GOVERNANCE MODELS SUPPORTIVE OF DISTRIBUTED GREEN INFRASTRUTURE FOR DECARBONISED RESILIENT CITIES

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1. INTRODUCTION

Local governments are exploring various carbon reduction strategies to achieve low or even zero carbon urban development that offer a higher quality of living than typical 'business-as-usual' development approaches. Municipalities are also concerned with building capacity to withstand changing climate by increasing the physical resilience of urban infrastructures (McDaniels et al. 2007). Redesigning low-carbon city centres with distributed infrastructure networks is gaining increasing interest, as well as improving resource flows that foster community resilience and improved energy, water and waste services (Biggs, Ryan et al. 2007; Ren and Gao 2010).

Compared with traditional central energy supply, distributed systems can employ a wide range of technologies for low carbon society construction including: combined heat and power plants (CHP), photovoltaic systems (PV), small wind turbines and other systems using renewable energy sources, (e.g. biogas digesters) (Ren and Gao, 2010). The distributed water system approach is called 'Water Sensitive Urban Design' and uses the full water cycle, from rain and local water sources like groundwater, to recycle grey water and blackwater to ensure water usage is reduced (Newman 2009). These alternative models of power for water supply, wastewater and waste treatment are referred to as 'green infrastructure' and the term is typically based around the principles of decentralised infrastructure (PB and CUSP 2010).

Centralised production relies on extensive infrastructure to transport energy and water lengthy distances in a linear and isolated manner; this is wasteful because of line losses and power shedding, whereas distributed power and water systems are tailored to match localised demand and resource availability (Newman 2009). Small-scale generation close to load creates significant efficiencies, allowing in the case of distributed energy the recovery of heat, otherwise wasted (CSIRO 2009). The system resembles more closely the circular metabolism approach of natural ecosystems that use outputs of various processes as inputs for others (Jones 2008). Green infrastructure is linked to the concept of sustainability as it typically aims to "reduce resource consumption, cost of supply, reduce cost of treatment and reduce carbon footprint whilst ensuring liveable qualities (PB and CUSP 2010)."

In Australia, there is a significant role for distributed green infrastructure services in achieving carbon emission reduction targets. Recent reports suggest cogeneration technology could provide a 20% reduction in electricity demand over a 15-year period (Nous Group 2007). Yet, minimal policy has been put in place to realise this value. Since privatisation, government has been reluctant to intervene in an energy market established for large, centralised utilities (Thompson 2008). However, opportunities provided by new technologies and the pressures of climate change are prompting local authorities to explore alternative governance strategies to deliver energy, water and waste services.

The emergence of distributed green infrastructure systems pose a unique set of challenges for its implementation and management and these are generating new modes of multi-level governance at national, regional and local level (Gough et al. 2008). This study examines the emerging shift towards distributed infrastructure systems and the parallel transition that is occurring towards decentralised forms of governance to support climate change strategies such as, low carbon urban development. An examination of various case studies of urban development in this paper, will demonstrate certain trends of governance emerging that have significantly impacted the establishment of distributed power and water services and dramatically reduced carbon emissions.

2. DISTRIBUTED GREEN INFRASTRUCTURE

2.1 Role of Infrastructure for Low Carbon Urban Development

The dynamics of urban infrastructure systems can be understood rather than simple physical entities but as 'socio-technical regimes' that while facilitating large resource flows also contribute immensely to environmental problems such as air, water and soil pollution and global warming (Monstadt 2009). Infrastructure networks shape urban settlement, mobility, construction engineering and technology innovation (Monstadt 2009). They thus play a significant role in socio-ecological issues like climate change and therefore urban governance needs to recognise their impact on carbon emissions and consider restructuring infrastructure in its carbon management strategies (Monstadt 2009). Although infrastructure systems have substantial implications for urban governance, until recently, they have attracted little attention in contemporary governance studies (Monstadt 2009).

2.2 Centralised and Distributed Energy Infrastructure

Conventional centralised electricity in cities relies on coal-fired power for its generation and is the largest contributor to the build-up of carbon emissions in the atmosphere. It is extremely inefficient as 2/3 of the energy generated as heat is rejected as steam through cooling towers or water-cooling systems (Jones 2007). A further 9% loss of energy occurs in the grid transmission (2%) and distribution (7%) networks so that less than 33% of the energy delivered is consumable energy (Jones 2008). These energy systems are inherently inflexible and can be easily damaged (Biggs, Ryan et al. 2008). A disruption in one area cascades into impacts on other areas (Cutter et al. 2008) and therefore, they are particularly vulnerable to climate-related catastrophes (Vogela et al. 2007) or even terrorist attacks (Newman 2009).

Decentralised energy services are connected to the distribution network not the national grid transmission network. They typically involve combined heat and power (CHP or cogeneration), combined cooling, heat and power (CCHP or trigeneration), renewable energy and fuel cells. This system avoids grid losses by generating and supplying electricity nearby consumer loads and using the recovery of waste heat from power generation to provide additional heating, hot water and cooling services to customers rather than just electricity. This scheme results in up to 90% efficiencies (Jones 2008) and provides value to customers whilst enhancing the financial viability of decentralised energy (PB and CUSP 2010). The threat of climate change along with national security is influencing governments to consider distributed energy systems as a viable alternative because they offer structural robustness, low cost, reliable operation and significant carbon reduction opportunities (Yazdani and Jeffrey 2010).

