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Transforming urban energy systems: The role of local governments' regional energy master plan

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ABSTRACT

Recent estimates suggest that cities account for approximately three-quarters of global energy-related carbon emissions. At the Paris climate agreement in 2015, major cities were identified as a key player to decarbonise the energy generation sector. Australia is one of the most urbanised countries in the world, within which the local government sector has a significant capacity to accelerate a transition to clean energy generation. Through a case study of a renewable energy master plan involving five urban-councils in Sydney, this study uncovers the underlying drivers and emerging project challenges behind a cooperative joint-council approach. Social and environmental responsibility was found to be the primary motivator to develop a regional renewable energy master plan. Leveraging the collective bargaining-power through a regional joint-procurement process was an equally significant motivation. The study also revealed five major challenges. Most projects are reliant on some degree of funding from commonwealth and state government grants which are often associated with political uncertainty and a lack of continuity in programs and funding. Different positions exist as to the preferred financing options for solar-systems among councils. The previous success of a collective bargaining by councils that secured below-market prices supply-contracts of fossil-based electricity, paradoxically, reduced the financial viability of the current renewable energy project. The installable roof-space of some sites was over-estimated when not considering an on-site demand and low feed-in-tariff dynamics. Insolvency risk of renewable energy suppliers was identified as a factor that could impact on the long-term success of the project. Looking forward there are opportunities for progressing clean energy generation transformation through collective action by local government. Revolving clean energy funds can be used to establish and support renewable energy and energy efficiency projects. Regional collaboration can draw on existing technical expertise and institutional and political learnings. Power supply arrangements between councils should be supported through innovative governance and financial arrangements. Combined, these initiatives should be framed to distribute risks, lessen uncertainty and support innovation.

1. Introduction

The Paris climate agreement in 2015 has invigorated global drive for a rapid decarbonisation of major economies. Cities account for three-quarters of global energy-related greenhouse gas (GHG) emissions (Gouldson et al., 2016; IEA, 2016; IPCC, 2014; Seto et al., 2014) which is attributed to the 54% and growing proportion of the world's population living in cities (United Nations, 2014). Australia is one of the world's most urbanised countries with 82% of its population living in major cities (Glenn, 2016). It is also the highest per capita GHG emitter among the OECD countries and consumes 86% of its electricity from fossil-fuels (Australian Government, 2015b; Perry et al., 2015). Within Australia's three tiers of government (commonwealth, state and local), the local government (LG) sector has been estimated to have the capacity to influence up to 50% of GHG emissions through its various responsibilities, including urban planning, development approvals, waste management, the operation of community buildings and facilities, provision of public infrastructure and street lighting (Cheung et al., 2016; Commonwealth of Australia, 1995; Lindseth, 2004; Lumb

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et al., 1995). Recent research in this field (Cheung et al., 2016) suggests that the LG sector in Australia has aspired to reduce their GHG emissions through local clean energy generation projects. However, the sector is confronted with three main challenges: financial constraints (especially those in the state of New South Wales (NSW) subject to state government imposed rate-pegging); the current pricing and regulation of electricity markets, which has set low feed-in-tariffs for renewable energy (RE); and the perception that the investment in RE projects is outside the traditional and core services of local government (CEFC, 2016).

Building on previous work that identified challenges and opportunities for the LG sector to finance alternative energy projects in Australia (Cheung et al., 2016), this research provides an in-depth case study of the development of a regional RE master plan. The regional approach draws on the collaboration between five urban-councils from the southern Sydney region in NSW (Ashfield, Bankstown, Canada Bay, Canterbury and Marrickville). We focus on the motivations underpinning the formation of the collaborative approach and subsequent process used to select an RE supplier for solar-systems installation and ongoing services. The intent of the research is to uncover underlying motivations and emerging challenges that may be transferable to other local government authorities. Our study finds that despite RE energy generation being seen as outside a council's traditional core service responsibilities, the participating councils were primarily motivated by their strong social and environmental responsibilities and actively sought to transition their energy consumption to clean energy generated locally. However, this aspiration is limited internally by their inherent financial constraints and externally by energy market regulations.

The financial constraints facing the LG sector are intertwined with an often backward-looking and traditional focus on what have been considered core services. The inertia to prioritise and fund traditional services is juxtaposed against new models of governance that support community based involvement in strategic planning and a broader focus on sustainability. Responding to new governance models and to position sustainability as central to strategic planning, the joint-council approach to energy planning and provision seeks to proactively overcome financial and other resource barriers that have to-date limited the uptake of RE technologies by LG. This is achieved through delivering financial benefits individually and collectively to the councils linked to economies of scale as part of joint procurement contract negotiations and establishing stronger institutional capacity through inter and intra council resource sharing.

In evaluating and selecting a long-term RE supplier through the joint council approach, a number of major challenges were identified. First, councils had different positions with respect to the preferred financing options. These were primarily divided into those wanting an up-front capital purchase and those, primarily with limited or constrained financial resources, a zero-upfront capital Power Purchase Agreement (PPA) contract. A failure to agree on either option meant the economies of scale for the supply and maintenance of RE systems could not be reached. Second, through a similar joint-tendering procurement process the councils achieved a favorable electricity supply contract at rates significantly below market prices, in effect having access to cheaper traditional, and largely fossil fuel based, energy. This electricity supply contract effectively reduced the financial viability of all renewable energy projects and serves to perpetuate the inertia of traditional energy providers. Third, the estimation of roof space for solar-systems on some buildings did not consider on-site electricity demand and the low feed-in-tariff rates, as set by the state energy regulator, paid to the councils for excess generation. In effect savings of RE through onsite generation was not matched to demand and actual financial returns. Finally, the financial solvency of renewable energy suppliers could not be guaranteed for the entire lifetime of the projects especially for the councils favoring a PPA contract. This was deemed a financial and operational risk to the participating councils through their procurement process.

These challenges highlighted two underling conditions that impact on the future transition of renewable energy projects. Internally, councils generally have inherent financial constraints or at least are beholden to traditional budget allocations (which either preclude or limit expenditure on RE) and past energy agreements. Limited staff resources and capacity, particularly for small or medium sized councils, also lessens the opportunity for internal champions to promote RE and the likelihood that they have specific technical and financial expertise to assess new and complex renewable energy projects. Externally, market and technological conditions, including low feed-in-tariffs, prohibition of sharing local energy among sites, non-market readiness of virtual net metering and power-storage technologies collectively create additional implementation barriers.

Our study makes significant contributions to the literature of the urban LG energy transition and policy dimensions in two ways. First, it examines renewable energy transformation at multiple scales: i) at the micro-scale, it uncovers issues surrounding project delivery and how councils can effectively and practically deliver on their RE targets; ii) at the macro-scale, it explores the impact of market pricing, regulation and technological readiness barriers. The results of this study can inform policy-makers at state and commonwealth government levels to improve climate/energy laws, strategies, policies and regulations that could support the transition efforts by the LG sector. Second, through our detailed analysis of the regional joint-procurement process we offer insights in how a viable local energy-transition model can be innovated. Given the major contribution of cities to GHG emissions, the transition by LG towards RE generation for their own assets and at a community level can have a significant impact to fast-track the delivery of national emission-reduction targets.

