The Energy Panel of the Royal Society of New Zealand's response to the Parliamentary Commissioner for the Environment's questions on barriers facing microgeneration

As part of their ongoing work on electricity, energy and the environment, the Parliamentary Commissioner for the Environment (PCE) is investigating the opportunities for microgeneration in New Zealand and the barriers that these systems face. This document forms the response of the Royal Society's Energy Panel to the questions that the PCE posed.

Key Question 1 - What are the main benefits of microgeneration?

User Benefits
The distributed generation (DG) capacity inherent in the concept allows optimal use and integration of resources which in themselves would conventionally be seen as too small to be economic. Distributed heating such as for solar water should also be considered with generation in terms of "distributed energy". There is potential for increases in efficiency of thermal generation through the use of localized dual heating/power systems (such as provided by Whispergen or diesel/biodiesel gensets or gas engines). In this paper it is assumed that DG will largely involve local renewable energy resources but by the usual definitions DG can also include small scale oil, gas and even coal fired systems feeding into the local grid.

Investor Benefits
Current microgeneration technologies generally provide a low risk option when a power source is available and the user remains grid connected. Generators are small scale so investment can be incremental, which means that investment risks are low. Small generation means that there is no effect upon spot prices, so profits for each investment are easier to quantify than for large investments. A proportion of microgeneration is likely to be not network-connected but will contribute to demand load reductions. Where grid access does not exist distributed energy can be a cheaper option to constructing lines and poles. The lessons learned in New Zealand for micro-grids could well apply to developing countries and the 1.6 billion people without electricity services. Future export opportunities will probably be significant.

System Benefits
Microgeneration allows supply risks to be spread as there is less local dependence on the grid. Current technologies aid the use of renewable energy sources. However, this must be set against the risk of growth in diesel generation if microgeneration as it stands is pushed.

There is the possibility of a reduction in overall transmission losses as power does not have to be transmitted over such large distances. Local generation can defer the upgrading of existing distribution lines that are near their maximum load carrying capacity.

Key Question 2 - What are the opportunities for microgeneration in NZ? Are there any specific contexts where they are especially appropriate?

The best investment opportunities are in remote areas, where transmission losses are significant or line congestion is an issue. Technologies which are or could be applied here are: wind, tidal, solar heat and power, microhydro, and combined heat/power systems. New Zealand has considerable natural advantages for the first four of these, and successful experience in the fifth.

As well as remote locations, deployment opportunities for microgeneration are typically to offset peak generation (e.g. Christchurch diesel), peak demand reduction (e.g. solar PV on commercial buildings for afternoon summer HVAC demand), and supply security for critical loads (e.g. banks, hospitals, high income individuals). The price and scale do not usually compete with baseload grid at this stage of their development but microgeneration may allow individual businesses to better manage constrained grid electricity supply.

Key Question 3 – What are the potential drawbacks of microgeneration or issues that need to be addressed for them to make a useful contribution?

Microgeneration is currently more expensive than centrally generated electricity. Some will pay extra for secure, local supply, but this could be a waste of money if centralised generation can provide that security. Depending upon the technology chosen, microgeneration may also not be more reliable. Therefore an investor must have significant incentives to invest, such as the lack of a grid connection, available resources for generation, or interest in direct generation initiatives. Capital costs are also a significant barrier for individual owners.

We note that the rising cost of conventional generation and supply may naturally make microgeneration an increasingly attractive option in coming years. In that case, strong and consistent Government support will still be required, including a regulatory/safety protocol, and a development vision. In the longer term, mass production of the various technologies, greater experience from learning by doing, and development of intelligent control systems will result in lower costs

If the costs of carbon emissions are included for all generators, then thermal generation based on fossil fuels would be discouraged, whether on a micro or utility scale. However, carbon costs will be relatively less important for microgeneration, as microgenerators will be buying their fuel in the retail market where carbon costs are a smaller fraction of their fuel bills. Hence carbon charges will have less influence on microgenerators.

Microgeneration would be encouraged if grid expansion was limited and consequently there was no investment in large-scale generation, or if there were other drivers for microgeneration. However, the current cost structure ignores carbon costs. Thus a push for microgeneration now would result in the growth of diesel generator sets and other fossil-fuel generation. This growth may occur anyway for peak shaving and to avoid blackout risk. From an environmental viewpoint, this would increase carbon emissions and localised pollution.

Key Question 4 - What are the main barriers to the uptake of microgeneration in NZ? and
Key Question 5 - What would it take to overcome these barriers?

The key barriers are:

- Capacity and reach of the microgeneration industry
- Structural problems with the electricity market
- Costs of acquiring resource consents
- Connection protocols and charges (being evaluated by MED).

Microgeneration industry capacity

The most important asset for New Zealand is not any particular technology option. It is trained, competent, skilled, experienced mechanical and energy systems engineers, installers and maintainers. Many electrical engineers trained in the realm of large scale power generation systems are less willing to accept a vision for DG becoming main stream.

