DECENTRALISED WATER SYSTEMS – CREATING CONDUCIVE INSTITUTIONAL ARRANGEMENTS

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ABSTRACT

Decentralised water systems make economic and environmental sense but are only slowly being taken up across Australia. This paper discusses the points in favour of decentralisation and the drivers and enablers which have led to projects being accepted in the Australian context. Further, by comparing and contrasting experiences in Australia and the US, where decentralised systems are prevalent, this paper makes recommendations on steps Australia might take to provide more conducive institutional arrangements for decentralised systems.

INTRODUCTION

The adoption of decentralised water systems, especially for wastewater management, has been discussed for years and studies have demonstrated the economic and environmental advantages when used in appropriate contexts.

Pinkham et al. (2004) were commissioned by the US Environment Protection Authority to undertake a comprehensive investigation of the value of decentralised wastewater systems. They demonstrated the superiority of decentralised systems over centralised systems across a range of financial planning and financial risk categories. Whilst centralised systems certainly offer economies of scale in treatment, they come with diseconomies of scale in sewer collection systems, which take up to 80% of capital and two-thirds of operation and maintenance costs (Pinkham et al. 2004). With the rapidly increasing interest in and demand for recycling, decentralised systems provide a double bonus here, negating the need for both large scale collection and redistribution systems. On replacement or refurbishment, large diameter sewer mains have high costs and create greater disruption (Pinkham et al. 2004).

Another economic advantage to decentralised systems is that they allow a much closer match between capacity and actual demand, the capital cost of capacity is moved to the future; debt and financing costs are reduced; new technologies can be adopted; and levels of treatment can be locally targeted e.g. nutrient removal (Pinkham et al. 2004). All this means more economical investment.

From an environmental perspective, decentralised systems are considered less resource intensive (Lens et al. 2001). Local life cycle assessment studies confirm this for specific locations in Melbourne (Grant et al. 2006). Decentralised wastewater systems also reduce ecological impacts by facilitating biosolids and nutrients reuse close to their source (Lens et al. 2001): this reduces the impacts associated with transport of fertilisers and agricultural products, and limits cumulative impacts on the aquatic environment caused by large volume effluent discharges.

The reliability, vulnerability, and resilience of wastewater treatment systems vary – some key factors are related to scale and others are independent of it (Pinkham et al. 2004). What is clear is that the potential for large scale environmental and public health impacts due to system failure are significantly reduced by small scale decentralised systems (Fane & Fane 2005). Decentralised system risks are of lower consequence for a given failure, however the risk of failure when proper management is not available, may be higher (Fane, Willetts et al. 2005, Willetts et al. 2007). Decentralisation of water management may also provide a more realistic scale for social sustainability through public engagement in water services (Lens et al. 2001).

Despite the evidence in favour of decentralised systems for certain contexts, take-up in Australia has been relatively slow, compared to that in the

USA. Even there, take up is slower than the Environment Protection Agency (USEPA) would prefer – a recent study (Etnier et al. 2007) undertaken on its behalf focused on strategies to overcome the barriers identified as most influential to engineers equitably considering decentralised wastewater systems: (1) financial reward for using centralised systems, (2) lack of knowledge of decentralised systems, (3) unfavorable regulatory systems, and (4) lack of systems thinking applied to wastewater issues. These barriers are mirrored in Australia.

This paper discusses the drivers and enablers for decentralised wastewater systems in Australia; draws some comparisons with success stories from the USA in terms of institutional arrangements and business models, and offers some recommendations for Australia.

SCOPE AND DEFINITIONS

In this paper, we are focused on decentralised systems and the associated institutional arrangements. Because related terms are used in various ways, we begin by defining what we mean by decentralised, on-site, and distributed systems:

- on-site: treatment technologies and/or management systems at the scale of an individual lot
- decentralised: treatment technologies and/or management systems at the scale of multiple buildings e.g. cluster, neighbourhood, precinct, suburb, but not city scale
- distributed: treatment technologies and/or management systems situated in multiple locations across a community, as either decentralised or on-site. Distributed systems may be embedded within an existing centralised system or stand alone.