The remainder of the paper is organized as follows. Section 2 provides a review of the literature on the renewable energy transition in the LG sector in Australia and illustrates various internal and external challenges and barriers for the local energy transition. Section 3 outlines the mixed-methods strategy in data collection and analysis that is applied in this paper. Section 4 presents the key findings of our study that are further discussed in Section 5. Section 6 concludes with key recommendations to resolve internal and external barriers, and how to optimally facilitate and accelerate a renewable energy transition for the LG sector.

2. Local government as an enabler for renewable energy transition in cities

For many years, the LG sector has been active in formulating local climate action plans, particularly those cities from Annex I countries[1] (Seto et al., 2014). For some countries, such as France and Japan, local climate actions plans are mandatory (Yalçın and Lefèvre, 2012; Sugiyama and Takeuchi, 2008), while for others, such as Australia, they are voluntary. For the LG sector that has voluntary planning and reporting requirements, their motivation to develop, implement and assess progress of their climate action plans is based on many underlying drivers, needs, political and

[1] The group of countries in Annex I to the UNFCCC includes all OECD countries and economies in transition. Annex I countries committed themselves as part of the Kyoto Protocol specifically to the aim of returning individually or jointly to their 1990 levels of greenhouse gas emissions by the year 2000.

economic objectives as well as their institutional capacity. In the absence of a nationally mandated climate policy, a catalyst for local action on climate change commenced under the Cities for Climate Protection program (CCP), an initiative of the International Council for Local Environmental Initiatives (ICLEI) established in 1993. In Australia, the CCP program was initially funded by a $13 million[2] grant from the commonwealth government (Bulkeley, 2000) and subsequent funds were allocated from both commonwealth and state governments through to 2009. Funding was used to support the development of local climate mitigation plans and their implementation (Bulkeley, 2010). Beyond 2009, action on climate mitigation has waned across the LG sector with notable exceptions including the City of Melbourne and City of Sydney. These large and financially secure city councils have continued to lead, champion and implement their ambitious local climate/energy actions, aided more recently by the *C40 Cities Climate Leadership Group* (C40, 2016). For many councils across Australia, a lack of financial and institutional capacity continues to impede the implementation of RE projects and their committed ambition for GHG reduction targets remains merely an aspiration (see, e.g., Cheung et al., 2016).

2.1. Disjointed climate/energy politics and market barriers

Local governments aspiring to advance their RE generation are confronted with multiple external challenges. Australia's approach to national climate and energy policy continues to be subject to political division, change and often detachment (Cheung and Davies, 2017; Warren et al., 2016). Since 1988, Australia's climate policy has been deeply grounded by its rich fossil resources (BREE, 2014a) that contribute approximately 85% to the domestic electricity consumption (Australian Government, 2015a) and 7% to the export revenue of Australia's national GDP in 2013/14 (BREE, 2014b). The national economic dependency on fossil fuels (Curran, 2009) and the influence of fossil-fuel industries (Hamilton, 2007; Pearse, 2007) has had substantial impact on the constantly shifting national climate and energy agenda. This is reflected by diverging goals, policies and paths within and between the three tiers of government (Beeson and McDonald, 2013; Crowley, 2010, 2012; 2013; Hetherington and Soutphommasane, 2010; McDonald, 2012, 2013; 2015; Warren et al., 2016). Contributing to this milieu has been a revolving door of Prime Ministers that have encompassed the spectrum of climate change understanding ranging from support to denial (Cheung and Davies, 2017). This instability and uncertainty has led to a failure to induce the required long-term capital investment for the development of RE technologies and related industries in Australia (Christoff, 2013; Crowley, 2013; Diesendorf, 2012; McDonald, 2005; Maryniak et al, 2018; Simpson and Clifton, 2014).

From a market perspective, under the current regulatory model of the National Electricity Market (NEM), each state government is responsible for managing their own electricity generation and supply policies, while operating within overarching national policies and agreements (Warren et al., 2016). These arrangements make the governance structures within and between states, and across different levels of government complex. Consequently, the current NEM model is still based on a system which favors centralised generation and distribution of large fossil-fuel power plants (built and initially operated by state government and now mostly owned and operated by the private sector), while tariff structures are inadequate to enable an effective transition to multiple decentralized RE generation sources (IPART, 2002; TEC, 2009, 2010). The national Clean Energy Act 2011 effectively allocated power to the states to establish their own feed-in-tariff that is regarded as the market instrument for inducing RE investment (Commonwealth of Australia, 2011), although across most jurisdictions the feed-in-tariff does not sufficiently incentivize investment in RE systems. The role of the local government sector is rarely, if at all, mentioned within national or state energy policy discussions.

Each state government is responsible for the funding of their feed-in-tariffs. Like the national energy policy, tariffs are subject to political and administrative changes (Buckman and Diesendorf, 2010; Martin and Rice, 2013; Zahedi, 2010). For example, in NSW the Solar Bonus Scheme introduced on 1 January 2010 was designed to accelerate the RE uptake. This was supported through an initial gross feed-in-tariff[3] of $0.60/kWh for seven years to December 2016 (NSW Auditor General, 2011). This feed-in-tariff has been wound back to $0.20/kWh in May 2011 as a result of an over subscription that impacted on the state budget. By 30 June 2011, the Solar Bonus Scheme had cost the NSW government $142m and total costs for the scheme were, at the time, projected to be between $1.05 billion and $1.75 billion (NSW Auditor General, 2011). The current unsubsidized feed-in-tariff (reviewed and published by the NSW Independent Pricing and Regulatory Tribunal each year) are benchmarked from 5.5 to 7.2 cents per kWh, reflecting the wholesale electricity price in the NEM (IPART, 2014). This level of feed-in-tariff has rendered many solar PV projects with high feed-in and low onsite-consumption patterns financially infeasible. The financial viability of RE projects has been further compounded by the repeal of a carbon-pricing mechanism and rising gas prices,[4] causing many councils' forward-thinking trigeneration projects, such as City of Sydney and Bankstown City, to become economically unviable and being shelved (Bankstown Council, 2015 p.97; Vorrath, 2013).

In 2009, the federal government announced that subject to a pre-deployment report, $100 million would be invested to develop a commercial-scale smart grid demonstration project in partnership with the energy sector (Australian Government, 2009). Smart grids are modernised electricity grids that interact with information technology and communications infrastructure to better integrate distributed renewable energy sources into the grid. Smart grids also provide a more reliable and secure power system through smart metering, intelligent load and demand management (Amini et al., 2013; Boroojeni et al., 2017). However, the disjointed climate/energy politics has left Australia still without a comprehensive long-term plan to develop and implement a modern or smart grid (Engineers Australia, 2017). The current regulatory regime of the electricity market in Australia is designed to support centralised energy distribution and does not easily allow the sharing of energy between sites (Jones, 2010). For local government, energy distribution policy continues to be a major barrier as councils own multiple buildings that can generate electricity, such as through roof top PV systems, but are not easily able to redistribute their power to their other facilities. As a result the LG sector is forced to prioritise investment in RE to sites where supply matches demand. Therefore, the economic and environmental co-benefits for local government to play a major role in transforming the energy systems will not be realized unless there is effective policy reform to remove market-regulatory barriers which have

[2] In the following, given the Australian context of this study we will denote Australian Dollars simply by $.