Microgeneration, as with any other conversion, conservation or management technology, must be designed and deployed on a site-by-site basis depending on local load profiles and resources. In order to optimize resource use, minimize waste, and fit into the bigger picture of the community, the grid and the environment, each opportunity should be assessed and modelled. Each system must be designed, installed and maintained by people who know what they are doing. Without professional design, maximum benefits of the technology may not be realized. Experience from overseas must also be examined in the critical light of local experience.

The biggest barrier to this and other opportunities is the lack of professional energy engineering practice, education and training.

Microgeneration industry reach and diversity

Along with the industry's limited capacity comes a limited ability to reach and inform potential users. The smallest of these potential users are householders, single businesses and farms, many of whom are not aware of their own energy impact, let alone the myriad possibilities for improvement. There is still little public understanding of microgeneration opportunities in New Zealand.
The lack of knowledge in users is matched by a limited capacity in the industry to promote that knowledge to potential users. These users would gain from professional support when managing their energy use; still more gains could be realised from professional management and provision of energy services through professional analysis, design and deployment. This is a huge and wide-spread task. The industry falls at the first hurdle. It is not large enough to be known by many potential users, nor does it have sufficient size to service those potential users. This also limits the physical availability of the technologies.

Education is needed regarding the potential, risks, and upside/downside factors of microgeneration. Public awareness is also a factor that needs to be improved in any discussion of energy. The slow uptake of energy saving measures over the last twenty years suggests that this issue is not reaching the public and that stronger incentives might be required to interest the public in cost-effective efficiency improvements. Market based approaches that appropriately reward cost-effective efficiency and DG initiatives should also be pursued. Effective, well-designed market measures are likely to be robust in the long term and the allocation of resources between demand and supply-side initiatives is likely to be efficient.

Furthermore, there are so many technologies with different energy sources, different operating requirements and consenting issues that some question if there is even such thing as a ‘microgeneration industry’. For example, the difficulties of putting a PV panel on a domestic roof are completely different to installing a microhydro generator on a farmer’s riverbank, so experienced gained with one technology or application may not help with other technologies or applications. We do not expect the larger-scale energy industry to be monolithic, nor should we expect the microgeneration industry to be so.

Structural problems

There are several structural barriers to microgeneration uptake.

Consent costs

While there are issues around multiple users of small hydro systems including damaging the resource or the environment, the costs of acquiring resource consents, where required, can be harsh for these small projects. In one project the financial cost of acquiring consents was five times the cost of the technology (not including time costs). These administrative issues will clearly reduce uptake and may increase costs to the level where microgeneration becomes uneconomic in practical application. This is an issue that Government can readily address by better (off-the-shelf) processes to deal with micro-generation project proposals.

Integration

Integration of microgeneration capacity into the grid is currently very difficult due to regulatory and business constraints. Local microgenerators are not able to easily supply power to the grid system through net metering systems and the current electricity supply regulation system provides large energy companies with the ability to suppress microgeneration initiatives.

Safety and maintenance issues would occur if significant microgeneration capacity is held under private ownership. However, the emphasis on these concerns is another route that is used to prevent integration.

In addition there are still no national guidelines or code of practice available, in spite of MED and the Electricity Commission having undertaken consultation and working on them for almost 2 years.

The benefits of renewable microgeneration are more social and environmental rather than economic. The exclusive focus on a competitive market limits changes in generation and supports incumbents by discounting their social and environmental costs.

The generation/transmission split

Microgeneration could solve many localised transmission problems – overloaded lines could be eased by placing small generation sources at the user end of the line. However, the legal line drawn between line companies and generation companies hinders this.

Other examples have been seen where lack of coordination or interest between local and regional bodies has prevented microgeneration opportunities being used. For many organisations, such as refuse dumps, microgeneration is not a core businesses and there are no bodies who could come in and deliver a hassle-free solution. Again, the microgeneration industry in New Zealand is not large enough to be able to deliver solutions alone; for many potential users, the industry is not even large enough to find and inform those potential users.

Meeting energy services without generation

The ideal solution to meeting energy services is to do so without external energy demand and with minimal energy conversion needs. Passive solar space heating, water heating, insulation, thermal mass and daylighting are all examples of meeting energy demands without external supply. These technologies are beneficial to users by providing reliable services at zero cost. They are beneficial to the nation by improving overall energy efficiency and providing services without needing national-scale infrastructure, emitting pollution or making demands on our balance of trade. However, these technologies face a structural problem. They are not beneficial to existing industries because there is no on-going revenue stream, nor are they highly valued by residential markets or architects, as they are often invisible solutions. They obviate problems rather than solving them and while many companies propose to sell solutions, none sell obviations. Existing industries have no incentive to provide them.

As these technologies are in the national interest but are hard to provide through existing market routes, it is clearly the government's role to promote them. An indirect route would be to educate users so that users can arrange for these types of technologies. However, an example of a more direct route is minimum efficiency standards in goods and buildings. These raise energy efficiency and do so by providing industries with clear targets that they must meet. Options for ensuring effective energy efficiency measures are properly rewarded in the market should also be pursued. For example, mandatory building efficiency rating measures, which are in use in other countries, mean that investments on energy efficiency receive better recognition in the market than at present.

