Analysis of barriers to Distributed Generation (DG):

A report prepared for the Energy Efficiency and Conservation Authority (EECA)

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1. Executive summary

1.1 Findings

This report looks at the ability to invest in or install distributed generation (DG) under the current model of electricity generation and distribution. It has been prepared for the Energy Efficiency and Conservation Authority (EECA) and is intended to inform the approach they take to encouraging greater uptake of DG.

For most of the history of wide-scale electricity use the paradigm has been large scale central generation with transmission and distribution to the point of consumption. Until very recently, DG has been a minor aspect of the way electricity is produced and consumed. It appears that both in New Zealand and in other jurisdictions the way electricity is generated and consumed may be on the verge of a significant change.

This change is brought about by a step change in electricity costs in the past decade; a recognition that consuming less without compromising comfort or growth is worthwhile and achievable goal; a growing focus on security of supply and reliability, technology advances and a recent policy emphasis on reducing greenhouse gas emissions. The role of DG in this new environment is quite different than the way it may have been viewed as recently as the 1990s when many electricity markets were being established.

This report examines current arrangements and literature relating to DG in both New Zealand and across a number of other jurisdictions. The benefits and barriers to DG are listed but are not quantified. However, based on the research conducted for the report, it seems clear that a cost benefit analysis of DG should be carried out. Such a quantification exercise would likely demonstrate that much more can be achieved if DG is embraced as part of our energy needs rather than leaving its growth to the vagaries of current market design and institutional arrangements.

The benefits that come from DG take many different forms although benefits are not explicitly the subject of this report. Even so, the research highlighted a high level list of benefits that were fairly similar from jurisdiction to jurisdiction. For the purpose of this report we have reproduced the list provided by the Parliamentary Commissioner for the Environment in 2006 and added to it.

DG is not a homogenous form of generation. It includes a wide variety of technologies and fuel sources each with its own unique characteristics. As a separate issue the motivation to install DG is also unique to individual owners/developers. For the purpose of this study we have differentiated between five types of owners who seem to share similar motivations. These are:

- Domestic (< 10 kW)
- Commercial (>10kW)
- Independent embedded
- Grid connected (large renewable)

- Stand alone power system (SPS)

Inevitably, some development fails to progress because the schemes or ideas are over-optimistic in terms of the physical details or the economics. Others would deliver some of the benefits from DG but for the ability to capture the full value of the benefits it delivers. A number of detailed barriers are listed and these have been reconciled with similar lists from overseas markets.

Issues like the hassles associated with connecting into a network or the disproportionate cost of gaining consents for small schemes are being addressed slowly. Other barriers can be thought of in two ways.

1. Arrangements for the production, distribution, sale and purchase of electricity are based around a large scale central generation model.
2. Individual DG installations (including micro and embedded) are small by definition and therefore vulnerable to having the costs of getting established or the cost of participating in markets overwhelming the value it can capture where some of those costs are high fixed costs or set in relation to much larger schemes.

Identifying the benefits from DG and the barriers to realising them is a useful but small step towards lowering the barriers. They are not going to lower themselves. Nor is market arrangements going to spontaneously change to reflect a different paradigm in the way electricity is generated, distributed and consumed.

If there is a role for Government it is to first address whether the rules and regulations are appropriate for a contemporary electricity production and distribution system. Next their role is to have a cost benefit of DG done and make an assessment whether changes to market design or interventions are worth adopting. That is consistent with the Regulatory Impact Analysis (RIA) approach set out by the New Zealand Treasury. The RIA criteria call for “evidence and, in particular evidence of (cost-) effectiveness used to prioritise major intervention choices, where feasible”.

For the purpose of carrying out an RIA of lowering barriers we have grouped the full list down to five discrete areas as follows:

- The electricity industry status quo prevails.
- Recognising the potential of DG.
- Regulatory, technical and scale hassles.
- Financial viability of establishing DG.
- Capturing network and transmission benefits.

These reflect recurring themes in the way barriers manifest themselves in all jurisdictions studied, including New Zealand. In some ways all of these can be thought of as a by-product of the pervasive influence of the status quo. That is, institutional and market arrangements have evolved around a central large-scale generation model relying on one-way transmission and distribution flows. The resulting paradigm may be referred to in economics as “path dependency” and is referred to here as “the status quo prevails”. If DG is to reach its full potential and deliver substantially on the benefits it produces, current arrangements may have to undergo significant changes.

Government could take it as self evident that benefits, especially public benefits, were not being realised as a result of poor uptake or of weak investment of DG and act accordingly. The flaw with that approach is that measures taken in the absence of a net benefit test might be inefficient in the sense that the benefits may not be realised by the targeted beneficiaries. There is also a risk that superficial measures are not successful because the core, underlying issues remain.

In a number of jurisdictions acceptance of the loss of benefits resulting from poor uptake of DG opportunities has lead to the introduction of a variety of interventions or subsidies rather than modifying the institutional arrangements and rules. A good example of one such mechanism is feed in tariffs (FIT). The introduction of FITs does not automatically address the status quo and as is being learnt, can be poorly designed. In the case of poor FIT design the market-based incentives are still weak, and there are also the decorative effects of the FIT to deal with.

The five key findings of this report are:

1. There are a number of barriers faced by prospective investors in DG whether they are looking at micro DG for home /office or investors of small scale embedded generation.
2. The case for intervention *per se* should be made before specific mechanisms are targeted or work to change market arrangements is initiated.
3. The estimate of benefits in New Zealand should explicitly include the contribution DG can make to security of supply and competitive pressure on prices.
4. For DG to develop the model of electricity production, distribution and consumption may have to change from a large centralised generation model to more of a distribution model. This would require "*the bringing together of many complementary policies. Split incentives, access to finance, renewable energy policies, energy prices, skill and industry capacity from architects through to builders and trades people, can all impact on the uptake of distributed energy and must be addressed simultaneously.*"[1]
5. A number of benefits that come from DG are consistent with benefits that are the target of mainstream public policy in a number of countries.