[3] Gross tariff scheme – all electricity produced by the solar PV system is paid for at the feed-in-tariff rate.

[4] Australia is on track to become the largest exporter of liquefied natural gas by 2017 which had tightened the domestic gas supply and pushed the gas price up (DRET, undated).

negative impacts on the financial feasibility of investments in larger scale local energy generation that can be shared across the same property portfolio (Rutovitz and Dunstan, 2009). Such market barriers have profound impacts for cities that are not just an agglomeration of local governments, but are comprised of many homes, commercial and industrial premises, all of which could have the potential to locally supply and distribute energy outside of the conventional energy market.

2.2. Inherent fiscal constraints and structural reform

Most local governments in Australia are financially constrained as a consequence of many factors, including increased responsibilities allocated by higher tiers of governments, rising community expectations for services and facilities, as well as their limited ability to raise local rates (Commonwealth of Australia, 2001; LGSA, 2006). This has led many state governments to pursue amalgamations on the assumption that mergers will provide greater economic efficiencies (Byrnes and Dollery, 2010). The financial constraints are even more significant in the state of NSW, due to state government imposed rate pegging (IPART, 2009). Over time, rate pegging has led to significant funding shortfalls coupled with socio-political concerns about a perceived reluctance to raise rates to meet budget shortfalls, address the depreciation of assets and meet changing and increasing service expectations (ILGRP, 2013). For climate change mitigation and adaptation, the lack of funding from rating income and other internal income generating sources has forced many councils to rely solely on national and state grants to fund RE generation and energy efficiency projects (Pillora, 2011; Storey et al., 2012). For the state of NSW this financial position was highlighted in the Financial Sustainability Ratings Report from the NSW Treasury Corporation which noted 52% of councils were in a 'moderate' financial position; that is the councils carried a minor to moderate operating deficit or even a significant operating deficit (Treasury Corporation, 2013). The NSW Treasury rating review was used to support structural reform to the local government sector in NSW to revitalise the institutional capacity and fiscal sustainability of local governments (Dollery, 2014; ILGRP, 2013), also referred to the *Fit for the Future* program (OLG, 2014).

2.3. Regional capacity building through joint energy planning

The *Regional Organisations of Councils* (ROC) represents a specific form of voluntary collaborative partnerships among neighbouring councils in geographical regions (Gooding, 2012). The objectives for a group of councils to develop and maintain a ROC are to achieve better outcomes for their communities with reduced costs, improved shared-service delivery, regional capacity building or pursuing multi-purpose agendas through advocacy around wider regional policy issues (Dollery et al., 2009; Somerville and Gibbs, 2012). There are 17 ROCs in NSW with seven ROCs in the Sydney metropolitan area. The delivery of shared services under the ROC model remains patchy. This is a consequence of varying size, number and wealth of participating councils, the level of commitment of the member-councils and institutional leadership involved (LGASA, 2012; NSW Government, 2011; Productivity Commission, 2012).

The *Southern Sydney Regional Organisation of Councils* (SSROC) is one of the seven metropolitan ROCs founded in 1986. At its inception there were 16 councils,[5] while this number has been reduced to 11, following local government amalgamations.[6] The councils that make up the SSROC are responsible for 1.6 million people from culturally and economically diverse backgrounds. The per annum average household income ranges from $38,000 in the western suburbs to $113,700 in the eastern suburbs (NSW Government, 2014b). The financial sustainability rating of the councils is also highly variable, as are their actions on climate mitigation and adaptation.

The SSROC has been at the forefront of regional environmental initiatives in Sydney. Recent projects include: a Street Lighting Improvement Program, the *Our Energy Future* master plan, the *Our Solar Future* master plan, a Regional Waste and Resource Recovery Strategy and a Regional Waste Audit. Specific involvement in these initiatives is determined by each of the councils individually and reflects their capacity and policy alignment. The Our Energy Future (OEF) master plan was built on and evolved from 'A Greenhouse Strategy for the Southern Sydney Region' (1992). This strategy outlined the important role local government can play in reducing regional GHG emissions through local actions. In 2003, ten member-councils[7] committed to the *Regional Greenhouse Plan* (RGP) developed under the CCP program to reduce GHG emissions from their council areas by at least 20% against 1997 levels by 2010 (SSROC, 2003). However, progress against this plan has been slow and challenging, not only in the delivery of renewable energy projects but also in quantifying and tracking emissions from their operations (SSROC, 2011).

Driven by the increasing cost of electricity and the need to achieve carbon emissions reductions, eight of the member-councils[8] appointed an independent consultant to conduct a high-level investigation into options for renewable energy technologies and business models for the participating local government areas.[9] This led to the development of the OEF master plan (Ison et al., 2013). The OEF master plan provided a united approach to GHG reduction for the participating councils and identified cost-efficiencies, benefits of sharing of resources and expertise in tackling cross-boundary issues of local RE generation and consumption. Following the recommendations in the OEF master plan, the SSROC called for an expression of interest from RE suppliers to deliver products and services for the participating councils in 2015. This study examines the approach and identifies various issues that arose in the RE suppliers evaluation and selection processes.

3. Methodology

The research adopted in this study is a mixed-methods strategy, combining both qualitative and quantitative data collection (Creswell and Plano Clark, 2011) to achieve the following two key research aims:

1. To understand the drivers underlying the development of the 'Our Energy Future' (OEF) master plan through the SSROC.

[5] SSROC member-councils – Ashfield Council, Bankstown City Council, Burwood Council, City of Botany Bay, City of Canada Bay, City of Canterbury, City of Sydney, Hurstville City Council, Kogarah City Council, Leichhardt Municipal Council, Marrickville Council, Randwick City Council, Rockdale City Council, Sutherland Shire Council, Waverley Council, Woollahra Municipal Council.

[6] SSROC member-councils after the merger - Bayside, Burwood, Canterbury-Bankstown, Canada Bay, City of Sydney, Georges River, Inner West, Randwick, Sutherland Shire, Waverley, Woollahra.

[7] Participating councils include: Botany Bay, Canterbury, Hurstville, Kogarah, Marrickville, Rockdale, South Sydney, Sutherland Shire, Waverley, Woollahra.

[8] Participating councils include: Ashfield, Bankstown, Canada Bay, Canterbury, Kogarah, Leichhardt, Rockdale, Marrickville.

[9] Local government area – includes both residential and commercial communities under a council's jurisdiction.

2. To identify the emerging challenges from the implementation stage of the OEF master plan in selecting the best renewable energy supplier.

In answering these questions, this study also aims to identify learnings and insights to support RE transformation for the local government and energy sectors.

3.1. Analytical framework

Our analytical framework is based on the public service motivation (PSM) concept (Bozeman and Su, 2015; Christensen et al., 2017; Vandenabeele, 2007). PSM is typically described as 'the belief, values and attitudes that go beyond self-interest and organizational interest, that concern the interest of a larger political entity and that motivate individuals to act accordingly whenever appropriate' (Vandenabeele, 2007 p.547). An operational theory of PSM encompasses both causes and consequences derived from an interdisciplinary approach, combining elements of institutional theory and motivational psychology. Analyses focus on the actors involved in the transition processes to gain an insightful knowledge of their incentive structures[10] and positions[11] shaped by the availability of resources in the layered institutions[12] which might enhance or constrain their actions (Hoppe and Van Bueren, 2015). Hence, the conducted data analysis is guided by these elements of the incentive structures, positions and actions within the layered institutions. Qualitative data in the case study are drawn to provide insightful narratives, while quantitative data are used to enhance and deepen the knowledge of the qualitative interpretation.

