being driven mainly by increasing electricity generation from geothermal and wind sources. Currently, New Zealand has around 81% renewable-based electricity generation (Ministry of Business, Innovation & Employment, 2016), and the government has a plan to increase it up to 90% by 2025 (Ministry of Economic Development, 2011). New Zealand is continuing to increase its renewable electricity contribution, not only through large, utility-scale renewables, but also through small-scale implementations without any policies like feed-in-tariff or subsidy policies (Byrd et al., 2013). In recent years, this renewable progress is being continuously tracked on a quarterly basis (Energy Statistics, 2015), and the government is making all other efforts for the efficient extraction of these renewable energy sources.

In New Zealand, energy-related greenhouse gas emissions account for 43% of the total greenhouse gas emissions, and this is basically from the fossil fuel used in transport, manufacturing, construction and electricity generation (New Zealand Business Council for Sustainable Development, 2011). The total liquid fuel used is responsible for more than 57% of emissions, followed by 23% country's emissions from natural gas (see Fig. 4). Considering the energy consumption, import dependency and the GHG emission profile, the transport sector is considered as one of the priority sectors for New Zealand, and this provides a significant opportunity for reducing energy demand, as well as greenhouse gas emissions, in the near future (New Zealand Business Council for Sustainable Development, 2011; Bart van Campen and Kirkpatrick, 2007).

3. Methodology

This paper provides a comparative analysis of the national efforts on the energy efficiency of the three renewable-rich OECD countries i.e. Iceland, Norway and New Zealand. Amongst these, it was identified that New Zealand has taken significant national strategies and is currently implementing a variety of sector-specific energy efficiency policies as compared to the other two countries. Therefore, a detailed review of the aim, processes, and outcomes of energy efficiency policies of New Zealand has been presented in this paper. Based on this extensive review, and the study of the other cross-sectoral policies (which have the potential to alter the energy sector conditions), sector-wise current challenges and future opportunities for further energy efficiency improvement are also identified.

3.1. Data collection and comparative analysis of policy initiatives

All the data for the New Zealand's policy research is obtained from the International Energy Agency (IEA) statistics database, as well as the New Zealand's Ministry of Business, Innovation and Employment energy database. For the comparative analysis of the three countries

[1] Total primary energy supply (TPES) is the total energy supplied for usage in New Zealand. This is estimated as domestic production plus imports, and subtracting exports and energy used for international transport (Energy Statistics, 2015).