2.3 Barriers to Distributed Services

The cost for decentralised energy services is very different from licensed central energy schemes because distributed services are delivered via the retail of heating, cooling and electricity directly to customers, which provides access to a higher price per unit above sale into a wholesale market (Thompson 2008). Since distributed energy services involve a different energy market a unique regulatory status should be provided (Jones 2007). However, current market barriers and high costs all deter development in decentralised energy schemes and disadvantage their potential for achieving carbon reduction goals (Jones 2007).

Like energy, possibilities for incorporating green infrastructure strategies for water at the precinct scale are principally reliant on demand and supply. On-site waste-water treatment technologies share similar barriers to decentralised energy systems associated with scale, viability and lack of information and public confidence in schemes. Decentralised water systems can greatly impact the up-front capital costs of a project and may not initially provide the economies of scale inherent in bigger centralised schemes. In Australia, decentralised waste-water projects are also confronted with numerous regulatory issues in relation to regulatory regimes where large-scale, conventional centralised administration of waste-water generation is the standard model. (Sustainability Victoria 2011).

New governance approaches are required such as, electricity regulatory and licensing systems to allow medium and larger decentralised CHP or CCHP schemes to participate freely in the energy market. Markets function at their optimum when they remain competitive without barriers to entry for new entrants within the market and with prices and quantities traded that reflect supply and demand conditions (ESAA 2009). Establishing incentives in the regulatory system for innovation and the introduction of new 'smart grid' technologies will assist network service providers to better manage distributed energy generation (ESAA 2009).

3. GOVERNANCE

3.1 Multi-level Governance

The term 'governance' refers to an approach or perspective to examine issues relating to the governing process (IEA 2009). Governance perspectives are no longer based on hierarchical, authoritative and linear control but new governing processes are concerned about flexibility, decentralization and networked specialization (Metzl 2001). Governance literature is interested in the flexibility of social systems to deal with changes; openness of institutions to provide broad participation of different actors; effectiveness of individual actors to interact at varying scales; social structures that promote learning and adaptability without limiting options for future development (Bulkeley and Betsill 2005; Walker and Salt, 2006). In this study, multi-level governance can be understood as the complex system of interactions between actors at all levels of government, engaged in the exercise of authority (IEA 2009).

This emerging shift towards a multi-layered and cooperative style of governance has parallels to the increasing preference for a distributed systems approach to energy infrastructure networks rather than centralised electricity generation (Briggs et al. 2008). For example, in a distributed model, more actors are employed at a local level and as specialised 'niche' operators rather than generalised; agents are situated within networks of resource and information exchange rather than isolated and hierarchical; and this reflects a system of co-dependency that links diverse organisations and increases the potential for improved mutual learning, cooperative management and innovation (Briggs et al. 2008). Coordinated action between multiple levels of government can help with improved access and implementation of distributed energy systems (Alber and Kern 2008)

3.2 Local Government Models for Ownership and Operation of Distributed Green Infrastructure

Local governments have traditionally held significant roles in providing essential services to residents such as, utility provision. Local government municipalities were often in the best position to expand local infrastructure networks, thereby ensuring public access and regulating prices (PB and CUSP 2010). Services were mainly administered by state owned utilities that controlled resource delivery to customers (PB and CUSP 2010). However, deregulation of electricity markets over the past 15 years has inspired an increasing range of municipality ownership models, including a variety of options for ownership and operation of utilities that provide viable structures to establish and manage decentralised energy systems, these include:

- **Model 1:** Full ownership, operation and administration directly within local government.
- **Model 2:** Local government ownership, private sector partner operation.
- **Model 3:** Total ownership and operation of the utility by local government through a wholly-owned subsidiary.
- **Model 4:** Partnerships with private companies, involving less than total ownership by the local government (Community Energy Association 2008). Often involving an Energy Service Company (ESCO), allows governments to retain some level of control whilst transferring technical and commercial risks to the market (PB and CUSP 2011).
- **Model 5:** Private owner/retailer models – involve distributed systems that are owned and operated by a private company and sometime also designed and built (PB and CUSP 2011).

These models will be highlighted in the below case studies.

4. CASE STUDIES

4.1 Borough of Woking, UK

The Borough of Woking in the UK has removed the entire community off coal-fired grid by installing a small district electric and heating utilities based on cogeneration (Jones 2010). It reduced carbon emissions by a staggering 80% in 2007 compared to 1990 base-level emissions and achieved cost savings of nearly £4.9m (Jones 2010). Over a period of 14 years, 81 co and trigeneration units were established and connected over a 'private wire' system to provide economically viable, efficient and resilient electricity, heating and cooling services to residents (Jones 2010). Through the UK Electricity Order 2001, the Council could generate, distribute and supply electricity directly to customers at economical rates (Jones 2010). The local government established partnerships with the private sector to finance a revolving fund for CHP schemes, these delivered sufficient energy gains for savings to be reused as revenue for other energy efficiency and renewable energy projects. Importantly, the Council's strategy did not rely on government funding to initiate action and instead it used local investment (seed funding) to build-up capacity as a framework for long-term investment and action in carbon emission reductions.

By establishing its own operated municipal utility, the local government owned the generation and distribution assets and thus had direct regulatory and operational control and could make its own technology choice decisions. The Council had the power to fix rates to ensure customers experienced immediate savings over the previous system, which in turn, generated community support to further expand the decentralised utility projects. This (Model 1) excludes the establishment of a separate legal corporation to manage the utility and offers flexibility and synergies with other local government operations, for example staffing may be reduced, as staff can be incorporated across the utility and other operations (Community Energy Association 2008). However, in directly owning and operating the energy utility, the local government adopts all the risks, both financial and legal related to operating an energy business. So, the Council needs substantial in-house expertise to commission, design, build and operate the scheme (Community Energy Association).