1.2 Summary of Barriers to DG in overseas markets

California

DG development in California is closely related to policy measures to encourage renewable energy generation. The State has a Renewables Portfolio Standard (RPS), which requires electric corporations to increase procurement from eligible renewable energy resources by at least 1% of their retail sales annually. The target was 20% by

[1] CSIRO Intelligent Grid *A value proposition for distributed energy in Australia* (2009)

2010, and California lawmakers are currently developing legislation to increase this to 33% by 2020.

The examples from California illustrate that although DG's potential is recognised, it is not currently a significant energy resource; the current DG penetration is 2.5 percent of total peak demand in California. Due to low penetration rates, DG installations do not have a large impact on, nor are they integrated with, the State's electric and natural gas infrastructures. As a result, many projects are highly customized and rely on incentives.

The DG industry is thus a nascent one that survives despite some difficult market conditions. There are numerous institutional, industry and market barriers that have impeded the growth and adoption of DG to date.

A DG strategic plan released in 2002 by the California Energy Commission (CEC) identified three types of barriers to DG uptake[2]. These included:

- technical barriers: including technical standards for interconnecting DG to the grid; testing and certification procedures for interconnection equipment;
- business practice barriers: including standard business terms and practices for a utility review of interconnections; and
- regulatory barriers: lack of regulatory tariffs and incentives for DG

The primary barrier to entry for DG technology was a lack of interconnection standards. To address these, Rule 21 was introduced by the CPUC in 2001 to by developing standard interconnection rules. The Rule 21 policy was a significant change to the industry and enabled eligible wholesale generators to interconnect distributed generation systems to the electrical grid.

To correct some of these barriers, the CPUC has enacted numerous DG initiative measures[3], which are pertinent to domestic, commercial, embedded and SPS customers.

United Kingdom

DG in the UK has grown remarkably since the early nineties. In 1993/4 there was 1.2 GW of distributed, independent generation in England and Wales. This has grown to over 12 GW in the ENA's DG connection activity in UK Distribution Networks report[4] (June, 2007).

[2] These barriers drew on material from a previous (2001) report by Alderfer, R. Brent et al. *Making Connections: Case Studies of Interconnection Barriers and their Impact on Distributed Power Projects*, NREL (National Renewable Energy Laboratories) SR-200-28053, May 2000.
[3] http://www.cpuc.ca.gov/PUC/energy/DistGen/index.htm

[4] ENA (2007) Distributed Generation Connection Activity in the Great British Distribution Networks. The data presented was accurate at June 2007 and information is collected by distribution network operators to illustrate connection activity.

The discussion and examination of DG technologies is closely couched and appears to be a direct result of the Government's strategy to pursue low-carbon energy generation.

Three general key market and regulatory failures affecting DG were listed in a review by Ofgem:

- market value for carbon. The implication is that DG technologies and opportunities are not correctly priced in the market, reducing uptake;
- regulatory barriers meaning that aspects of the regulatory framework are designed for centralised generation and prevent DG from developing; and
- informational barriers. No one source of easily understandable information exists on DG opportunities.

The UK Department of Energy and Climate Change have identified barriers to DG similar to those that exist in New Zealand. The focus in the UK literature is on microgeneration, and is therefore pertinent to consumers and small commercial entities.

Barriers to DG are beginning to be addressed through cooperative work programs led by Ofgem and the Department for Business, Innovation and Skills (BIS). The Distribution Working Group (DWG) manages four work programme areas including horizon scanning, network design, active network management, and facilitating small-scale generation[5].

Recent (2007) government policy to stimulate the take up of certain DG technologies include the zero-carbon new homes policy, rewards for low-carbon investments (for example, the Low Carbon Buildings Programme) and the Enhanced Capital Allowance Scheme.

Fiscal incentives also exist, in the form of a reduced value-added-tax (VAT) of 5% applicable to the installation of most microgeneration technologies. Further, private householders who sell surplus power (generated by microgeneration technology) or Renewable Obligation Certificates (ROCs) to energy retailers are exempt from income tax on that revenue.

Lastly, from the 1st April 2010, the Government is introducing a FIT regime that will ensure a 5-8% ROI for the installation of renewable micro generation in homes.

Australia: NEM

As in other jurisdictions, the principal motivation for DG policy advancement in Australia is the drive to pursue carbon reduction in energy generation. What we might phrase as path dependency is demonstrated by the way the NEM has developed over

[5] Source: ENSG Electricity Networks Strategy Group. http://www.ensg.gov.uk/index.php?article=16. The work program advises on the DNO's regulation that currently discourages the early adoption by consumers of microgeneration and has provided advice on the distributional price control review.

many years, with small scale energy and demand management filling niche roles within the dominant centralised supply model. The central supply model has resulted in numerous barriers to DG, for example a lack of a skill base to deliver distributed energy, and it has created diluted incentives to pursue DG.

A major and comprehensive review of the barriers to and benefits of DG in Australia is the report prepared by the CSIRO (Australian Commonwealth Scientific and Research Organisation) as a result of its Energy Transformed flagship program[6].

This report entitled *Intelligent Grid: A value proposition for wide-scale distributed energy solutions in Australia*, (December 2009) outlines the potential contribution distributed energy can make to significantly reduce greenhouse gas emissions in Australia and how these benefits can be realised. The study estimates the value of wide-scale uptake of distributed energy in Australia could be worth as much as A$130 billion in 2010 dollars by 2050.

As a part of the review of barrier studies in Australia, CSIRO (2009) conducted interviews with 47 industry and government stakeholders. This research suggested a hierarchy of issues to be addressed before DG (as a subset of distributed energy), achieves a wide scale uptake. These include:

- a lack of commercial viability as an alternative to mains grid supply;
- the value of DG is not captured where it reduces emissions, or costs that are otherwise socialised, primarily seen as costs of peak demand infrastructure. This also reduces the commercial viability of DG;
- policy and regulatory uncertainty of DG reduce the confidence and certainty of investors to implement DG. Regulations do not create strong incentives for cost efficiency and planning standards limit the correct value of DG to be realised;
- cultural bias of consumers, industry, and government against DG due to a lack of understanding of the value of DG compared with the status quo. Consumers may also face information asymmetries and have difficulty understanding the grid connection process; and
- immature DG market means that the cost and reliability of DG technologies are sub optimal. High capital costs also mean that domestic consumers refrain from adopting DG when they lack access to cheap finance.