3.2. Data collection and analysis

Qualitative and quantitative data were collected sequentially, and each was followed by an interim analysis to inform the next stage of design and subsequent data collection and analysis (Fig. 1).[13] Initial data (EOIs from all RE suppliers and the internal assessment methodology documents) was provided by the SSROC that formed our initial quantitative dataset.[14] The dataset was then reviewed to inform our research mixed-methods data collection design. As part of the agreement for the case study, a literature review on finding an appropriate multi-criteria group decision-making model was carried out prior to facilitating two focus group meetings which formed the first stage of our qualitative data collection. The data from the focus group informed the second stage of data collection from semi-structured interviews.

The focus group meetings had two aims. The first was to construct a multi-criteria group decision-making model (MCGDM) to assist the project appraisal-panel in evaluating and recommending a RE supplier.[15] The second was to observe the interactions and conversations of the evaluation-panel to ascertain areas of interest and concerns related to the expression of interest.

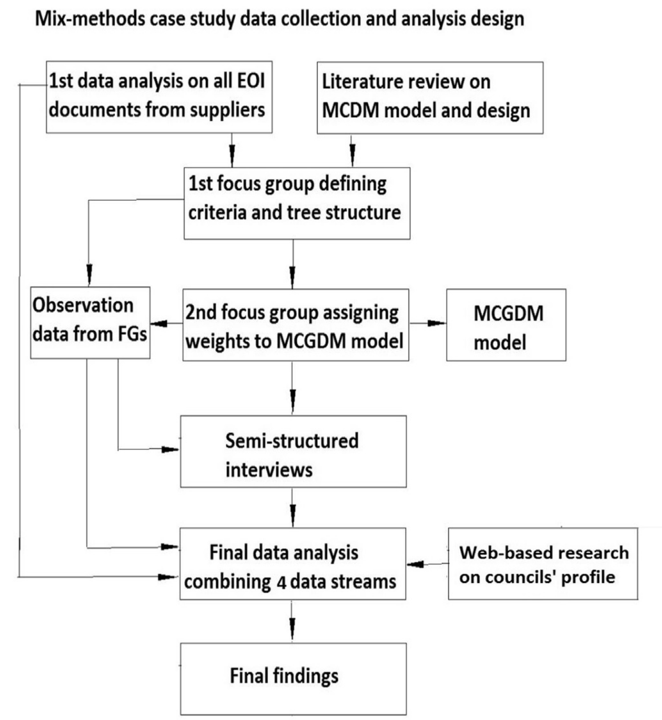

Fig. 1. Methodological design and operation sequence of data collection and analysis.

In this regard the MCGDM model can be considered as an outcome of the first stage of data collection and analysis.

In the second stage, semi-structured interviews were conducted with all the participants of the focus group, including the OEF program manager and five officers from participating councils. The aims of the interviews were to gain further insights on the underlying drivers and perceived challenges of the project and to solicit: additional internal project-specific data; internal RE funding mechanisms; energy consumption profiles; RE targets, and; progress of RE implementation. Interview questions were sent to interviewees prior to the interview to assist in data collection. The strength of economic factors informing RE progress was evaluated through a 5-point Likert-type scale, where '1' represents the least significant and '5' the most significant (Table 1). Other data was collected from the councils' websites (including information on council's annual financial statements and community strategic plans) and was used to triangulate with data from the interviews and surveys.

The sequential and convergent data collection and analysis design (Creswell and Plano Clark, 2011) of the four data sets (EOIs, focus group observations, interviews and councils' profiles), has the advantage of capturing new emergent themes through one stage of analysis, then informing the next stage of data collection/analysis. For example, the semi-structured interview questions on the internal funding mechanism for the past and future RE installations and other quantitative data were added, following the analysis result from the two focus group data when the discrepancy of preferred funding options and concerns on the below-market electricity price emerged. Since this is an empirical case study with a high level of homogeneity among the studied-population (a group of five urban-councils) and focus objectivity (investigating drivers and challenges at the micro-scale of a project) (Mason, 2010), the literature suggests that a small number of interviews should be sufficient to enable the development of meaningful themes and useful interpretations (Guest et al., 2006 p.78). Hence,

[10] Incentive structure – drivers arise from social, economic and environmental considerations and perspectives.

[11] Position – the preferred financing-option position of each member-council.

[12] Layered institutions – refer to the councils as members to the regional organisation of councils such as SSROC.

[13] Both focus group workshops and semi-structured interviews were approved by the Macquarie University Ethics Committee.

[14] Note that due to the commercial nature of the selection process, all EOIs from potential RE suppliers were provided by SSROC on the terms of a 'Non-disclosure' agreement signed by the authors. Therefore, commercially sensitive quantitative data such as sites, sizes and quotes can only be used for analysis purposes, but cannot be disclosed.

[15] Details on the MCGDM model selection, model development approach and the final model are provided in Appendix A.

Table 1
Ranking of underlying economic drivers for Our Energy Future master plan.

	Ashfield	Bankstown	Canada Bay	Canterbury	Marrickville	Total score
Enhance funding ability	3	1	3	2	2	11
Enhance regional bargaining power	4	4	5	4	5	22
Improve economies of scale	5	3	1	3	3	15
Build regional capacity	2	5	4	5	4	20
Minimise financial risk	1	2	2	1	1	7

(note – results are based on a 5-point Likert-type scale, where 1 represents the least significant and 5 the most significant, while total scores represent the sum across all drivers for each council).

our sample size of five councils with six interviews (including the SSROC program manager) is in line with the sample size adopted in other literature in the field.

4. Results

The results section is divided into two parts, reflecting the key aims of the project: to identify the drivers for the master plan; and to reveal emerging challenges. The drivers are discussed around three themes: public service motivations, financial position and renewable energy policy. Challenges are framed around: access to external funding and policy certainty; financing and funding arrangements; the below market electricity-supply contract; discrepancy between potential and actual rooftop generating capacity; and the suppliers financial risk.

The initial focus group meetings revealed the following key findings: each of the participating councils were motivated by environmental sustainability through which they recognised the relationship between the use of energy supplied by fossil fuels, rapidly increasing greenhouse gases in the atmosphere, and climate change (noting that this has been a politically contested issue in Australia). Councils were in favor of transitioning their fossil-based energy consumption to onsite clean energy production as a viable transition pathway. Two different positions were put forward on how to finance a RE project that hinged on whether a council had an internal energy revolving fund or not. Financial risks and possibly questionable benefits of a RE project were emphasized due to current below-market (fossil-fuel) electricity price supply-contracts (achieved through earlier similar joint-procurement process of the SSROC).