The Borough of Woking later partnered with Denmark's Energy Services Company (ESCO) Thameswey Ltd and Thameswey Energy Ltd to contract out the servicing and operation to a third party (Model 4). This enabled them to increase resources and the scale of generation more than what could be delivered by using only public sector finance, as well as improve management of the utilities. By partnering with a private sector partner corporation, the Council could also lower liability and risk than direct operation and benefit from the expertise of the private sector. The ESCO provided the framework to design, build, finance, operate and maintain small-scale CHP facilities of up to $5MW_e$ electricity output at relatively cheap capital (PB and CUSP 2010). Under an enabling agreement for exempt supplier operation with EDF Energy, the interconnected infrastructure, buildings and thermal networks could exchange energy via the distributed generating sites as a shared local electricity trading scheme, which involved an advanced building energy management system (BEMS) to control the system (Jones 2010).

4.2 London, UK

Woking's role in pioneering a path for decentralised energy within UK's privatised energy market inspired action across London. Similar to Woking, London could distribute and supply electricity to consumers through the UK Electricity Order 2001. However, regulations restricting CHP connection to only 1,000 households were unsuitable for London's high density. It is more cost and energy efficient to install larger CHP and CCHP, multi-utility schemes (including electricity, heating, cooling, air-conditioning, water supply, data and telecom) than small facilities restricted to individual buildings (Carr 2007). These regulations and high costs to decentralised energy within the UK electricity market and licensing arrangements created barriers for installation of London's intended site wide approach.

In 2006 London set up a joint venture ESCO with the London Climate Change Agency (LCCA), for private sector finance, and with EDF Energy, a major UK energy company who owned the London, Eastern and South-Eastern district networks to design, construct, install, operate and maintain a large-scale decentralised energy plan (Model 4) (Jones 2010). London's joint equity project meant their partners could share their risk and the local government could benefit from the private sector energy and finance expertise, as well as reduce the municipal's capital requirement. However, although under this model the local government retains some control for example through setting bylaws and operating policies, it is constrained by contracts signed with the service provider (Community Energy Association 2008).

The LCCA and the Major of London joint lobbied for a reviewal of barriers to service provision. In addition, a Working Group in 2007 was formed and with EDF as a major energy partner review processes were facilitated. These tactics resulted in the emergence of a new supply licence that permitted decentralised generators to operate above the public wires distribution network instead of the transmission network and thereby, avoid the nationalised centralised electricity market (Jones 2010). In 2009 existing supply licences were changed through the UK energy regulator Ofgem, to permit licenced utilities to work with distributed energy generators in an electricity trading system that balanced imports and exports between sites. Eighty-one decentralized energy plants across London now exchange surplus electricity with standby and top up energy groups (Jones 2010). Ofgem also introduced a cost reflective charge in 2010 to account for the short distances travelled by electricity via distribution networks compared with grid electricity (Jones 2007). London currently uses a combination of 53% decentralized energy and 47% large scale renewable energy in its bid to achieve the 60% reduction in carbon emissions by 2025 target that is proposed in the Mayor's Climate Change Action Plan (Jones 2008).

4.3 Sydney, New South Wales, Australia

Sydney's 'Green Transformers' program, plans to install a precinct-based trigeneration scheme, as well as waste to energy plants and water treatment to provide localized electricity, heating and cooling and recycled water services (Jones 2008). The New South Wales (NSW) non-regulatory barriers to distributed energy generation have traditionally involved excessive technical requests and high connection costs that were disproportionate to the size of the schemes (Jones 2008). These obstacles typically discouraged users and NSW had no suitable regulations to avoid anti-competitive conduct by distribution network operators (Jones 2008). Although Sydney City lacked the statutory powers of the Mayor of London, it used a planning and development strategy to incite public discussion and motivate change (Jones 2008). The municipal also applied pressure to remove regulatory barriers by holding meetings with the NSW Departments of Energy, Climate Change and Water and the Premier's Office and through a formed Working Party (Jones 2008).

Sydney established a municipally owned company led by the Lord Mayor, called the Sydney Climate Change Agency Ltd (SCCA) to implement public/private joint venture carbon abatement projects (Jones 2008). The SCCA formed an ESCO with Energy Australia to facilitate trade and supply of electricity over the public wires network at retail prices (Jones 2008). Although distribution use of system (DUoS) charges still applies for Energy Australia, the sale of electricity at retail prices means its value has increased by 400%, which overrides any potential loss of DUoS income for Energy Australia (Jones 2008). A request for tender is currently being launched by Sydney Council to test the market for utility companies who can design, install, operate and maintain decentralized energy networks across the City of Sydney Local Government Area (LGA), starting first with Council buildings. The request requires the tenders to provide both a Council Owned Model (Model 1 or 2) and Private ESCO Model (Model 4) in their applications. So far, the Council has received a submission from the company Cogent Energy Pty Ltd. The trigeneration network is estimated to supply 330MWe of power by 2030, which is 70% of Sydney's required electricity, reduce 20% GHG emission, and provide thermal energy to 36% dwellings and 43% non-residential buildings. When combined with renewable energy supplies, Sydney could possibly relinquish its coal-fired power dependency (Jones 2010). In addition, the Council's Trigeneration project will significantly reduce its exposure to a price on carbon, in regards to the Australian Government's carbon price scheme that has just been announced.