Incomplete energy prices and decision making bias, combined with an absence of an equitable, transparent valuation of DG technology and a insufficient understanding of the payment arrangements for DG have resulted in the value of DG being under-estimated.

[6] Source: http://www.csiro.au/org/Energy-Transformed-Flagship-Overview.html

Ontario, Canada

Through the Integrated Power System Plan (IPSP), the province is committed to doubling renewable energy capacity by 2025.In the context of this renewable energy target, the Ministry of Energy in 2005 requested that the Ontario Power Authority (OPA) and the OEB work together to address barriers to the development of small electricity generating projects using clean or renewable energy sources that are connected to the electricity distribution system in the province.

In November 2006, the OPA launched a Renewable Energy Standard Offer Program (RESOP) for the province, a program that focuses on generators under 10 megawatts connected to the distribution system. The RESOP is not a DG / DE program explicitly, however DG / DE is "coincidentally" eligible. According to the WWF survey referred to below, the RESOP program has a very minor amount of DG contracted in Toronto (6.7 MW in service through 50 contracts in the Toronto Zone) and so cannot be considered successful.

The most recent description of the barriers to DG in Canada that we found was a stakeholder survey of barriers and benefits of DG in Toronto[7]. The stakeholder survey was based upon 41 in-depth interviews and a literature review.

Overall, the main barrier that drives the others appear to be a lack of a strategic vision and plan for DG development to counter the inherent problems for DG raised by the centralised power generation model. The resulting system barriers privilege the needs of large central generators and extensive transmission and distribution infrastructure. Other barriers apparent in the survey were:

- a lack of knowledge of the benefits of DG due to a lack of information to the public;
- a costly and complicated regulatory environment meaning there is a lack of coordination and strategy across the market to support DG projects
- the financial cost of DG projects remains prohibitive; and
- energy prices do not capture the environmental benefits of DG.

Nord Pool (with a focus on Denmark)

The prime driving force for DG comes from initiatives to increase energy generation from renewable energy in accordance with targets set by European Commission.

Denmark seems to have further developed DG than the other Nordic countries. For example, Norway and Sweden have limited DG power of 1,500 kW (Komulainen & Kumpulainen, 2002). This fact is said to unsurprising given the low number of independent power producers in Norway, Finland and Sweden, creating less of a need of detailed DG policy recommendations or requirements. For this reason, we concentrate on Denmark.

[7] Distributed Generation in Toronto: A Stakeholder Survey of Barriers and Benefits. WWF (2009)

The Danish Authority in 2005 reported that some 57% of electrical capacity comes from CHP and 31% from renewables. This high penetration of DG appears to have been achieved through regulatory measures that resulted in incentives to promote CHP (heat planning legislation), and a FIT to promote both renewables and CHP[8].

Denmark politically fostered the development and diffusion of wind and CHP units in response to the oil crises. From 1% in 1980 to the current high penetration already cited, the progression of DG has benefited mainly from direct regulation that has a longer 'track record' than in many other developed countries.

No very recent explicit information was found pertaining to barriers in the Nord Pool market. The lack of standards and requirements for the connection of different DG technologies, the high cost of DG energy production and immature DG market environment are all cited in 2002 as restricting DG development.

Clearly, DG is more highly developed in certain countries like Denmark, and this would seem to indicate that the barriers have been overcome mainly by the regulatory regime. The success of DG in Denmark is also said to be due to the bottom up approach with large numbers of small firms, municipalities and cooperatives working in close cooperation (Martin, 2009).

[8] www.ens.dk/sw16508.asp Danish Energy Authority www.ens.dk

2. Introduction

This report analyses the barriers to the growth of distributed generation (DG) in New Zealand. It is written for the Energy and Conservation Authority (EECA) in response to a Request for Proposal in January 2010.

The analysis will inform EECA in its role of advising the Government on the imperative to actively support that development and to understand its role in encouraging the growth of this industry.

A wide range of factors inhibit the growth of distributed generation (DG) in New Zealand. Some of these factors constitute barriers in the sense of the approach taken by the NZ Courts (as summarised by the Commerce Commission[9]).

> *There may be considerable debate over whether or not particular matters qualify as barriers to entry in an economic sense. However, the New Zealand Courts have indicated they are not concerned with whether particular conditions are barriers in the technical sense, but rather whether they have the potential to prevent, impede or slow entry and expansion, and if so to what extent.*

There are a number of impediments to the development of greater DG that are not barriers in this sense. Some issues perceived as barriers are the outright technical and financial viability of a project. When it comes to the point of considering a role for government it is one thing to lower barriers. Facilitating poorly conceived projects, however, is an entirely different matter.

To the extent that a study of barriers invites a regulatory response, NZ Treasury provides guidelines[10] on how any such propositions should be approached.

> *The government wants to ensure that proposals involving regulatory options are subject to careful and robust Regulatory Impact analysis (RIA) to be certain that the problem cannot be adequately addressed through private arrangements, and that a regulatory solution is required in the public interest*.

When embarking on policy work Treasury recommends[11].

> *If there are potential regulatory implications that will lead to submission of a Cabinet paper a Preliminary Impact and Risk Assessment should be carried out* and

[9] Paragraph 216 Commerce Commission Investigation Report Commerce Act 1986 S 27, S 30 and S 36 Electricity Investigation 21 May 2009

[10] NZ Treasury *Regulatory Impact Analysis handbook* Section 2.1 (Nov. 2009)

[11] NZ Treasury *A quick guide to Cabinet's Regulatory Impact Analysis (RIA) requirements*

even if there are no potential regulatory implications the RIA framework still provides a useful basis for analysis

The stated research objective of this study[12] is to:

> Provide a wide ranging and comprehensive analysis of barriers to the greater uptake of distributed generation in New Zealand's electricity sector.

