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Examining the use of concept analysis and mapping software for renewable energy feed-in tariff design

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ABSTRACT

The Australian Government's installation of the now defunct carbon price in July 2012, triggered a review of the Renewable Energy (RE) Feed-In Tariff (FiT) policies in the state of Victoria. In this article, concept analysis techniques and mapping software have been used to examine RE FiT design elements and priorities proposed by eighty-six RE investors and FiT stakeholders during the course of the review. The results show that concept analysis and mapping can be used to analyse FiT designs enabling identification of combinations of discrete elements including fixed and variable payment rates, differing levels of market regulation and competition, varying tariff operating periods, and eligibility rules for RE system sizes, development sites and low emissions technologies. In addition, while the economic elements of FiT designs were afforded the highest priority by stakeholders, broader contemporary analysis shows that policy makers and regulators should continue to combine economic, technology, system and administration elements into tariffs that can deliver new RE supplies. Also, the results show that governments may elect to change the combinations of these design elements, introduce other ancillary policy instruments and regulatory mechanisms, and reshape the FiT schemes in order to accommodate significant shifts in public policies.

1. Introduction

Feed-in Tariffs for distributed RE sources is the dominant clean energy policy that has been credited with enabling RE developments and investment, while building energy security and addressing climate change [1–9]. Leading studies of FiT design assert that combinations of instrument elements (e.g. program length, fixed payment rates) must provide focused and sustained support for specific RE technologies in order to reduce costs, build energy diversity, and garner individual and business investment [1,10–12]. In addition, tariff design has been positioned as essential for balancing investor risks and consumer costs, including providing equitable tariff payment adjustment and program cap mechanisms [10,13]. Other contemporary studies have highlighted the importance of governments leading robust tariff design and implementation [14], including streamlining tariff administration and grid connection processes [15]; designing tariffs jointly for environmental outcomes and harsh economic realities [16]; using design philosophies that stimulate increased self-consumption of RE [17]; and, promoting designs that take account of tariff digression and impacts on future RE growth [18]. Collectively, these studies support the argument that FiT design factors are of critical importance [1,10,12,19]. Relevantly, there are internationally recognized examples where deficient FiT designs have resulted in poor RE product manufacturing and employment outcomes, and spiralling public costs [20,21]. Accordingly, it can be argued that a FiT must be purposefully designed to meet RE supply and emissions reduction targets, and avoid systemic failures [22,23].

Foundation studies show that FiT policies provide contractually binding payments for RE outputs for fixed periods, determined through the LCOE plus an investor rate of return (regulated), or the value of the RE generated using utility cost avoidance or external sustainability cost methodologies [12]. While investor returns can be paid at fixed (independent of market pricing) or premium rates (the spot market rate plus a fixed or variable premium payment) [12], the policies can also deliver broader economic benefits [4–7], including advancing industry development and innovative product

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Nomenclature

Technical

FiT	Feed-in Tariff, cents per kilowatt hour
LCOE	Levelized Cost of Energy, dollars per megawatt hour
PFiT	Premium Feed-in Tariff, cents per kilowatt hour
RET	Renewable Energy Target, per cent or Gigawatt hours
RPS	Renewable Portfolio Standard, per cent
SFiT	Standard Feed-in Tariff, cents per kilowatt hour
TFiT	Transitional Feed-in Tariff, cents per kilowatt hour

General

CAaM	Concept Analysis and Mapping
GO	Government Organization
NGO	Non-Government Organization
PV	Photo-voltaic
RE	Renewable Energy
VCEC	Victorian Competition and Efficiency Commission

research [24–29]. Importantly, RE research has determined that FiT schemes can stimulate rapid investment responses, while reducing perceptions of investment risk and improving energy costs transparency [25,29–33]. Also, studies conducted at national and industry levels illustrate the value of well-designed FiT schemes for controlling electricity price rises; improving energy security; and, enabling electricity markets expansion [1,21,25,34,35]. Further inquiries support the use of FiT policies for addressing RE supply targets under RPS regimes; developing non-dispatchable energy supplies; and, stimulating small scale RE systems growth [3,28,31,36–39].