4.4 Moreland City, Victoria, Australia

Business-as-usual projections show that the Moreland Council's energy costs are likely to increase by about 1 ½ to 2 times by 2020. So the Council has been exploring energy saving options to reduce their carbon emissions and save their ratepayers money. The Moreland City Council (MCC) and Moreland Energy Foundation (MEFL) have developed a joint venture project for a co-generation plant at Fawkner Leisure Centre to supply low carbon energy to the surrounding neighbourhood. Heat from generation will be used to warm the pool. MEFL will fund the initial $450,000 establishment costs of the plant from existing grants and the Federal Government's Solar Cities program will provide a grant of $105,000. The cogeneration plant is estimated to reduce the center's carbon emissions by more than 45 per cent and save about $60,000 a year. This revenue will be recycled back into other community energy and emission reduction projects in Moreland (MEFL 2011).

This project is part of an energy services agreement between MEFL and MCC called Moreland Energy Services (MES), whereby the utility MES receives the ongoing revenue from savings delivered to MCC through MES projects (Model 4). This revenue will pay MES's costs and deliver a community dividend to the Moreland community to fund further community emissions mitigations projects. MES will establish a Special Purpose (SP) Fund to manage both seed capital and revenue (MEFL 2010). The model has the ability to deliver results on smaller projects that would not merit the attention of a commercial energy services contractor (MEFL 2010). MEFL has taken the principle concept of energy services contracting and instead of using a private sector partner it is implementing this strategy with a not-for-profit agreement approach. MCC operates a variety of facilities that use energy to provide services to occupants and users, while MEFL is experienced in costing, delivering and monitoring the benefits of low carbon energy related projects in Moreland (MEFL 2010). Figure 1 below illustrates the governance structure.

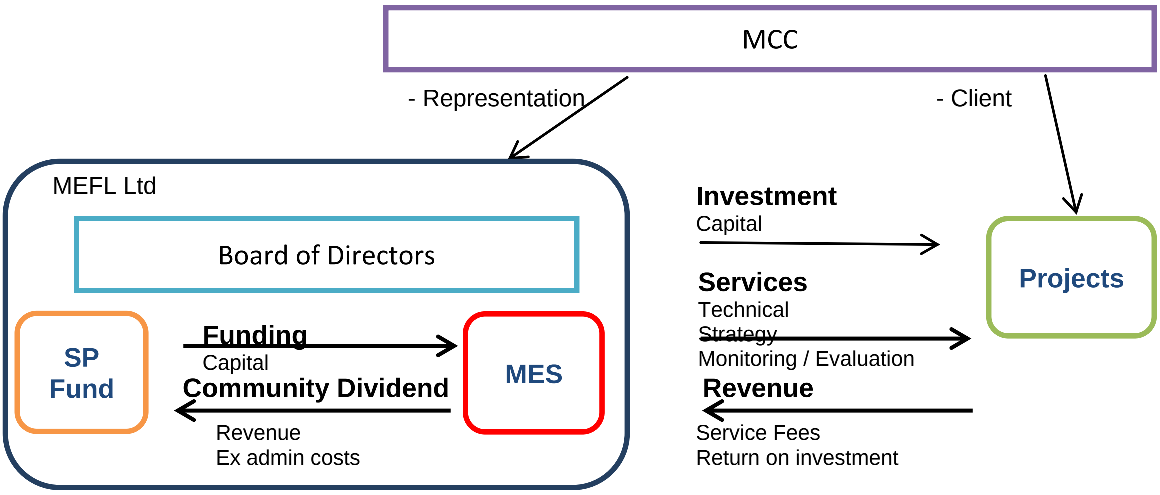

Figure 1. MEFL Government Structure. Source: (MEFL 2010).

The pilot project signifies the first time a Victorian Council and not-for-profit sustainable energy organization have collaborated to develop a carbon neutral precinct (MEFL 2011). These local power projects based on are predicted by Foundation chief Paul Murfitt to become the key to a sustainable future (MEFL 2011).

4.5 Augusta - Margaret River, Western Australia, Australia

Experiencing increasing reductions in rainfall, Western Australia (WA) can no longer sustain its current patterns of water use (Prangnell 2009). The National Water Initiative (NWI), State Sustainability Strategy, State Water Strategy and South West Water Strategy all identify the need to increase water recycling in Australia, Western Australia and the South West region (Prangnell 2010). The Shire of Augusta Margaret River has demonstrated outstanding leadership by developing an alternative model for small-scale distributed water supply, wastewater treatment and water recycling at Gracetown and Witchcliffe town (Prangnell 2009). Working with developers and the State Government, the Shire has opened its new town water recycling scheme, delivering recycled water to parks, sporting facilities, schools and the golf course. It builds the region's capacity to accommodate population growth and increasing demand for quality recreation and sporting amenities, whilst reducing impacts on potable and river water supplies by eliminating extraction of water from Margaret River and local ground water aquifers during summer for irrigation at a time when river flows and water availability have significantly dropped with decreased rainfall (Prangnell 2010). The Margaret River Water Recycling project will save 180ML per annum based on current irrigation demands and help to protect endangered species (Margaret River Hairy Marron and Lamprey Eel) and natural ecosystems (Prangnell 2010).

The new approach challenges assumptions about regulations and licensing that have held back development of recycled water services in WA. Usually, conventional water services would require that a water main from Margaret River provide scheme water as well as a sewer main to deliver wastewater back to the Margaret River Treatment Plant. This would mean pumping water and sewerage 23km to and from Gracetown and 10km to and from Witchcliffe. It would also require extracting even more water from the environment and involve high infrastructure costs and energy use (Prangnell 2009). The Shire has decided to introduce a new approach for water supply with a wholly owned and run decentralised water service, which demonstrates how such a scheme can work where lack of infrastructure has previously been an obstacle (Prangnell 2009).