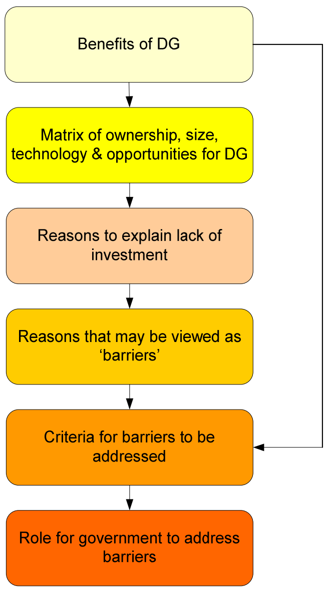
It draws upon and complements previous analysis undertaken by EECA on DG barriers as well as a host of research and survey materials sourced from New Zealand and overseas markets. It converges with the RIA approach with the question of what, if anything, should be done about the harriers. Again, the RIA is clear about this[13]:

> *The government's RIA framework encourages an evidence-based approach to policy development which helps ensure that all practical options for addressing the problem have been considered and the benefits of the preferred option not only exceed the costs but will deliver the highest level of net benefit.*

On the basis of what was sought by the RFP and Treasury's RIA approach, the methodology set out below has been followed in the preparation of this report.

Our approach was to break the question into the component parts set out in Figure 1 below. The aim of this approach was to ensure that we met the stated objective and provided a framework for the development of a public policy response in this sector.

Figure 1: Steps for analysis of barriers to greater DG uptake



[12] Request for proposal (RFP), Analysis of barriers to distributed generation (DG). Prepared by the Energy Efficiency and Conservation Authority (28 January 2009)

[13] NZ Treasury *Regulatory Impact Analysis handbook* Section 2.1 (Nov. 2009)

The report is structured accordingly. First, the forms of DG and some of the benefits from the use of DG are set out. This is followed by a consideration of the types of owners/developers of DG and the different motivations that may drive them to investigate the possibilities afforded by installing it. Having followed this logic the report then considered a comprehensive list of barriers agreed with EECA at the outset of the project.

To inform the discussion of barriers in New Zealand, we examined the international energy policy literature on DG and researched the barriers to DG in a selection of overseas electricity markets. These markets, in agreement with EECA, included:

- United Kingdom
- Australia (National Energy Market and Wholesale Energy Market)
- California
- Ontario (Canada)
- Northern Europe: Nord Pool

3. DG and its benefits

Distributed generation is characterised in many ways depending on the source and it orientation. The table below is a list of current DG technologies and fuels derived from a variety of sources. It shows that DG technology is a heterogeneous mixture of technologies. Some of these are old technology, some are new. Some are still very expensive and other less so. Some rely on renewable fuel sources and some rely on fossil fuels.

Technology	Fuel	Capacity
Solar PV (rooftop)	Sunlight	2–5 kilowatts-peak
Photovoltaics	Sunlight	>100 kW
On-site (micro) wind	Wind	5kW - 5 MW
On-shore wind	Wind	>5 MW
Small (micro) hydro	Water head	<10MW
Geothermal	Geothermal steam	1–100 MW
Biomass	Biomass - grown liquids and solids	1–20 MW
Fuel cell	Natural gas, fuel oil, hydrogen	1kW - 10 MW
Micro CHP	Natural gas, liquid fuels	500kW - 5 MW
Combined heat power (CHP)	Natural gas, liquid fuels	>5 MW
Micro Turbine	Natural gas, diesel, propane	25 - 500kW
Gas Turbine	Natural gas, liquid fuels	500kW - 300MW
Steam Turbine	Natural gas, liquid and solid fuels	Extensive
Reciprocating Engine	Combustible gas, gasoline, diesel	1 kW - 15 kW
Standing engine	Natural gas and some liquid fuels	1 - 25kW

The benefits of DG also vary depending on its technology, fuel source, size and location. The tables below list the advantages or benefits. The first table is reproduced from a report on local energy systems for New Zealand prepared by the Parliamentary

Commissioner for Environment[14] . Many lists prepared around the world are quite similar. There are a number of more commercial benefits that also appear on such lists and these are added on a composite second list. What the two tables highlight is the diversity of benefits that can be attributed to DG.

The potential benefits of local energy systems include:
• making use of energy sources, particularly renewable sources, that are not suitable for large electricity generating plants
• reducing the use of non-renewable energy sources, and their related emissions of greenhouse gases
• increasing the overall efficiency and resilience of energy systems by spreading energy generation throughout the network
• improving energy security by making end-users more self-reliant
• promoting economic competition by introducing new technologies into the marketplace
• encouraging regional development by creating jobs in New Zealand for designers, manufacturers, and tradespeople
• raising individuals' awareness of energy use, leading to behavioural changes
• improving health and reducing 'fuel poverty' by delivering warmer homes at lower running costs

Other benefits from wider uptake of DG include:
Greater network reliability (especially with the emergence of Smart Networks)
Less import into (and possibly export from) the network could result in • Deferred network investment • Lower transmission charges • Reduced energy losses
Reduced use of fossil fuels at peak demand
Reduced environmental impacts from smaller scale (including micro) installations
Lower energy prices as a result of a combination of greater competition, lower distribution/transmission costs and more diverse generation to support security of supply

[14] Parliamentary Commissioner for the Environment 'Get smart, think small Local energy systems for New Zealand' (2006)

At the heart of the barriers issue lies the problem that developers are not necessarily able to capture the total value of the benefits they are providing. That might be addressed through market design or intervention so that falls into a disucsison about the role for government. Some of these benefits are already the subject of policy in the following areas:

- Infrastructure
- Energy
- Environment and climate change
- Regional development

4. DG owners/developers

As observed earlier, DG is not a homogeneous product. DG installations differ in many ways, including their technology, fuel, and also their ownership.