Local institutional arrangements determine the potential ownership and management models for water service provision. The key components of the such models are:

- asset ownership
- public or private entity
- contractual arrangements between service entity and property owner
- financial arrangements: e.g. who pays construction costs, how are prices determined and costs are shared, etc.
- regulatory arrangements e.g. where compliance responsibility rests.

DECENTRALISED SYSTEMS IN THE USA

In the USA, distributed service provision is a well established feature of the infrastructure landscape. Rural electric cooperatives provide electricity to 40 million people (NRECA 2008), and a quarter of the population (some 60 million people) is serviced by distributed wastewater systems. Ten years ago, the US EPA recognised these systems as a necessary, useful and ongoing feature of that nation's infrastructure, provided that they were well managed. It is this proviso that we will focus on here, since the prevailing view in the USA industry (Yeager et al. 2006) mirrors our introductory comments - there is no doubt that we have the technology for the job - the limitation is in the institutional arrangements, appropriate regulations and management of the technology to ensure that, at a minimum, public health and environmental risks are mitigated. These governance arrangements should also enable an acceptable balance to be struck between financial security for management entities and reasonable charges for system owners/users.

To this end, the US EPA (2003) coined the term 'responsible management entity' (RME), and developed a typology of five management models, and various resources to guide their setting up and operation. Of interest here are the upper two levels of responsibility and sophistication (Levels 4 and 5), since these are most likely to be associated with decentralised systems. Lower levels (Levels 1, 2 and 3) are more likely to be associated with on-site systems.

In the USA, Level 4 RMEs have responsibility for operation and maintenance. Ownership of the treatment system rests with the property owner – directly for on-site components, or indirectly if a property owners' collective owns the facilities.

In Level 5, the RME owns the treatment systems (usually everything downstream of the sewer connection leaving the home/building) as well as having operation and maintenance responsibilities.

According to Yeager et al.'s (2006) study of the business attributes of successful RMEs, level 5 entities are most often associated with new developments. Here, they seek to avoid the construction costs associated with new technology. Instead, the developer pays, while the RME has oversight of the appropriateness of the design and quality of construction. The developer then cedes ownership to the RME.

The number of connections served by a single Level 4 or 5 RME varies from a few hundred to tens of thousands. Some operate in just one jurisdiction, while others operate in multiple states.

A wide variety of public and private business models and the concomitant institutional arrangements have evolved in the USA. The particular institutional arrangements are highly contextual, in reponse to local regulatory arrangements and their implementation, which differ from state to state, and sometimes from county to county. The main categories are (Yeager et al. 2006):

- private companies (both profit and not-for-profit)
- not-for-profit rural electric cooperatives that have expanded into the wastewater business
- 'special purpose districts', offering sewage services, often alongside other (e.g. water, waste, propane, road, telecomms) services
- public authorities e.g. county, municipality agencies and governments.

Private RMEs set up a business model that works within the local regulatory context. The Adenus group is one of the largest RMEs, serving around 30 000 households in 3 states. Its model is a privately-owned, for-profit, publicly regulated utility.

Public RMEs have a distinct advantages because they have greater legal powers to respond to unpaid bills, e.g. turn water off, and to gain access, easements etc. for maintenance.

A leading example of a public RME is Loudoun County Sanitation Authority (LCSA). Loudoun County is a suburb of Washington DC, and LCSA provides water wastewater service to the unincorporated portions of the county - some 53 000 connections (Danielson 2008). Historically, LCSA focused on more urbanised areas and centralised systems: local policy mandates that the rural areas of the county can only be served by onsite or cluster systems. Recently, LCSA has moved into cluster systems, in both ownership and contract operational roles, for decentralised wastewater facilities servicing schools, parks and recreation facilities, and towns. The result is that system violations have been reduced to near zero. LCSA benefits from the economies of scale that come from operating a large number of these systems, and LCSA is looking to extend into other business opportunities that provide better environmental outcomes, including local recycling and stormwater schemes.