Witchcliffe Developers involving Redgate Estate Pty Ltd and Redgate Developments Pty Ltd are funding the initial capital costs of the scheme as part of the Witchcliffe Village development and ownership of these assets and infrastructure will then be transferred to the Shire (Prangnell 2011). The Shire has an existing governance system, which can financially manage the water service business, including billing (Witchcliffe 2011). In this model the Shire owns the facility so it can guarantee a sensible margin for the scheme and a fair price to end users (Witchcliffe 2011). This model (Model 2) contrasts to the WA Brighton Estate development by Satterley, whereby developers paid for the capital costs of a third pipe recycled non potable water system and then ownership was transferred to the Water Corporation who collected ongoing revenue, which is a more typical process in WA (PB and CUSP 2011).

Finding a reliable utility to take on responsibility of the operation of the scheme was a challenge, as usually Local Governments in WA do not offer water services. The Water Corporation holds a monopoly as the only licensed service provider in the region and the main water service provider in the state (Prangnell 2009). So, it was not in the Water Corporation's interests to build a new plant or water recycling services for Gracetown and Witchcliffe (Prangnell 2009). To ensure the project was not jeopardised by this challenge, the Shire undertook an extensive tender review to choose its own water service provider. The global service provider, United Utilities Australia (UUA) was selected for Gracetown and Witchcliffe. As the licensee, UUA ensures the income streams insure costs and risks are handled and accredited (Witchcliffe 2011). The Shire bears minimal financial risks as all costs can be regained through rating of property in the service district (Witchcliffe 2011).

The approval process was made difficult by the fact that most organisations (with exception of Department of Health) had no approval processes and were not familiar with water recycling projects (Prangnell 2010). This project has thus streamlined the process to some degree for other water recycling projects. As well as being the first example of recycled water to a residential development in Western Australia, these towns are also the first example in WA of a private company becoming a licensed water service provider by the Economic Regulatory Authority (ERA), which is also an operator of the system on behalf of the Shire who is the owner of the asset (Prangnell 2009). Funds to operate the service and for asset renewal and replacement will be funded through service charges and consumption charges levied on serviced properties. The operational costs and asset replacement will be recovered through these service and consumption charges. The service will not require additional Council or Government provisioning subsidies (Witchcliffe 2011). Figure 2 below illustrates the governance structure of the Witchcliffe water scheme.

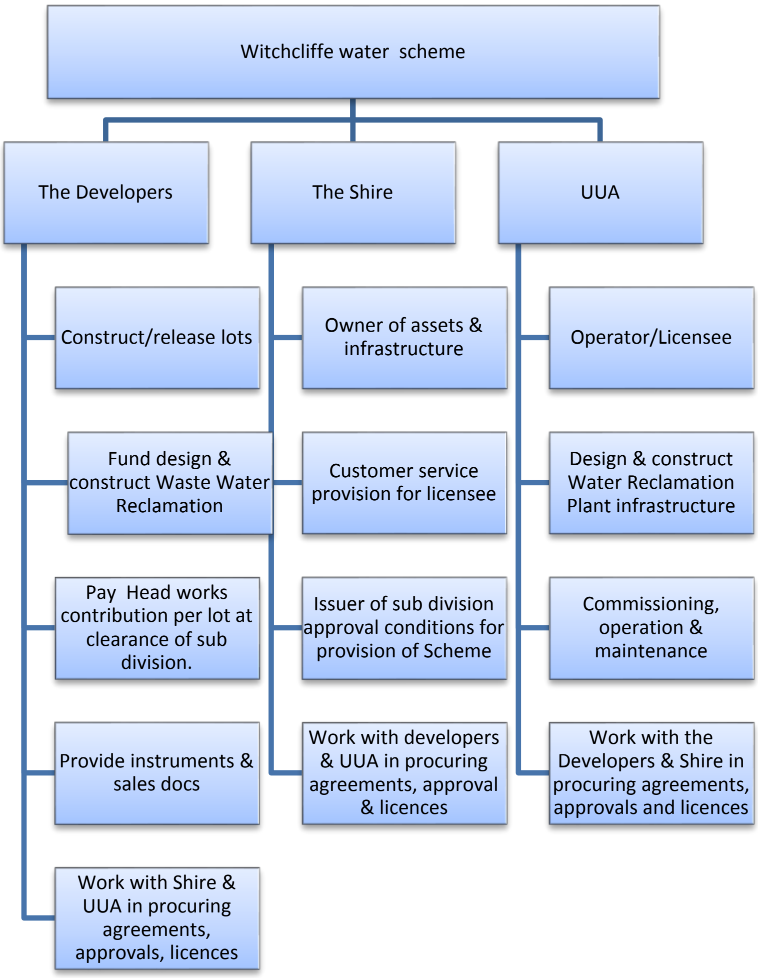

Figure 2. Roles and responsibilities of stakeholders in Witchcliffe Water Scheme. Source: (Witchcliffe Shire 2011).

4.6 Point Grey, Western Australia

The Point Grey new residential development south of Perth is an example of Model 5 - of a private owner/retailer model whereby a distributed system is owned and operated by a private company. Due to excessive costs for connecting to the conventional Water Corporation's infrastructure scheme, the property developer Port Bouvard has acquired a licence to establish its own onsite production of drinking water from groundwater and the treatment and reuse of wastewater within Point Grey development for irrigation and sewerage services (Pownall 2011). Port Bouvard has set up a wholly owned subsidiary utility called Peel Water Company to be the water service provider, which is cheaper than Water Corp and the developer can retain the water assets rather than transferring responsibility for its maintenance and management to the state (Pownall 2011). Water treatment experts Veolia Water have also been contracted to share responsibilities of site operator, while Permeate Partners will provide the ongoing technical support. Figure 3 illustrates the governance structure of the Peel Water company associated with Point Grey development site.