The motivation of DG developers differs depending on the technology they intend to deploy, the scale of the generator and the intended use of the output. The way these motivations manifest themselves may vary amongst owners/developers. Some of the key motivations appear to be:

- A desire for self sufficiency
- Lower power bills in the long term
- Investment risk/ reward
- A sense of contribution to environmental goals
- A desire to exploit a small-scale energy source

Owners or investors or developers will weigh these differently. For the purpose of discussing barriers to greater uptake of DG we have identified five categories of DG owners or developers who may have different weightings of motivations as follows:

1. Domestic (< 10 kW)

Urban domestic users tend to be motivated to reduce their power bills and, to some extent, contribute to reducing carbon emissions. There may be an element of self sufficiency; however this might be more the case in rural or remote settings. These considerations may outweigh high initial establishment costs. Some small users will factor in the capital costs against lower power bills but others may assign a high value to greater independence and contribution to environmental goals.

2. Commercial (>10kW)

Commercial users, whether office blocks, factories or farms, are likely to assign a higher weighting to the payback period of the DG installation. They will balance the investment cost against their power bills in the same way they make other business decisions. Self sufficiency and contribution to environmental goals are likely to be considered but are less likely to be the primary reason to invest in DG.

The dynamics for CHP generation may be slightly different again. This is more about higher energy efficiency which has a commercial benefit. Again, the environmental benefits may be factored into the decision but are less likely to be the primary motivation.

3. Independent embedded

The developer of embedded DG may have a combination of the same motivations as the users discussed above but these motivations may take quite a different form. They may see an opportunity to exploit a local fuel source (e.g. micro wind, a vision to develop exiting infrastructure (for example putting mini hydro into an irrigation race) or a desire to contribute to satisfy local consumers as discussed above.

In the section on benefits we noted that lines companies are supportive of DG as long as it meets a number of criteria around reliability and safety. They observe anecdotally that many DG opportunities brought to them are the vision of potential developers who are filled with passion but are short on practicalities or commercial understanding.

4. Grid connected (large renewable)

Many commentators equate DG with embedded generation. In its broadest sense it might include plant being developed independently of the portfolio generators capitalising on a specific fuel source (e.g. WEL networks Te Uku project) or a commercial operation (such as cogeneration at Te Rapa). These projects are included in an assessment of barriers to DG because they share some of the frustrations of the other categories listed here.

5. Stand alone power system (SPS)

Stand alone power might include PV in marine or mountain settings that do not connect to a network through to diesel gensets used as emergency power in hospitals. Again, these are included in this discussion because some of the frustrations are shared by the owners of these installations.

6. Explaining lack of investment

Developers or investors in DG of all sizes and motivations will face a number of problems to be solved before a project can start delivering power and with it, benefits. This section examines those hurdles. It is intended to inform EECA on ways it might assist developers.

Some of these hurdles are the normal hurdles associated with any purchase or business decision. For example, if a homeowner wishes to make alterations to their house there are a many elements to the decision. There are tradeoffs that have to be made between different features and there are always inconveniences in undertaking the alteration. Similarly, a business upgrading plant has to weigh the merits of the new plant against the pay back period. Lastly, developers of innovative machinery have to find a buyer, or bear the costs themselves.

Some of these hurdles are burdens faced by DG developers because of its scale, technology and fuel source. As discussed, industry arrangements are set up to cater more for large scale centralised generation than for smaller scale distributed generation. Some of the costs of establishing new generation are disproportionably high for small scale generation. It may also be that the arrangements simply fail to capture the full economic value of the DG and all beneficiaries are worse off if the development does not go ahead as a result. Some of these hurdles are barriers posed by biased market arrangements or unnecessary regulatory burden and these may warrant some change to market arrangements or intervention as discussed in the following section.

This section groups the hurdles in five ways as follows:

1. **The electricity industry status quo prevails**

The main reason to explain the reduced uptake of DG is that historically, institutions and practices around generating and distributing electricity have developed around a central large scale generation model.

The importance of the influence of the existing centralised generation model in terms of explicitly or implicitly creating barriers to DG is underlined in both New Zealand and in the overseas examples in section 9.

Martin (2009) directly links the significant barriers that DG will face in the future if it is to flourish to the centralised generation paradigm. The recent quest for energy efficiency and reliability and the reduction of greenhouse gas emissions are said to be behind the impetus to support certain DG technologies.

The study draws on examples from Europe and the UK, where the large differences in DG penetration are said to be due to the different regulatory aspects, political decisions, and the historical evolution of the electricity sector. In particular, the hurdles he describes are technical, economic, regulatory and environmental in nature, summarised below.

- Technical: The need to reinforce distribution networks due to new DG capabilities.

- Price competitiveness: DG is not as competitive as electricity generated from centralised sources. (The exception might be where transmission constraints limit imports into a particular region.) Many DG technologies have a prohibitively high cost per kWh, requiring more research and development to bring such costs down.

- Regulatory barriers: regulatory hurdles continue to impede the spread of DG as network operators have little incentive to give distributed generators access while distributed generators are unable to realise the full value of their generation.

- Environmental impact: Some forms of DG have adverse effects in terms of GHG emissions, such as diesel reciprocating engines. This is a barrier insofar as DG will have to privilege cleaner technologies in order to become a sustainable alternative paradigm.

If DG is to become a realistic alternative to centralised generation, it must overcome these hurdles. The example of Denmark (discussed in section 9) is referred to as proof that this is possible.

The role of DG has come to the fore relatively recently in response to two phenomena. Firstly, rising power costs have seen attention shift to cost-efficient solutions and decentralised generation is seen as having a strong role in reducing transmission costs at least. Secondly, there is a strong association between the thrust for renewable generation and energy efficiency with small scale generation located nearer to load centres.

2. Recognising the potential of DG

The cost of electricity has, until the last decade, been a relatively small part of domestic costs and industrial costs. The merit of harnessing local fuel sources has been less pronounced than is the case now. Information on where to go and what can be done is still relatively sparse. It is still, by any measure, a nascent industry.

3. Regulatory technical, and scale hassles

Institutional arrangements have been slow to provide for DG. The balance between the impact of DG on electrical systems and the environment has to be weighed against the benefits of it.