4.1. Underlying drivers for the joint Our Energy Future master plan

4.1.1. Public service motivations

Adopting an analytical framework based on the PSM concept (Bozeman and Su, 2015; Christensen et al., 2017; Vandenabeele, 2007), we found that the drivers behind the council's motivation to participate in the OEF master plan varied, although they were typically underpinned by sustainability motivations. This was reflected by the comment from the OEF program manager who noted that *"all councils except two in the SSROC region have regarded climate mitigation actions as part of their social and environmental responsibility of a council's normal operation and services to their communities."* The most frequently mentioned motivator to invest in RE from the council officers was the council's responsibility to their communities and environmental sustainability. Larger councils also saw themselves as having a leadership role: "*[…] we are the biggest council in the SSROC area and we want to show leadership in* supporting *the sustainability initiatives of SSROC*". Other comments reflected on the council's longstanding priority towards environmental issues as indicated in their corporate strategies, many of which included targets and metrics to reduce corporate and community GHG emissions. For others, particularly the smaller councils, motivations were internally driven by environmental officers, reflective of a public service motivation. Collectively, interviews revealed that officers charged with a responsibility for energy and climate programs were motivated by a sense of social and environmental responsibility and also saw the benefits of a regional approach.

When examining the aggregated ranking of economic-motivating factors through the survey (Table 1; Fig. 2), the data reveals that 'enhancing regional bargaining power' was considered as the most significant driver, followed by 'building regional capacity. These two elements underscore the aims of regional based local government cooperatives. As noted by one participant, *"council recognises the need to be more self-reliant in terms of energy programs, but being under-resourced has challenged our ability to tackle the problem on our own"* highlighting the importance of a regional cooperative approach.

4.1.2. Financial position

The ranking of the underlying economic drivers can be related to the financial characteristics of the participating councils. As shown in Table 2 and Fig. 2, all councils had an operating surplus for the fiscal year of 2014/15. However, three of the five councils would have reported a negative operating result without an injection of a grant from the state and commonwealth governments for maintenance or upgrading community infrastructure. Additionally, the five councils have debts ranging from $4m-$15m, with Marrickville having the highest and Canterbury having the lowest debt per capita. Given the RE projects are considered as a 'non-core' service, such projects tend to receive a lower level of importance and funding allocation in the Councils strategic plan and budget.

As suggested in Cheung et al. (2016), both the willingness and ability of a council to seek a rate increase will depend on the communities' household annual taxable income, among other factors. Across the SSROC area, the average annual household taxable income ranges from $38,000 to $113,000. Responses from officers working in the councils at the lower end of the average household income range, reinforced a social and political need to keep council rates low, thus, requiring alternative and innovative funding mechanisms for RE projects. Interestingly, these council officers also reported that building regional capacity as an economic driver of the OEF master plan was of greatest importance.

An asset base of a council is important in contributing to the council's secondary rental income as well as providing roof space for solar PV projects. Bankstown and Canada Bay councils have a greater asset base (buildings) for roof-top PV systems than the other councils. We note that these two councils are also slightly more concerned about financial risks of the OEF in comparison to the other three councils. However, overall, the councils in our sample rank minimizing financial risks as the least important economic driver of the OEF master plan, yet risk management, including financial risks, remained a key part of the selection process for a RE provider.

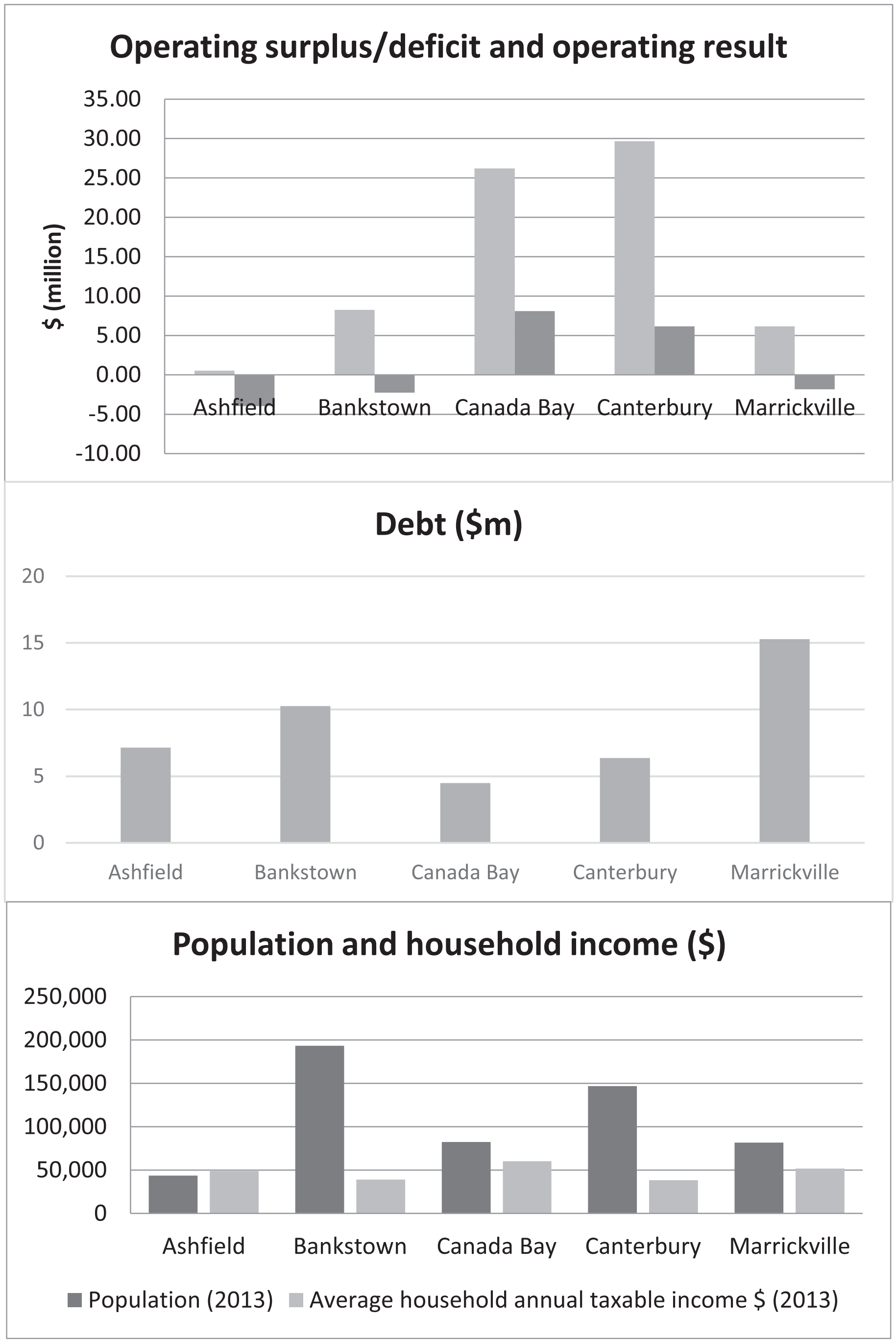

Fig. 2. Financial profiles for Ashfield, Bankstown, Canada Bay, Canterbury and Marrickville councils. The upper panel illustrates the operating surplus/deficit ($m) for the financial year 2014/15 as well as the annual operating result before grants ($m). The middle panel displays the debt ($m) for each of the five councils. The lower panel provides information on the population and the average household annual taxable income for each council.