Research, development and demonstration barriers

Cross-disciplinary nature of research for microgeneration

The silo nature of research funding may put barriers in the way of funding for microgeneration technologies because these typically cross discipline boundaries. Passive solar design provides low-technology and zero-cost heating and cooling and thus can reduce our nations' energy demand. However, research into its implementation and uptake affects the building industry, not the energy industry. Many other technologies involved in microgeneration could fall into gaps between scientific areas or between industries. The Building Code does not address such issues either.

The recent shift to an outcome-based approach by FRST should greatly reduce this problem. The research is joined under a single portfolio "Optimising Physical Resource Use and Infrastructure Services", which takes an energy services approach that includes both energy and building. The focus on outcomes, rather than specific technologies or scientific disciplines, means that research proposals are to be directed towards improving usable, tangible and relevant results. However, whether the outcomes-based approach really does deliver benefits to energy services research and to microgeneration will not be known until the results of this portfolio investment round are seen.

Funding for development and demonstration

As with many other disruptive technologies, the lack of funding for development and demonstration in NZ limits commercialisation of local ideas. Both public and private funding are limited and often directed to supporting ideas from existing industries. There has been a step change in the rate of formation of spin-out companies from universities and CRIs, possibly in response to both changed government incentives and some targeted funding instruments such as the New Economy Research Fund, the Pre seed Accelerator Fund and the NZ Venture Investment Fund[1]. However, barriers in this area are still strong and more seed funding is needed to allow implementation of early systems on a realistic scale and development of techniques to reduce costs and issues around integration with the grid.

Other barriers exist with the availability of experienced staff for commercialization and technology transfer. However, these barriers are common to many high-tech areas in New Zealand.

Technical barriers

Microgeneration still needs an energy source in order to generate power and heat. Fossil-fuel use is leading to climate change and exposing us to increasing volatility of price and supply. If microgeneration is not based upon renewables, then NZ continues to put itself at risk to these factors.

As intermittent wind and solar systems become a larger fraction of generation, storage technologies will become more essential. We need better understanding of how the existing storage capacity of NZ's substantial hydro generation system can be effectively utilized.

Key Question 6 - What microgeneration technologies could be suitable for use in New Zealand now?

Microgeneration is just an energy conversion technology. The technology doesn't have any intrinsic "goodness" nor is it necessarily a solution for anything. Microhydro, wind, solar, wave, tidal, and combined heat/power systems all have roles to play, depends on location, and fuel source.

The Whispergen and similar combined heat and power units are less suited to NZ than Northern Europe since our winters are warmer and the heat demand (the main output from such technologies) is lower.

Key Question 7 - What microgeneration technologies could be suitable for use in New Zealand over the longer term (e.g. in 25 years)?

We don't see the technologies changing significantly from those listed above, although we would expect to see increasing use of biomass-derived fuels in combined heat/power systems. A wide range of technologies have been developed in recent years ranging from steam engines and gasifier/gensets to Stirling engines and fuel cells.

The cost of photovoltaics will continue to reduce in price in terms of c/kWh produced and they will become increasingly viable in some areas.

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[1] "Measurement of spin-outs from Foundation-funded research", NZIER/FRST, 2005, http://www.frst.govt.nz/evaluation/downloads/technology/20051124_Measurement_of_Spinouts.pdf

However, this depends entirely on the decisions of big players in the New Zealand energy market. For example, if an LNG plant is built and LNG imported, then the expected higher prices for LNG may make microgeneration more economic in comparison with gas. If substantial investments are made in a reliable and extensive grid then remoteness of load becomes less of an issue. If nothing significant is done in transmission and generation, then many technologies will become economically viable.

Key Question 8 - What actions could the government take to encourage microgeneration (if appropriate)?

1. The first task should be to develop a vision for micro-generation development over the next two decades combined with programmes to improve public awareness and education.
2. Removal of unnecessary regulatory barriers which currently directly or effectively prevent integration of microgeneration systems with the national system (e.g. A fair market for net metering, resolving the generation/transmission split, consent costs).
3. Fair protocols, standards and costs for network connection of micro-generation.
4. Longer term policies. Current short government horizons place all the risk on investors, despite the government being a cause of some of those commercial risks. An example is the risk imposed through the government's possible future policies in response to climate change. Until these policies are set, the investment situation is uncertain and thus far from inviting.
5. Support for research on both technology and its implementation in the New Zealand context with particular regard to control systems and demonstration plants.
6. Promote ways to meet energy services with less or no use of energy, such as demonstrating the use of these services at a household or community level.
7. Support energy engineering as a profession.

Summary

Technology is not the issue. There are a wide range of developing and developed technologies for micro-generation. The key issues around deployment are economics, scale, regulations, and complexity and distortion of incentives and non-financial costs as well as a lack of understanding by both the industry and the public.