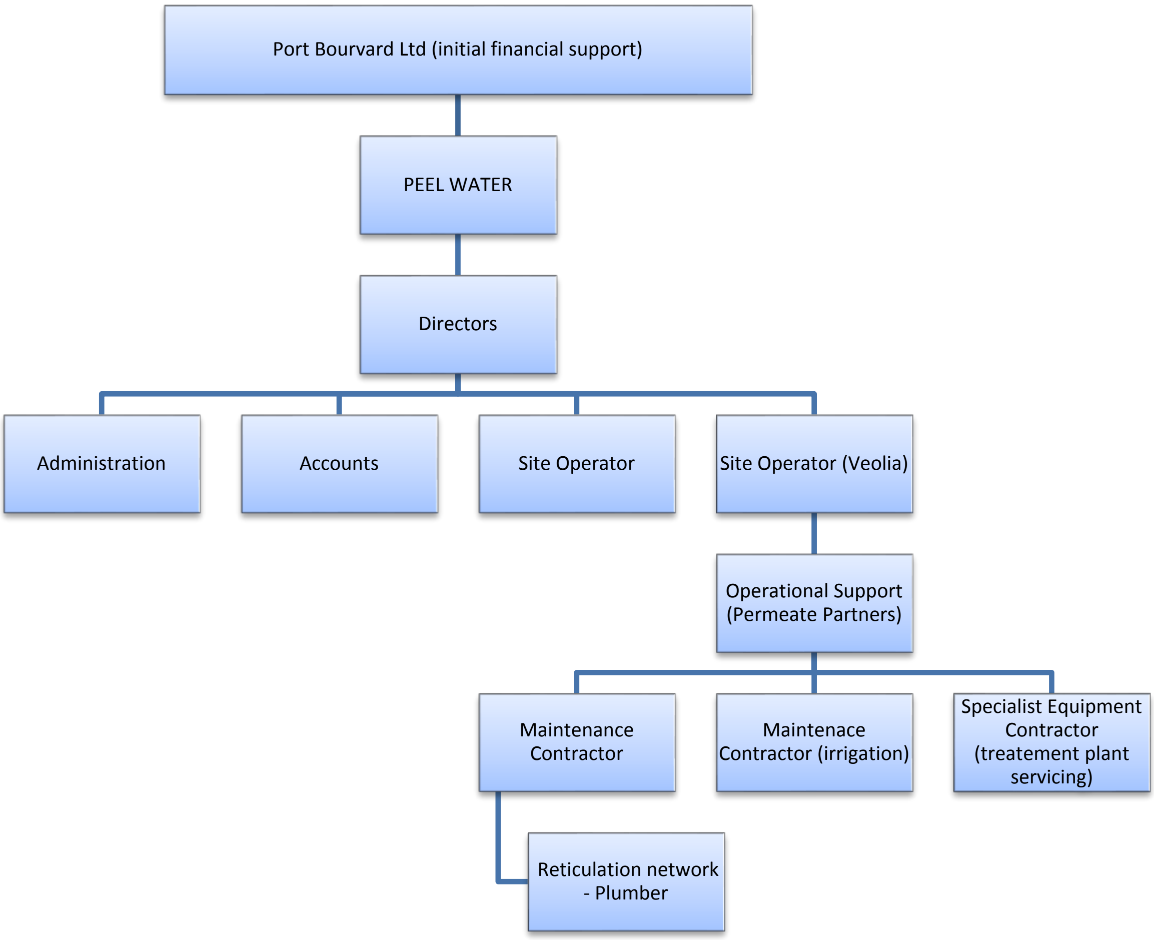

Figure 3. Peel Water governance structure (Source: Pownall 2011).

5. DISCUSSION

In Australia, decision-making tools including planning and government proposals are geared towards centralised, business-as-usual infrastructure and can be biased against decentralised sustainable infrastructure proposals; these impediments contribute to increased project costs and can greatly impact viability. Proposals containing sustainability features require more time from government officials to assess and in some cases, sustainable technology is disadvantaged by traditional cost-benefit methodology, which discounts non-monetised sustainability benefits (Sustainability Victoria 2011). Additional challenges include time delays on gaining approval requirements for sustainability technology due to a lack of precedent and sometimes new policy or regulation needing to be created – causing another disincentive (Sustainability Victoria 2011). Tender processes for innovative developments can also be jeopardized by a lack of confidence and familiarity with sustainable technologies in the sector (Sustainability Victoria 2011). The most significant barrier to decentralized energy is the economic barriers in the National Electricity Market, which requires the Australian Government, to take similar action to the UK Government and remove them.

In regards to Western Australian significant reforms are required to the WA energy market to create an open and contestable market with improved network regulatory regime that has fewer barriers for entry especially for smaller scale distributed generation (WASEA 2009). Access restrictions due to network constraints currently impede development of distributed energy options. Tariffs are not cost reflective, instead they are set below cost of generation and a distributed service provider receives no financial reward for deferring capital infrastructure (WASEA 2009). Building incentives within WA's regulatory regime for new 'smart grid' technologies, such as a gross feed in tariff will incentivize the development of district energy saving schemes and improve management of increased distributed energy generation (ESAA 2009). For example, the Renewable Energy Buyback Scheme is not offered to commercial premises. Larger decentralised schemes should be able to avoid shared costs with the centralized energy market through license exempt status. The current Government ownership of Verve and Synergy causes significant market distortion that disadvantages potential new market entrants and these subsidies and biases continue to exacerbate the distortion. For fair competition subsides for fossil fuel should be removed on the supply-side to make a truly cost reflective price available. If the subsidies are not removed then further support needs to be provided to alternative sources of energy to ensure more rigorous competition (SEA 2011). Current regulations prohibit the sale of electricity by independent providers to retail customers as Synergy holds a monopoly over this and therefore economic feasibility may rely on identifying a commercial customer through a Power Purchase Agreement (PB and CUSP 2011). In addition, the rapidly changing and uncertain policy context, particularly at Federal level, is creating another obstacle to investment in the sector. So, there is an urgent need for all levels of government to commit to stable long term arrangements.