4.1.3. Renewable energy policy

Table 3 summarises emission targets, energy use and funding mechanisms of the councils.[16] All councils, except Canterbury, have formal GHG emission and RE targets as part of their strategic plan. Interestingly, with the exception of Bankstown, no specific implementation, tracking and reporting mechanisms were in place across the councils to track outcomes of energy efficiency or RE generation initiatives. Bankstown reported ongoing GHG emission reductions, however, their community strategic plan did not specifically mention a renewable energy target or plan. This reveals possible gaps in corporate governance systems across all councils which either does not link policy or strategic documents to longer term financial plans or annual budgets.

Notable across all councils is the modest generation of RE as a proportion of total energy use and specifically compared with stated GHG reduction and RE generation targets (Table 3). The data reveals a discord between policy and investment, irrespective of the

[16] Collection of these internal data through semi-structured interviews was informed by the analysis of all the EOIs and data from the two focus group meetings to support and strengthen our qualitative analysis results.

Table 2
Council financial profiles 2014/15.

	Ashfield	Bankstown	Canada Bay	Canterbury	Marrickville
Total Income ($m)	41.10	161.41	99.97	131.03	106.63
Operating Surplus or (Deficit) ($m)	0.55	8.25	26.21	29.67	6.17
Operating Result before grants ($m)[a]	(-3.96)	(-2.25)	8.1	6.14	(-1.84)
Debt ($m)	7.14	10.25	4.48	6.37	15.28
Net Assets ($m)	284	2012	3653	1053	989
Population (2013)	43,661	193,398	82,201	146,729	81,689
Average household annual taxable income (2013)	$48,859	$39,083	$60,161	$38,145	$51,700

[a] Net Operating Result for the year before Grants and Contributions provided for Capital Purposes. This grant is from state and federal governments for the purposes of community infrastructure maintenance or upgrading.

Table 3
Councils emission targets and energy profiles 2014/15.

	Ashfield	Bankstown	Canada Bay	Canterbury	Marrickville
Targets	20% energy and GHG reduction on 2011/12 level by 2020	20% GHG reduction from 2009/10 level from electricity and gas by 2020	35% GHG reduction on 2011/12 level by 2023 30% renewable source electricity by 2030 (SSROC) 30% energy consumption reduction on 2011/12 level by 2023	No target	25% GHG reduction on 2000 levels by 2020
Total electricity consumed	1,937,500 kWh	16,015,660 kWh	4,467,817 kWh	8,356,820 kWh	7,643,257 kWh
Street lighting/total electricity	n/a	51%	50%	30%	52%
Electricity from Renewables	1%	0.85%	<1%	1.6%.	1.9%
Internal revolving fund	No	No	No	Yes	Yes

councils' financial capacity (Table 2). This highlights that while there may be public service motivation, particularly by environmental staff, to transition to a more sustainable/RE future, a dedication of funding to the politically agreed targets is typically not being achieved. While the regional energy master plan is employed to improve the regional bargaining power (Table 2), this approach is no ‘magic pudding’ nor has it been able to reconcile inter-council differences as to the councils' preferred funding model.

4.2. Emerging project challenges

Our convergent analysis of the four data sets (EOIs, focus group recordings/observations, interviews and councils’ profiles) revealed the following five emerging project challenges.

4.2.1. Access to external funding and policy certainty

Funding to support the RE investment to achieve the policy targets was generally via commonwealth or state government grants, even when a council had an internal revolving energy fund. Interviewees reported that government grant programs were often changing and were less reliable than in the past. These comments reflect the political uncertainty in national and state climate policy and how this is reflected in the financial arrangements with LG. We conclude that ongoing investment by LG for RE projects has and will continue to be dependent on grant programs from the higher tiers of government and this will be dependent on policy certainty and associated budget commitments that has been lacking over the past decade and longer (Cheung and Davies, 2017).

4.2.2. Financing and funding arrangements

Only two of the five councils, namely Canterbury and Marrickville, have an internal revolving fund[17] as a formal mechanism specifically designed to support RE investment (Table 3). These councils have a higher share of RE generation (Canterbury 1.6% and Marrickville 1.9%) in comparison to the other three councils (<1%) without an internal revolving fund. This suggests such a scheme is valuable in securing the needed longer-term funding for energy efficiency and RE generation projects. Notwithstanding, the relative achievement of the internal revolving funds, as illustrated in Fig. 3, the generation of renewable energy across all councils is very small when compared to the targets.

Both a barrier and challenge encountered in this project was that the participating councils were divided as to the funding model to implement the RE projects. Preference for a capital-upfront payment was supported by those councils with a revolving energy fund as these had working capital hypothecated to invest in RE projects. The other councils preferred a zero-upfront payment cost that had longer pay back periods. Contractors were not willing to offer a combination of both payment models. These different positions, although they did not cause tension at the beginning of the process, became more obvious during two focus group workshops and through subsequent officer interviews. A failure to agree on a financing option would have meant that the economies of scale for the supply and maintenance of RE systems could not be reached, i.e. would have resulted in negative cost impacts.

Interviews also revealed that for all councils, new RE projects must demonstrate to the executive (generally for smaller projects) and for elected officials (for major investments) energy-reduction and cost-savings to gain approval. Under the joint-procurement agreement this presents a challenge to the project, requiring in advance executive and political commitment to the project, including the financing options that will determine the return on investment. For the purpose of evaluating submissions, the project also identified the need for a standard financial evaluation model to form part of a procurement process. The process through which companies evaluated the return on investment frequently did not disclose the financial assumptions, what prevented like for like comparisons of the submissions.

[17] This funding system captures savings from renewable energy and energy-saving projects for the explicit purpose of financing similar future projects.

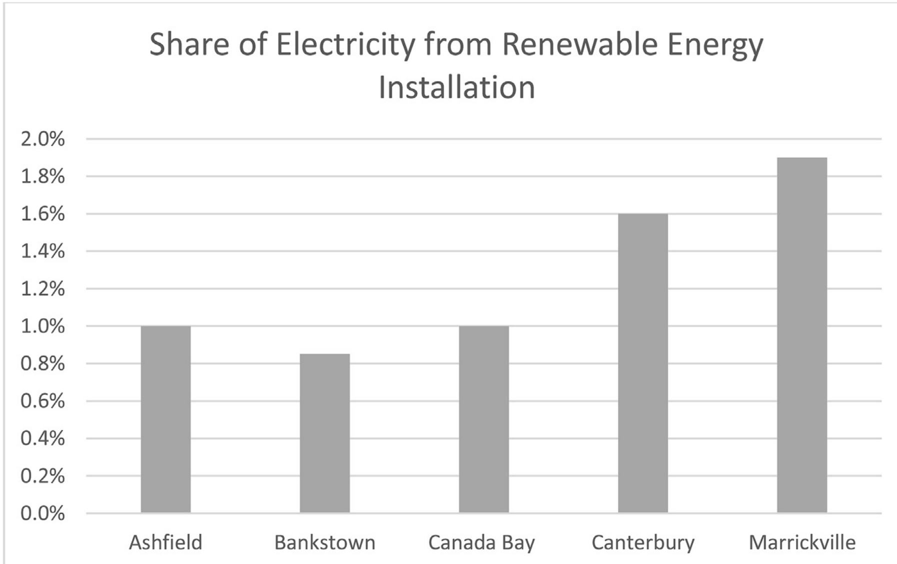

Fig. 3. Share of electricity from renewable energy installations for the five councils. Note that the two councils with the highest share of consumption from renewables, i.e. Canterbury (1.6%) and Marrickville (1.9%) have an internal revolving energy fund that seems to be a valuable scheme in securing longer-term funding for energy efficiency and RE generation projects.