4. Financial viability of establishing DG

Some of the technologies that lend themselves best to small scale DG are still expensive. The best example of this is the cost of domestic photovoltaic. Removing all of the barriers that exist will not necessarily lower the cost of installing PV. As we see in a number of countries, PV has only taken a strong foothold where governments have subsidised the capital costs and installation costs.

5. Capturing network and transmission benefits

Establishment of a strong DG base can result in lowering the investment requirement for transmission and distribution. Measuring these benefits and incorporating an ability to pass these on to DG owners is not straightforward.

7. The barriers

The discussion of each hurdle includes references, where pertinent, to each of these different categories of developer/investor.

7.1. The electricity industry status quo prevails

1. For decades energy solutions have been primarily based on a central generation model relying on transmission and distribution for delivery. The professional body (engineers, architects, regulators, economists and technology focussed groups) responsible for the next generation of energy are trained and have gained their experience under this model. Even with pressure on the industry arising from environmental policy and security of supply concerns, any variation to this model may be seen as innovation more than part of a mainstream solution.

   Domestic and Commercial applications. Historically, back-up generation has mainly taken the form of diesel generators available where grid connected supply fails. Photovoltaics have been confined to bursts of enthusiasm to harness a green fuel but the technology has been prohibitively expensive. Various other forms of DG at this level have not had anything like the impetus they now have.

   Embedded generation. There have always been small generation units and indeed there are small hydro units established when electricity first arrived in New Zealand that are still operating today. They were the original embedded generators and now look very much like the DG now being encouraged. However, the incentives to develop DG have just not had much momentum until, perhaps, the last decade.

   Grid connected. Grid-connected DG has mainly taken the form of cogeneration or CHP. Grid-connected distributed generation has mainly come to the fore in the form of renewable generation and this has been lead by wind.

   SPS. Technology advances and lines costs have inspired a significant uptake of independent generation units. There are a growing number of houses that are off grid and there are a number of applications for miniature PV. These include weather stations and navigational aids in waterways.

2. For developers or investors establishing DG is complicated because of the maze of regulatory, installation and electrical requirements. Institutional arrangements favour centralised generation. Market and regulatory arrangements have not evolved in a way that allows the DG developer to access the full value of the benefits DG provides.

   Domestic and Commercial applications. Even with a focus on energy efficiency and a potential contribution to environmental goals the DG industry is very new in New Zealand. The DG regulations have been a step in the right direction.

Embedded generation. It is this group who probably face the greatest frustration in this section. The interest in and findings from EECA's DG fund demonstrate this. Surveys of applicants to the fund cite the cost and frustration of the resource consent process as a key barrier. A second key barrier is the technical requirement imposed by lines companies before connection,

Grid connected. This section is less acute for grid-connected generators. They tend to be larger in scale. They tend to be associated with a substantial business or directly associated with established generator/retailers.

3. Until very recently energy supply has been relatively much cheaper compared to other costs, thus the case for DG has been intuitively less compelling.

Domestic and commercial applications. The cost of gas fired generation and the realties of the impact of fossil fuel generation on the environment have seen a growing awareness of the merits of DG for domestic and commercial uses.

Embedded. The development of embedded generation tends to have been driven by a desire to reduce load on networks or to harness a local fuel source. The increase in the overall cost of electricity supply has augmented this trend but each project still has to meet its own commercial thresholds before it can go ahead. 75% of respondents to EECA's survey of applicants to the feasibility study cite cost, off take prices or financial viability as the key barrier.

Grid connected. This is not such a strong point for grid-connected generation as this space has been mostly filled with cogeneration or CHP. That approach to generation has been pursued because of its cost effectiveness. However, as with the other developer types, the possibilities of DG providing a cost effective alternative to traditional generation and especially an alternative to fossil fuelled generation has seen more of this type of DG pursued.

4. Climate change provides an impetus for renewable generation of all sizes but climate change policy does not translate into improving incentives for DG.

Domestic. Of the owner classifications, the domestic users may be the least commercially orientated and the most emotionally orientated relatively speaking. The thought of doing something for the environment may motivate many consumers but there is a limit to how much of their own costs they might go to make that contribution.

Commercial. Commercial businesses may want to contribute to environmental goals but they are even less likely to do it at a net cost than domestic users.

Embedded. It is likely that a high proportion of embedded generation proposals draw heavily on the environmental benefits to justify projects. For the purpose of funding and investment this may not be sufficient justification.

Grid connected. Larger scale DG may weigh environmental benefits but are even less likely to factor environmental goals into decision making.

7.2. Recognising the potential of DG

1. Consumers with a potential to install DG fall into two categories, those who are not aware of the possibilities and those who are. In the case of potential installers who are not aware of the possibility the hurdle is to make them aware.

For those who are aware of the possibility the hurdles include:

- Knowing where to start to find a quality product and choose an appropriately trained installer
- Understanding the financial benefits of DG
- Understanding the regulatory and legal requirements for DG owners

Domestic and Commercial applications. The domestic and small scale DG industry is a nascent industry in New Zealand terms. For anyone interested mainstream DG, advertising is limited. Information can be found in the Yellow Pages where alternative Energy needs are lumped together under "solar energy equipment" where admittedly there are a number of options. A Google search on a variety of likely subjects mostly directs interested parties to EECA. Further hunting turns up a commercial website http://www.whatpowercrisis.co.nz/ that offers "NZ's Alternative Energy Centre". There are sure to be other sources of information, but the point is that anyone seeking to install generation has difficulty in finding suppliers.

A search under generation on the BRANZ website yields a paper entitled Generating Energy at Home dated August/September 2008. This is a quite useful look at the subject. It, in turn, references The Parliamentary Commissioner for the Environment's publication 'Get smart, think small – Local energy systems in New Zealand' (2006).