The Energy Minister Peter Collier has announced plans to expand the range of energy supplies for WA's electricity retailer – Synergy and increase competition in the State's energy market (DPC 2011). Synergy is searching for a diverse and secure source of energy from new and existing market participants to provide in excess of 1,000 megawatts of renewable and non-renewable generation as part of the ''Powering WA's Future Initiative,' (DPC 2011). The change may reduce barriers to distributed power generation and open up opportunities for private sector generation and sale of co or tri generation energy within developments, such as City of Stirling and Cockburn Coast in Perth that aim to integrate clean, green energies.

Western Australia's largest impediment for implementation of recycled wastewater is the Western Australian (WA) Department of Health, which legislates the use of A-class standard treated wastewater for only irrigation, blocking it for other services such as toilet flushing or clothes washing. This regulation exists even though other Australian states have approved the use of A-class treated wastewater for these applications (PB and CUSP 2011). The barrier means WA developers currently have no incentive to provide a third pipe recycled non potable water supply system for wastewater treatment to improve water security (PB and CUSP 2011).

6. CONCLUSION

This study has explored some of the opportunities available for distributed energy systems by reviewing case studies of existing and proven developments, which have all brought together important governing elements. Benefits of local ownership and operation of utilities and the provision of district energy services to the community have been discussed, highlighting their ability to offer local government considerable control over the scheme and reinvest revenue back into community climate change projects. A popular choice for implementing distributed infrastructure schemes for local government appears to be an ESCO approach, as it lessens the responsibility and risk of the scheme for Council and allows local government to benefit from added financial resources and expertise from the private sector.

The case studies have demonstrated that in addition to market barriers, it is necessary to navigate regulation specific to the technologies because many of the technologies have not been commercially or widely adopted. This causes a lack of precedent for government officers to make approval and licensing decisions (Sustainability Victoria 2011). Crucial to the case study achievements has been effective policies, government leadership, application and integration of technology, sound economic models and an engaged community.

Woking's joint equity partnerships through the Thameswey Ltd ESCO provided not only investment in exchange for an ownership share of the project but also the finance and expertise of the private sector to implement district scale renewable energy projects. London demonstrated the capacity to look beyond immediate, bottom-line considerations and balance investment return with customer rates to improve infrastructure development and dramatically cut carbon emissions. Whilst identification and removal of specific deterrents is critical, the UK experience demonstrates the value in cohesive and proactive policy settings. In Australia, there have been a series of processes to assess regulatory and market-pricing barriers to distributed generation at the National level. Recent policy developments surrounding carbon mitigation are providing greater financial incentives for distributed energy applications, as well as a much-needed review of regulatory constraints. The likelihood of a carbon price being integrated into electricity costs in Australia is stimulating growing interest in decentralised projects. Some of the opportunities available have been discussed in this report, including the prospect for Sydney and Moreland City of local government ownership and operation of utilities and providing district energy (e.g. heating, cooling and electricity) services to buildings in the community, as well as the progress made in Western Australia with municipally owned wastewater recycling schemes.

The key lesson from all these case studies is that, freed from the complexities of centralised infrastructure, distributed green infrastructure services such as; district trigeneration and recycled wastewater schemes can and do realise their profitable potential for building capacity for long-term investment in carbon emission reductions to achieve major carbon abatement, increased local energy security and community resilience to climate change at cost savings for local government and community residents.

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REFERENCES

Alber, G., & Kern, K. (2008). Governing Climate Change in Cities: Modes of Urban Climate Governance in Multi-level Systems, Paper presented at the Competitive Cities and Climate Change, Milan, Italy.

Biggs, C., Ryan, C., Wiseman, J., & Larsen, K. (2008). Distributed Water Systems: A networked and localised approach for sustainable water services. Melbourne Victoria Eco-Innovation Lab (VEIL). University of Melbourne.

Bulkeley, H., & Betsill, M. (2005). Rethinking Sustainable Cities: Multilevel Governance and the 'Urban' Politics of Climate Change. *Environmental Politics, 14*(1), 42-63.

Bulkeley, H., & Kern, K. (2006). Local Government and the Governing of Climate Change in Germany and the UK. *Urban Studies, 43*(12), 2237-2259. Retrieved May 6, 2011 from http://usj.sagepub.com/content/43/12/2237.

Carr, C. (2007). *Comparative Costs of Operating On-Site/Private Wire Distributed Energy Systems on a Licensed rather than License Exempt Basis - A report for the London Climate Change Agency*. UK.

Community Energy Association. (2008). *Utilities and Financing: Renewable Energy Guide for Local Governments in British Columbia*. Vancouver.

CSIRO. (2009). *Intelligent Grid, A value proposition for distributing energy in Australia.* Retrieved October 22, 2010 from http://www.csiro.au. /files/ptzy.pdf.

Cutter, S. L., Barnes, L., Berry, M., Burton, C., Evans, E., & Tate, E. (2008). A place-based model for understanding community resilience to natural disasters. *Global Environmental Change, 18*, 598-606.