4.2.3. Barrier of the current below-market electricity-supply contract price

The SSROC has previously used a joint-procurement process to negotiate a bulk electricity-supply agreement at a rate lower than the market commercial price. Ironically, the success of the current below-market electricity contract, has hindered the economic viability of the investment in RE. From a tendering perspective, the terms of the current electricity-supply agreement remain commercially confidential and cannot be disclosed in the EOI documents. This has meant respondents to the EOI were not privy to the current electricity contract rates and therefore their estimates for a return on investment for the RE projects were inflated. Consequently, the evaluation of the submissions has put in question the financial feasibility of RE projects and the program as a whole.

Some submissions to the EOI did factor in a 'below market' grid electricity price, but also incorporated an increasing price trajectory as part of their long-term agreement and modelling for the profitable return on investment for the RE suppliers. The level of the PPA price is contingent on the portfolio-volume size, discount rate, supplier's profit margin and the length of the PPA contract term. Without knowing what is the current electricity-supply price and uncertainty on the ultimate portfolio-volume (such as roof space and demand) and the length of the RE supply term, these variables present challenges, when seeking to provide financial certainty as to the feasibility and implementation of new RE projects.

4.2.4. Discrepancy between potential and actual rooftop generating capacity

Matching an onsite solar generation potential (supply) and energy use (demand) across all sites proved to be a challenge for councils and respondents to the EOI. There was high variability in the estimated roof-space between the submissions that in turn affected the generating capacity of the projected PV systems and economic returns. The technical 'potential' of the PV generation capacity was based on a physical installable roof-space. It did not account for the onsite power generation and consumption pattern and in turn was not able to factor in the impact of the feed-in-tariff. For an individual building to maximize its benefit from a PV installation, it should closely match its onsite generation with consumption and given current market feed in tariffs minimise any surplus power to be fed to the grid. Therefore, for many sites evaluated in the EOI, the true financial returns would be lower in practice, thus reducing the return on investment. Noteworthy, the feed-in tariff barrier reflects just one of the broader obstacles for the RE sector that include the non-market readiness of virtual net metering,[18] prohibited sharing between sites (that may be achieved via private wire); and the non-grid parity of power-storage technologies.

4.2.5. Financial risk

Another challenge arises from the fact that internal procurement processes used by government typically place significant weight on the financial strength of a company. For the emerging and rapidly evolving RE sector, many companies are relatively new and have a limited financial history from which to undertake a rigorous financial health check. This presents a notable procurement risk for councils, particularly when the PPA contracts include long-term maintenance obligations, with periods often exceeding the current life of the company. As revealed in this study, one company that submitted an EOI had subsequently filed for bankruptcy, emphasizing the importance of considering financial risk, including counterparty default risk, for RE projects.

5. Discussion

This study applied an analytical framework, based on institutional oriented PSM theories developed by Vandenabeele (2007) at the micro-scale of the RE master plan implementation phase. Following the PSM concept, our analysis has focussed on key actors

[18] Virtual net metering (VNM) allows for the grouping of multiple customer sites and crediting solar PV export from single or multiple sites over this combined consumption. This will reflect the benefit of localised solar generation to the network and allow for greater returns to the customer than the current mandated export based feed-in-tariff. The VNM in Australia is still at experimental phase in developing a methodology for calculating the avoided network augmentation costs that could be passed on to customers entering a VNM agreement.

involved in the transition process. The aim was to gain insights on the incentive structures (i.e., economic, social and environmental) of the actors, drivers for the implementation, and positions that shape the availability of resources within the individual council and collectively as members of a larger regional organisation (SSROC). Within this framework, our study uncovered underlying drivers and emerging challenges that are pertinent to RE transformation for the local government sector in Australia.

With regard to the incentive structures, the five member-councils are driven by a sense of social and environmental responsibility. This is evidenced by ambitious GHG emission reduction targets notwithstanding their limited financial capacity. The OEF master plan aspires to generate 30% of the electricity needs of the participating councils and their LGA by RE equivalent to 800 MW technical potential[19]. This ambitious target reflects how councils' see themselves as leaders and facilitators in transforming local energy systems (Ison et al., 2013). However, as illustrated by our study, the role of LG in the RE transformation space, is not straightforward. Key factors that will challenge the role of LG as champions for RE reform include balancing internal financial constraints with competing priorities and the external regional RE-planning agreements along with overcoming market regulatory and technological conditions.

Within a council, there exist technical, financial, and governance barriers which form an interwoven web that impede RE program and project implementation. Understanding both the technical and financial intricacies of the rapidly evolving RE market requires specific skills often not at hand in smaller councils. This may extend to understating the potential capability of new RE systems that can be adaptable and upgradable with future advancement of RE technologies. Financially, the use of novel joint-procurement models without incorporating universally established standards such as, e.g., internal revolving energy funds, complicates the already restrictive and traditional procurement processes by LG. Councils are risk adverse and have established governance systems to manage risk and uncertainty, and these standards weigh heavily on new business and technologies. For rapidly evolving sectors, such as the RE market, financial risk, product redundancy, changing business ownership, insolvencies, collectively create a sense of uncertainty and instability. While these risks can possibly be managed, they present a degree of the unknown and serve as barrier or at least an additional hurdle within an already rigorous and onerous procurement process.

Finally, the physical accounting of each of the council's assets and its energy use remains a technical obstacle that has consequential impacts at the procurement and tendering level. On-site energy metering and building management systems, while established technologies, are not readily used across the LG sector and in this study impacted on the planning and delivery of the OEF masterplan. Perhaps this should not be overly surprising, given this study revealed that only one of the councils had an effective monitoring system to account for its energy and GHG emissions reduction progress. This points towards a need for a combined asset and energy management system that would help facilitate improved decision making and address many of the internal technical, financial and governance obstacles.

The external operating and regulatory environment of the electricity sector is both complex and inherently wedded to conventional centralised energy generation (Warren et al., 2016; TEC, 2009, 2010; IPART, 2002). Market pricing of centralised electricity and its distribution continue to remain a major impediment that is further worsened by low feed-in-tariffs, prohibitions of sharing of locally generated energy among sites of the same owner, unavailability of virtual net metering and the non-grid parity of power-storage technologies. Individually and collectively these present particular barriers to local government with highly distributed assets and energy needs. Even with joint-procurement programs, the economies of scale that can be generated through aggregation may not be sufficient to break these sector norms. As revealed in this study, many of the existing structural components of the electricity market that prompted the need for a joint-regional approach for conventional electricity supply contracts have paradoxically become an obstacle for a transition to a higher share of RE. The joint-regional approach to securing a cheaper fossil-electricity supply contract is now compromising the potential advantages of the current grid-parity RE options under normal market conditions.