To provide sufficient certainty in income for a decentralised system RME, some kind of ongoing contractual arrangement is necessary between the property owner and the RME. In the USA, this arrangement is often linked to the property itself, so that when the property changes hands, the contractual arrangement remains.

A key feature of the decentralised wastewater industry in the USA is that, in general, at RME levels 4 and 5, there is no competition for service provision in a given location.

In the USA, prices are determined by a public utility commission, or similar, so the onus is on the RME to demonstrate the costs associated with the service provided, and make representation to the commission. These commissions regulate rates that can be charged by publicly owned, for-profit utilities, but typically do not regulate governmental, quasi-governmental, and non-profit organisations (for example town public works department, sanitation district, homeowners' association). Indications are that a lack of effective pricing systems has been one of the main barriers to successful outcomes in the USA.

COMPARING PRACTICE IN THE USA AND AUSTRALIA

The situation in Australia is different from that in the USA, and decentralised systems are not as widely adopted. In the sections that follow, we consider successful decentralised systems in urban Australia. We draw out push and pull drivers. Push factors are those trends where the response is a question of 'how', rather than 'whether'. Pull factors are aspirational. We then identify emerging enablers of decentralised systems, business models, and lessons for Australia.

DRIVERS (PUSH FACTORS)

Initially, a key driver for introducing decentralised systems was the presence of hard-to-service pockets amid larger communities; adopting a decentralised approach enabled a business to extend services, especially sewerage, to those difficult spots. Whites Road in Brisbane is an example of such a development, although it took a decade to come to fruition.

Commercial imperatives for developers drove another cohort of projects, which were not feasible under a centralised model, but which could be made viable with decentralised approaches. Aurora (around 8 000 lots) in Melbourne was constrained by lack of trunk sewers, and VicUrban was committed to a new sustainable land release. The result for the water system is strong efficiency and a development scale residential recycling system owned and operated by Yarra Valley Water. Payne Road (22 lots) in Brisbane was constrained by lack of sewer capacity. The body corporate has responsibility for ongoing management of the decentralised technologies - rain tanks, fire fighting system, greywater treatment and subsurface irrigation. Take-up of house and land packages has been slower than hoped, so it may still be premature to judge the success of this model. Noosa North Shore Eco Resort, across the river from Noosa in Queensland, is a resort development which employs decentralised features (rainwater tanks and a membrane bioreactor plant to recycle effluent) because Noosa Council declined to extend its centralised services across the river.

A trend towards medium density developments in many established urban areas is putting existing water services under strain, and we predict that this will be a key driver for future decentralised systems, as will aging infrastructure and overloaded main sewers.

DRIVERS (PULL FACTORS)

A strong pull factors has been the passionate commitment of particular proponents, who believed in decentralised systems and overcame barriers to implement a project. In that group, Sydney Olympic Park had strong green credentials to demonstrate, so overcame many hurdles to set up its WRAMS (water recycling and management system) in time for the 2000 Sydney Olympics. Similarly, Currumbin Ecovillage in Queensland was championed by a committed individual.

A growing pull factor for decentralised systems is green building rating systems, such as the Green Star Rating system operated by the Green Building Council of Australia. The profile achievable through a high rating is now recognised as very valuable to a developer in marketing terms, and there are points available for greywater recycling, blackwater recycling, and decreasing flows to the sewer.

ENABLERS

Existing practices and systems can undermine change, willingly or unwittingly. Enablers are necessary to overcome these.

A supportive institutional climate for decentralised systems is a strong enabling factor, expressed in many different ways. Planning permission, regulatory authorisation to serve as a water business (the Sydney Olympic Park system is registered as a water authority in New South Wales) and all other necessary bureaucratic approvals can be enablers when positive, and all but insurmountable barriers when negative.