Department of Premier and Cabinet Legal Notice, (DPC). (2011). *Peter Collier – New opportunities for private sector generation.* Retrieved August 17, 2011 from http://www.mediastatements.wa.gov.au/Pages/Results.aspx?ItemID=143217.

Energy Supply Association of Australia (ESAA). (2009). *Western Australian Energy Market Study. A pathway to an efficient energy market in Western Australia*.

Gough, I., Meadowcroft, J., Dryzek, J., Gerhards, J., Lengfeld, H., & Markandya, A. (2008). JESP symposium: Climate change and social policy. *Journal of European Social Policy, 18*(4), 325-344. Retrieved March 4, 2011 from http://esp.sagepub.com/content/18/4/325.short. doi: 10.1177/0958928708094890

IEA. (2009). Innovation in Multi-level Governance for Energy Efficiency, Sharing experience with multi-level governance to enhance energy efficiency. Paris.

Investa. (2011). *Australia's First Trigeneraton Precinct For Commercial Buildings*. Fact Sheet. Investa.

Jones, A. (2007). *OFGEM Distributed Energy Review, Review of Arrangements for Distributed (Decentralised) Energy*. Distributed Energy Working Group, London Climate Change Agency. London.

Jones, A. (2008). *City of Sydney Vision 2030 Report*. Sydney.

Jones, A. (2010). *Removal of the Barriers to Trigeneration*, Appendix 1, City of Sydney Property Portfolio - Decentralised Energy Strategic Direction. Sydney.

McDaniels, T., Chang, S., Peterson, K., Mikawoz, J., & Reed, D. (2007). Empirical Framework for Characterizing Infrastructure Failure Interdependencies. *Journal of Infrastructure Systems*.

McDaniels, T., Chang, S., Cole, D., Mikawoz, J., & Longstaff, H. (2008). Fostering resilience to extreme events within infrastructure systems: Characterizing decision contexts for mitigation and adaptation. *Global Environmental Change, 18*, 310– 318.

Metzl, J. F. (2001). Network Diplomacy. *Georgetown Journal of International Affairs.*

Monstadt, J. (2009). Conceptualizing the political ecology of urban infrastructures: insights from technology and urban studies. *Environment and Planning A, 41*(8), 1924-1942. Retrieved April 15, 2011, from http://www.envplan.com/abstract.cgi?id=a4145

Moreland Energy Foundation (MEFL). (2010). *Moreland Energy Services: Creating value from energy expenditure.* Moreland Energy Foundation.

Moreland Energy Foundation (MEFL). (2011). *Low-carbon energy plan for Fawkne*r. Retrieved August 3, 2011, from http://www.mefl.com.au/news-and-events/item/756-low-carbon-energy-plan-for-fawkner.html.

Newman, P. (2009). *Peter Newman: The Distributed City*. Retrieved March 10, 2011, from http://blog.islandpress.org/300/peter-newman-the-distributed-city.

Nous Group. (2007). *Understanding the Potential to Reduce Victoria's Greenhouse Gas Emissions.* Prepared for Victorian Department of Premier and Cabinet. Retrieved May, 22, 2008 from http://www.climatechange.vic.gov.au/summit

PB & CUSP. (2010). *Stirling City Centre Alliance*. Authors: Beattie, C., Bunning, J., Newman, P., Olmeadow, E., Olmeadow, D., & Walsh, M.

PB & CUSP. (2011). *Cockburn Coast Green Infrastructure Study – Implementation Strategy*. Authors: Walsh, M.

Pownall, M. (2011). *Water Utility for Point Grey.*

Prangnell, W. (2009). *Village Scale Integrated Water, Wastewater and Recycling: A New Model for WA.* Augusta Margaret River.

Prangnell, W. (2010). *WA Water Awards 2010: Margaret River Water Recycling*. Augusta Margaret River, Shire of Augusta Margaret River.

Prangnell, W. (2011). *Witchcliffe Water Reclamation Scheme: Business Plan.* Margaret River.

Ren, H., & Gao, W. (2010). A MLP model for integrated plan and evaluation of distributed energy systems. *Applied Energy, 87*, 1001-1014.

Sustainability Victoria. (2011). *Business models for enabling sustainable precincts*. Research report March 2011. Prepared for Sustainability Victoria by Moreland Energy Foundation, Net Balance and Green Spark Consulting. Sustainability Victoria. Melbourne.

Sustainable Energy Association of Australia, (SEA). (2011). *Response to the Energy 2031 Directions Paper*. Sustainable Energy Association of Australia.

Thompson, B. (2008). *Decentralised Energy – in the Victorian Context*. Brian Robinson Fellowship 2007-08 Report. Moreland Energy Foundation, Australia.

Vogela, C., Moserb, C. S., Kaspersonc, E. R., & Dabelko, D. G. (2007). Linking vulnerability, adaptation, and resilience science to practice: Pathways, players, and partnerships. *Global Environmental Change, 17*, 349–364.

Walker, B., & Salt, D. (2006). *Resilience Thinking: Sustainable Ecosystems and People in a Changing World.* Washington, D.C.

Western Australian Sustainable Energy Association (WASEA). (2009). *Regulatory Barriers to Sustainable Energy in Urban Contexts in South-West Western Australia*. Prepared by WASEA, HAC and Future Smart Strategies for The Stirling City Centre Alliance.

Witchcliffe Shire. (2011). *Business Plan for Witchcliffe Water Reclamation Scheme.* Shire of Witchcliffe.

Yazdani, A., & Jeffrey, P. (2010). *A complex network approach to robustness and vulnerability of spatially organized water distribution networks*. School of Applied Sciences. Craneld University. Cranfield.