However, FiT policies also possess some disadvantages. Studies of FiT implementation show that tariffs can drive higher public costs and taxes; increase capital equipment costs, installation fees and maintenance charges; limit returns on RE investments, and deliver windfall profits for electricity retailers [22,24,28,40–42]. Unsurprisingly, some researchers are openly critical of FiT instruments asserting that few sustainability benefits have resulted at the national level (e.g. Germany) [22]. Notwithstanding these reservations, it is difficult to design FiT policies that collectively take account of electricity costs and price factors, legislated RE quotas, and mandatory RE targets [1–3,30]. Unfortunately, tariff designers often have to contend with little, or no, change in energy use and demand management behaviours [43], poorly constructed RE dispatch, transmission and distribution processes and regulations [42,44], and government-mandated suboptimal geographic locations for RE development [29,35]. Hence, these factors present challenges for tariff design.

Further examination of the literature also highlights that FiT instruments do not operate in policy or program isolation. As an example, FiT policies can be coupled with RPS policies (i.e. prescription of energy demand to be met by RE) to grow new RE supply [12,39]. Tariff policies can also form part of larger innovation frameworks and programs that offer incentives to grow RE supplies, overcome policy voids and systemic failures, and advance the penetration of RE technologies into communities and business [45]. In addition, contemporary studies explicate how grid-connected residential RE systems, based on innovative business models, can support optimal bidding of energy supply volumes into the market by prosumers to secure feed-in payments, subject to timing, electricity pricing and prevailing risk appetite factors [46]. Hence, these streams of research show that FiT policies work within composite policy and regulatory arrangements to deliver new RE supplies.

This study supports the extant literature that advocates high quality FiT designs [1–3,10,19,47] with elements such as equitable access to electricity grids; robust and resilient transmission and distribution networks; a combination of tariff rates, RE quotas or program caps; tariff rate and participation adjustment protocols; and, efficient administration [1–5,36,47]. Studies also show that successful designs may allow for commercial (own and lease) and off grid system investments; gross tariffs for securing early investment returns; allowances for shifts in energy demand; and, energy production costs recovery [2,32,44,48–50]. In sum, robust FiT designs must be economically and socially sustainable, with the capacity to promote energy supply chain collaborations [26,33].

The motivation for this study was based on analysing and explicating FiT design elements in the context of Australia's RET of 23.5% by 2020 (i.e. approximately 33,000 GWh of RE sourced electricity) [51,52], including the installation and removal of a carbon price regime in 2011 and 2014, respectively [53]. A challenge for state and territory governments is the design of FiT policies that can grow RE investments and meet the RET, taking account of changing energy policies, economic conditions and electricity markets [51,54]. Hence, the site selected for analysis is Australia's second largest state, Victoria, where the state government was looking to design future RE FiT instruments that would rationalize existing FiT instruments; take account of carbon price policy shifts; and, support continued RE investment [54,55].

Given this motivation, the objectives for the research were clustered into two main areas as follows. First, given the directions of leading studies in FiT design [1,10,12,19], the identification and analysis of a combination of design elements (e.g. net/gross tariffs; capacity caps; system size ranges; public funding) with overlaid stakeholder priorities (e.g. economic, environmental, administrative) provide further theoretical insights and precision to extant benchmark research. The results also offer instructive direction for policy makers and regulators involved in tariff design and implementation. Second, through the application of a dedicated CAaM policy analysis technique [56,57], the research also provided a holistic composite analysis of tariff design elements, perceived benefits and potential RE growth barriers. Importantly, this enabled closer examination of additional and ancillary policy instruments (e.g. RE reverse auctions) [13] that can complement and adjust tariff designs and assist in growing RE stocks.

In meeting these objectives, the research makes useful and diverse contributions in the theory, practitioner, and research method disciplines. In the theory space, the study advances the examination and explication of combinations of tariff design elements, an area previously identified by leading scholars as important for future research [1,10,12,19]. Also, in the context of policy making and regulatory practice, the research offers alternate insights of how tariff design elements might be developed and adapted, and incorporated into broader and potentially more volatile energy policy regimes. As a further contribution, in applying CAaM techniques to the study, the research has resourcefully expanded the use of this multiple stakeholder analysis tool into the RE sector and energy policy design and development.

The balance of the article is developed as follows. The next section will discuss the background to the study and outline the research setting. Next, the article will describe the research method, including the CAaM technique, data collection and analysis procedures, followed by a discussion of the results. The concluding statements highlight the importance of implementing robust tariff designs, outline how Victorian FiT schemes benefit from adopting and/or adjusting combinations of design elements, and offer directions for ongoing research.