The availability of authoritative guidelines legitimises decentralised systems in the minds of a naturally conservative water industry. Sydney Water (2006) has published guidelines for sewer mining, setting out its commitments and obligations; while the New South Wales Government, through the Department of Water and Energy (2007) has published interim guidelines for the management of recycled water schemes. These guidelines provide a clearer framework for the management of human health and environmental risk associated recycled water and thereby make planning and approval processes more straight forward.

On the international scale, the World Health Organisation (2005) published guidelines for the reuse and recycling of human faecal matter.

Most significantly, the New South Wales *Water Industry Competition Act 2006 No 104* was promulgated, with the express purpose of establishing 'a scheme to promote the economically efficient use and operation of, and investment in, significant water industry infrastructure, thereby promoting effective competition in upstream or downstream markets'. This is a major step forward and it has opened the door to decentralised systems, as well as other forms of urban water infrastructure provided by third parties.

The Water Industry Competition Act 2006 consists of three key measures, including: a licensing regime for private sector participants in the water industry; an access regime to allow for the storage and transport of water and sewage using existing significant water and sewerage networks; and binding arbitration of sewer mining disputes (Department of Water and Energy 2007).

Sound, objective costing methods, permitting the proponents to find the least cost solution, considering organisational financial perspectives as well as a whole-of-community basis, are necessary. A guidebook recently released by Mitchell et al. (2007) facilitates the costing process: it identifies nine principles from economics, systems, and risk management which, taken together, allow meaningful comparison of technologies across the two primary divides of supply and demand, and decentralised and centralised infrastructure.

BUSINESS MODELS

In Australia, a narrower range of business models pertains than in the USA. Generally, decentralised systems are set up either by the developer of the precinct or by the incumbent utility, and all Australian utilities are state or local government owned. Some are departments of state, territory or local governments, but others, especially the larger ones, are corporations, with government shareholders, paying dividends to those shareholders.

Many existing Australian decentralised wastewater systems have been initiated through joint ventures between governments and developers, with ownership, operation and maintenance often passing to the local water utility. Some examples include Mawson Lakes, a joint development by Delfin and the South Australian Government, where water infrastructure is owned and operated by SA Water (Acil Tasman 2005); Aurora in Melbourne is a VicUrban development with water infrastructure managed by Yarra Valley Water; and Pimpama Coomera WaterFuture Masterplan in Queensland has been developed by Gold Coast City Council and run by Gold Coast Water. At Sydney Olympic Park the stormwater and wastewater reclamation system is owned by the Sydney Olympic Park Authority (SOPA), which became a water supply authority in its own right in order to meet with the legislative requirements of the day. SOPA owns the water recycling and stormwater harvesting system (WRAMS), and has a 25-year agreement with a private company to operate and maintain the treatment plants (ACIL Tasman, 2005).

However, this common business model could change with the introduction of the *Water Industry Competition Act 2006* (WICA), which will allow privately owned RMEs to become major players in the ownership and management of decentralised water systems in Australia.

Some alternatives to this model are already emerging, such as the Currumbin Ecovillage in South-east Queensland, where the water infrastructure will be owned by the body corporate and will be operated and monitored by private contractors (Shepherd 2008).

LESSONS FOR AUSTRALIA

This sections highlights some key challenges, lessons and potential solutions to integrating decentralised systems into Australia's water industry. Issues of pricing, 'service provider of last resort', necessary monitoring and management requirements, transparent costing and economic analysis from the perspective of whole-of-community, planning and approval protocols and the need for flexibility in business models are all discussed.

Decentralised systems can be used as stand-alone systems, or may be embedded in larger centralised networks. And, although similar technologies are likely to be used in these two situations, different institutional issues will arise in each. To maximise the benefits of decentralised systems, appropriate institutional arrangements will need to be designed to facilitate uptake in both situations.