A search for 'distributed generation' on the website of each of the five principal generator/retailers in New Zealand turned up one result. That generator/retailer supplies

- Answers to FAQs,
- Terms and conditions for residential distributed generation
- Application for residential distributed generation
- Distributors' responsibilities

An article in the April 2010 *Lifestyle farmer* sets out the issue relating to renewable energy. *Lifestyle farmer* is not necessarily a mainstream paper but it is a new phenomenon to see such articles with accompanying advertisements for roof top generation options. The article states that "*as electricity climbs some rural property owners are looking towards renewable energy systems.*

Michael Lawley of EcoInnovations is quoted as saying "*we can't recommend an investment in a sustainable energy system unless it makes economic sense*". He also urges potential investors to understand the process. He recommends investors "*go into this with your eyes open and ensure you are fully informed*"

Clearly, information about the possibilities afforded by micro generation for the home and commercial premises is limited and is not readily available.

Embedded. 75% of respondents to EECA's survey of applications for funding from the Feasibility fund stated that they had a low or very low understanding of the viability of their project prior to completing the feasibility study. All respondents reported a significant increase in their understanding of the financial, technical and environmental viability of their embedded generation projects

A search for 'distributed generation' on five lines company websites produced five out of five results as shown below. Each website provided quite comprehensive information on what to do, where to go and who to talk to about embedded generation within that network. That does not mean that the companies were necessarily helpful or encouraging, but it does show that they want to be in discussions with anyone wanting to connect to their network.

These references explain

- What is meant by distributed generation;
- The steps that must be taken;
- The equipment that must be installed;
- The standards that must be met when connecting to the network; and
- How distributed generation can be used to reduce peak load charges where applicable.

2. Potential embedded generation DG developers may also face the hurdle of not knowing where to start but the issue for them is more likely to revolve around
   - Suitable locations for their particular DG type
   - The ability to evaluate the best of several possible locations
   - An understanding of the distribution network charges, transmission charging regime and the benefits to the network owner.
3. The increase in the cost of delivered electricity has been the focus of many consumers but the habits of consumption (usage, choice of appliances or plant and the fit-out of buildings) remain based on historical usage patterns.

Domestic and Commercial applications. As consumers we buy our electricity from retailers and, as a rule, we look to them to know what our options might be to reduce cost or otherwise better manage our consumption. Recent years have seen a higher level of advice on energy efficiency helped by the step change in costs that occurred between 2000 and 2005 as well as the awareness of the link between consumption and climate change. As shown above only one of five of the main retailers in New Zealand is forthcoming in the area of DG.

4. In renting situations where ownership of the DG assets and responsibility for power bills are not linked, the incentive to consider DG solutions is even less than with domestic owner occupiers. Landlords have little incentive to invest in building energy management – including DG - given that the tenant pays the energy bills.

Similarly, tenants have little incentive to spend their money on energy-related capital improvements such as DG.

7.3. Regulatory, technical and scale hassles

1. Standards, codes of practice and supplier accreditation schemes differ from other electrical products in two ways. Firstly, DG that has the ability to feed back into the network or grid requires a framework specific to that practice. Secondly, at the current low levels of penetration, it may be less developed than other electrical products. This can make it more difficult for consumers to ensure that they have selected the right product and that the product that they have selected will be installed correctly.

   Domestic and Commercial applications. As discussed above it is difficult enough to establish the possibilities afforded by domestic scale generation; actually getting the right product installed is a further difficulty.

   Embedded. Clearly the lines companies are keen to be involved with any party wishing to connect generation on their network. Inevitably they will have concerns about managing the flows, power factor and outages. They actually have an incentive to encourage DG as it has the potential to lower their costs and defer investment. None of that necessarily translates into enthusiastic support for the developer.

2. The DG connection process may still be difficult despite the regulations. This is exacerbated by a lack of agreed technical standards for the connection of DG amongst lines companies.

3. The scale of New Zealand's micro DG industry may result in high installation and locally sourced component costs relative to other countries. The speed at which the industry is able to develop and take advantage of new technological developments may be limited.

   This is certainly the case for wind generation, with a global turbine shortage as reported in Barry & Chapman (2009). As a result of the shortage, and rising steel prices, turbines are difficult and expensive to source from overseas. This high cost of turbines along with the exchange rate variations was identified by the IEA as the main market barriers to wind power in New Zealand.

4. In remote locations DG may be able to serve as an economic alternative to distribution services. The incentive for this should be clear in the continuity of supply provisions in the Electricity Industry Bill (S107 – S110).

5. The concept of the innovation diffusion curve describes the different stages of the evolution and uptake of new technology. In particular, innovators and early adopters face the hurdle of securing funding for R&D, accessing venture capital high technology risk and institutional arrangements favouring "old" technology.

6. Obtaining resource and building consents for DG may be as cumbersome and costly as gaining consents for generation schemes that are larger and more environmentally invasive. The degree of difficulty also may vary from council to council.

Embedded and grid connected DG. This is probably the most pronounced example of a process that is geared up for the large projects and, as a result, can be disproportionately expensive for smaller scale projects. Clearly there is a sound purpose to the RMA and DG projects should face a process that balances the consumers' needs with the merits of DG, but it may be possible for the process to be more accessible. As Chapman notes:

> *Both small and large wind generation projects have reported faced significant barriers in obtaining resource consents. Although the costs are similar irrespective of whether a small or large project is at issue, the delay is reportedly longer for large-scale wind farms* (Barry & Chapman (2009)).

7. DG developers may not be familiar with tax implications of developing or other financing options.

   For example, according to the EC's model domestic contract for delivered electricity (April 2008), a generator is liable to pay income tax on any money received for exported electricity. Further, exporting electricity constitutes a taxable activity for GST (and requires GST registration) if the total value exceeds $40,000 in any 12 month period.

7.4. Financial viability of DG

1. DG developers may be unwilling or unable to sell directly to the wholesale (spot) market, take the price volatility risk and face the prudential requirements. This may be a result of their own risk appetite or a reflection of the project finance requirements.