[19] Technical potential: installable roof space does not account for the onsite consumption pattern and feed-in-tariff economic relationship, the grid's capacity to accept all the renewable power feed-in and competing demand for roof space from solar hot water.

6. Conclusions and recommendations

Sustainability motivations were the major driver for council officers' to advocate for and participate in the regional approach to RE master planning. This corresponds with the public service motivation concept (e.g. Vandenabeele, 2007) and in this study specifically revealed the importance of environmental responsibilities to climate change, the value of institutional leadership and recognition of financial constraints and seeking opportunities to overcome these to fund RE projects.

At a governance level, all councils had ambitious RE and GHG reduction policies, although progress towards targets was limited and even more so where a council did not have dedicated RE funding reserves, such as an internal revolving energy fund. The absence of a hypothecated reserve to allocate funding towards RE projects also impacted on the preferred contractual model as part of the joint procurement process that was not flagged at the beginning of the project but emerged at the end. Those councils with an internal revolving energy fund preferred a capital purchase contract, while those without were more inclined towards a zero-upfront contract which also had longer payback periods. Such a disagreement has the potential to challenge the viability of a project installation. This issue highlights a collective disconnect between longer term policy priorities and the associated targets and how these are funded through the annual budget process.

Joint tendering has been a successful model through which groups of councils have been able to procure more favorable prices for goods and services, including energy. This study revealed past regional joint-tendering delivered a below-market price supply contract of fossil-electricity that is likely to have an adverse impact on the financial feasibility of many RE projects. The financial viability of RE is significant for councils given that regional bargaining power was seen as the most important economic driver for the 'Our Energy Future' master plan. Looking forward, procurement contracts for both renewable and traditional energy services could be coupled so as not to create an 'internal competition' and prioritise a council's energy policy outcome.

Funding for RE projects within the councils in this study remain tied to commonwealth or state government grants typically as a co-leverage contribution to support its financially viability. This underscores the pressures faced by the LG sector which are unable to fully deliver on their multifaceted service obligations and policy commitments. External grants, or in effect subsidies, are needed for local government to support the RE transformation process and fulfil their potential as a sector able to reduce GHG emissions.

Resolving the external energy market and technological barriers remain the final issue identified in this study. While councils have the authority to make decisions and implement local energy transition plans (such as the OEF master plan of SSROC), our study shows there is a complex web of market and technological barriers, that should be investigated more thoroughly in future work. Councils need to better understand their own energy demands that in turn will optimise site-by-site RE installations. Presently the state government set feed-in-tariffs are low and preclude the financial viability of many RE projects, where a building may have roof space (capacity) to generate electricity but not the demand to use it. This can be overcome through various policy and market interventions including the support of private wire systems linking buildings, allowing councils (and others) to balance out their combined site based RE generation and demand across their property portfolio and through technology innovations such as utilising battery storage as a means to offset market restrictions. Future research should be helpful to better understand the additional benefits and optimal strategies for implementation of RE projects in combination with batteries.

The energy sector is undergoing rapid change, as evidenced by the Our Energy Future regional strategic plan and procurement strategy. We acknowledge that the installation of rooftop solar-systems by local government is not transformative on its own right but may serve as a catalyst for a greater emphasis on the development of a decentralized energy systems in cities through more expanded regional collaboration and supporting structural changes to the physical and institutional systems that govern the Australian energy market.

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Appendix A

MCGDM model selection and construction approaches

Model Selection

The process of tendering, evaluation and selection of an appropriate supplier for the long-term Our Energy Future master plan, encompassing the five member-councils of SSROC, involves many stakeholders and multiple-evaluation criteria that entail the use of specific instruments to choose an optimal option (Polatidis et al., 2006). Multi-criteria decision analysis (MCDA) provides a reliable methodology to rank alternative options in the presence of numerous objectives and constraints (Haralambopoulos and Polatidis, 2003; Huang et al., 1995; Lootsma et al., 1990; Siskos and Hubert, 1983). However, despite many available MCDM methods, none of them can be considered as superior for all kinds of decision-making situations (Guitouni and Martel, 1998; Salminen et al., 1998; Simpson, 1996).

It is crucial to choose an appropriate MCDM methodology in the context of the objectives for the decision-making processes. To assess and select an appropriate RE supplier, a combined Analytic Hierarchy Process (AHP) with group decision-making is considered. The choice is based on its ease of applicability and the multi-criteria structure which follows an intuitive way to adopt both qualitative and quantitative judgement scales and weights. Hereby, information on preference for the different evaluation criteria is provided by a diverse set of stakeholders. The benefit of group hierarchy of scale can reduce ambiguities and provide explicit consistency, whereas weight aggregation can reflect consensus in reaching a group compromise (Alencar and Almeida, 2008; Choo et al., 1999; Ishizaka and Labib, 2009).

Model Development Approach

Two focus group workshops with participants from the evaluation-panel members were facilitated to construct a tailored MCGDM model. The three AHP basic approaches of problem modelling, weight valuation and aggregation were adopted. The goal and all the corresponding criteria were identified and grouped together according to their nature and relationships in the first workshop. These groups of criteria were then streamlined and structured into a hierarchical order of criteria and sub-criteria. The first version of the tree structure was communicated to the panel for further discussion and improvement. The assignment of weights and aggregation rules were completed at the second workshop through group discussion and consensus. Table A-1 is the final hierarchical structure of the model which was guided by a detailed SSROC internal evaluation procedure, manually laying out evaluation methods, rules and setting well-defined numerical values (0–5) for each Tier-3 sub-criterion (manual developed internally).

Each assessor was given a scoring sheet to record their individual scores which was then aggregated into group values for each Tier-3 sub-criterion, and then averaged as group consensus score for each Tier-3 criterion. The final ranking score for each suppliers were obtained through additive aggregation as per weighting factors assigned in Table A-1 up the hierarchical tree.

Table A-1
Multicriteria group decision-making model for evaluating renewable energy suppliers

Tier 1 Criteria	Tier 2 Criteria	Tier 3 Criteria
Economic aspect 50%	Energy cost performance 40%	LCOE (price/kwh) – 30%
		Contract term to own energy systems – 5%
		Discount rate used – 3%
		Assumptions, life span of components – 1%
		Generation capacity and degradation rate – 1%
	Operation & maintenance cost 10%	Maintenance cost and frequency – 5%
		Inclusion and special conditions – 5%
Technological aspect 20%	System components 8%	Brand/quality – 6%
		Capacity to add storage – 1%
		Other advance features – 1%

(*continued on next page*)

Table A-1 (*continued*)

Tier 1 Criteria	Tier 2 Criteria	Tier 3 Criteria
	Warranty period	System components warranty – 3%
	6%	Installation workmanship warranty – 3%
	Energy data provision	Data generation and integration for monitoring purpose – 3%
	6%	System performance guarantee/data – 3%
Supplier capacity 30%	Company profile	Length of business and financial capacity – 5%
	15%	Customer base and references – 5%
		Local/international – 1%
		Product stewardship – 2%
		Corporate social responsibility – 2%
	Project management capacity	Project team/resources – 10%
	15%	Project implementation approach and indicative timeline with milestones – 5%

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