Where systems retain a linkage to centralised networks, even if this is only for emergency or unusual circumstances (such as plant failure or power outage) the access, pricing and 'service provider of last resort' arrangements need to be structured so as to allow the operators of both the decentralised and centralised systems to maintain viability.

For instance, the introduction of privately owned decentralised systems into a previous monopoly business's area will have only a small impact at first. There is, however, the potential to render a utility's business non-viable if the proportion of the community serviced by the decentralised system rises above a certain point. Regulatory and business models need to ensure that the 'host' utility is able to recover the (net) costs incurred.

Likewise, pricing for the access regime must be conducive to the viability of a decentralised operator. To ensure the viability of both parties, transparent and fullsome accounting for both the costs incurred and cost avoided by the utility is required.

Experience in the USA points to the lack of effective pricing systems as being one of the main barriers to successful outcomes for decentralised systems and organisations that operate term.

Of course, if the incumbent business chooses to provide the decentralised service, then financial and any management concerns can be allayed through the maintenance of centralised utility control.

Regardless of ownership and management arrangements, both the USA and Australian experience highlight the need to ensure appropriate oversight and management of decentralised operations. The importance of centralised management for distributed systems, preferably via SCADA (supervisory control and data acquisition) can not be overestimated.

As noted earlier, in considering the 'drivers' and 'pull factors' for decentralised systems, the practical and commercial imperative to service difficult pockets has been key to date. So has a desire for more environmentally sound outcomes in given locations. More recently this desire has been translated into a wider market demand through Green Star ratings of buildings. This paper predicts that a future driver for decentralised systems will be their cost effectiveness in solving network constraint issues in particular locations. More transparent costing of water system augmentations in Australia could pave the way for greater adoption of decentralised systems, where they are cost effective.

Current institutional arrangements in Australia do not sufficiently enforce 'least cost' solutions. Utilities currently can spread the high cost of extending centralised system across all users, and this masks the situations in which a decentralised solution might have provided a lower cost solution. Recent history has seen the large scale preferences within authorities associated with perceived risks associated with decentralised systems leading to the extension of centralised systems, sometimes despite analysis indicating potentially significant cost advantages that could be achieved with a decentralised system using advanced levels of wastewater treatment (see for example Bundeena and Maianbar case discussed in, Livingston et al. 2004).

Identified enablers for the introduction of decentralised systems include straight-forward protocols for planning and approval, as well as institutional frameworks that encourage a variety of viable business models.

Decentralised systems lean towards more flexible business models than the standard utility one in which consumers are billed a standardised rate for access, water consumption and sewerage collection by a centralised autority which owns and operates all system assets. Experience shows that more varied business models are possible with distributed wastewater systems.

Whether this can lead to a situation where customers have a choice of water service provider in a given location is separate question. The USA experience has found that, to date, in general, there is not competition for water service provision in a given location.

The New South Wales Water Industry Competition Act 2006 No 104 has the potential to enable a a variety of viable business models for decentralised wastewater. Among the many issues still to be addressed, however, are: 'provider of last resort' arrangements; liability for non-compliance with quality and/or environmental standards; overall management and coordination; and pricing (for consumers and providers who utilise other organisation's infrastructure).

Given the complexity of the necessary changes to create conducive institutional arrangements for decentralised systems, additional research and analysis in the coming years will be critical. One important enabler in the USA is the federal funding for research into the management of decentralised wastewater systems and development of guidance materials that enhance capacities for decentralised system management. Similar such investments will likely be required in Australia.

CONCLUSIONS

To enable decentralised systems to establish a foothold alongside conventional, centralised approaches, where decentralised systems can provide a better economic and environmental outcome, Australia will need to create a more conducive institutional climate, notably:

1. enabling legislation and government policies that facilitate introduction of decentralised systems; such as the NSW Water Competition Act 2006
2. a wider range of business models; flexible and adaptable, and enabling an effective market, including private RMEs and publicly owned water businesses
3. pricing, operating and supervision arrangements which ensure short and long term stability of the whole system; including centralised and distributed systems.

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