Embedded. The issue of financial viability is critical. Even if all of the other barriers were swept away, the issue of being able to secure adequate prices with adequate certainty and for a satisfactory duration can be the core factor. As things stand in New Zealand, embedded generation is, for the most part, offered to established generator/retailers who are essentially, competitors. A number of other arrangements are emerging such as small scale start up retailers (e.g. Simply Energy[15]), lines companies, (subject to the provisions of the ERIA) and other possible arrangements matching with nearby load. Even so, for the purpose of raising capital or funding, the prospective value of the off take is a critical issue. As noted by Barry & Chapman:

> *In the discussion of wind, independent generators have difficulty finding hedge contracts to cover their spot market exposure. Further, the relatively small number of large, vertically integrated companies that compete in both retail and generation markets implies a potential*

[15] See Simply Energy's website http://www.simplyenergy.co.nz/

problem for small, independent wind developers. These developers have little option but to negotiate power purchase agreements with retailers who are not only considerably larger, but will also likely be a competitor in the generation market (Barry & Chapman (2009).

In the survey of applicants to EECA's feasibility fund, 75% of respondents cited financial viability and central to that was the subject of securing an off take arrangement.

Grid connected. Most grid-connected DG is developed in collaboration with industrial processes or by generator/retailers that have portfolios and can absorb the risk management issues.

2. If DG developers who cannot or will not sell directly to the wholesale market face the prospect of selling their electricity to a vertically integrated retailer who may lack incentives to offer prices above their cost of generation.

3. No liquid and transparent forward market exists for DG developers to forward sell or mange their risks.

   This is about to change. In response to the Ministerial Review and provisions in the Electricity Industry Bill 111-1 (2009), Government Bill industry has initiated the development of an electricity futures contract. Announcements reported on June 3[16] set out what is underway:

   EnergyHedge Limited, the company established by the five major generators to develop the electricity forward market in line with the requirements of the Ministerial Review, has announced that the Australian Securities Exchange (ASX) has won the contract to provide the trading platform and central clearing house for the New Zealand electricity futures and options market.

   The Ministerial Review into electricity market performance completed last year recommended that all major electricity generators with over 500MW of capacity put in place an electricity hedge market by 1 June.

   Contact Energy, Genesis Energy, Meridian Energy, Mighty River Power, and TrustPower are all required to participate.

   The market needs to pass a liquidity test by 1 June 2011, defined as 3,000GWh of unmatched open interest.

   Futures contracts are fixed volume, standard dates and predetermined duration. Critically they are able to be traded by anyone regardless of their credit worthiness as long as they can meet the deposit and margin requirements of the exchange. This development means that stand alone generators or retailers will have an avenue to protect against price volatility. Bespoke contracts would still be available from the generator/retailers or intermediaries. Tailored contracts

[16] Matt Richie Energy News *ASX wins contract for electricity hedge market* Thursday June 3 2010

might become more available if intermediaries emerge prepared to sell them t investors and use the futures contract to manage their risk.

4. Few electricity retailers offer to purchase electricity from small scale generation or publish buy-back rates. This can make it difficult for consumers with small scale generation to identify the best deal for them.

   Domestic and Commercial applications. We are aware that some generator retailers offer an attractive buy back rate for under 3kW but they do not actively encourage it. Even at prices quoted for that scale it is not necessarily economic based on the cost of the technologies adopted.

5. Capital costs may be higher relative to the price of network-supplied electricity.

6. For domestic users in particular there may be a link between the length of payback for DG, the average duration of house ownership and a perception that buyers may discount the value of DG.

7.5. Capturing network and transmission benefits

1. DG developers may face difficulties with some network owners negotiating to access some of the avoided transmission benefits that result from the establishment of the DG.

2. Network upgrades required to connect a DG plant will benefit other DG plant connected to the network in the same locality at a later date. The pricing principles in the DG regulations state that the cost of upgrades for the initial DG plant will be paid up front by the DG owner. A portion of these costs will then be refunded to the initial DG plant owner if other DG plant are connected which share the initial DG plant's network upgrades within a three year time period. As a result, DG connection charges *may* be inconsistent and hence discriminatory when compared with load connection charges and DG developers may face significant uncertainties as to whether they may be able to recoup shared connection costs.

8. What constitutes a barrier

Based on the number of reports, submissions and presentations on DG, and as seen in the multiple barriers described in the previous section, there are clearly a number of frustrations experienced by prospective investors and developers.

Some of these are about the viability of projects. Often the developer or investor will assign a high value to self sufficiency and lower power bills going forward so that personal cost benefit analysis is satisfied but that may not meet the financial viability threshold of another investor. For others, technology might be expensive and they are reliant on prices paid for energy to validate the project. That leads to the question of whether the frustration is a barrier in the sense of market failure or the high cost of regulation. That, in turn, leads to the question of whether there is a role for government, a question that is discussed in a later section.

In brief the role of Government in this respect is to determine whether the activity in question is of net benefit to society in the first instance. If it is then their role is to determine whether the barriers should be addressed. This can be done by ensuring that the market design is fit for purpose and if not then going about modifying it. If it is fit for purpose then there may be a case for intervention. That is the point where a discussion on appropriate interventions arises.

This paper does not carry out a cost benefit analysis as an input for public policy development. It does look at the barriers facing developers of each category of DG as defined earlier.

The approach taken by the NZ Courts (as summarised by the Commerce Commission[17]) is as follows:

> *There may be considerable debate over whether or not particular matters qualify as barriers to entry in an economic sense. However, the New Zealand Courts have indicated they are not concerned with whether particular conditions are barriers in the technical sense, but rather whether they have the potential to prevent, impede or slow entry and expansion, and if so to what extent.*

While we are able to point to the benefits of DG, that does not mean all DG is necessary beneficial. Some projects may be too difficult or so expensive that their viability is not so much an issue of accessing the value of those benefits, rather, of primary concern is it being a non-viable project.

The following table summarises the barriers for the purpose of considering a role for government. It is based on the barriers discussed in the previous chapter and findings from international comparator studies to be found in following chapters.

[17] Paragraph 216 Commerce Commission Investigation Report Commerce Act 1986 S 27, S 30 and S 36 Electricity Investigation (21 May 2009)

Table 1: Barriers to greater development of DG

Barriers to greater development of DG	
The electricity industry status quo prevails	Energy solutions are historically based on a central generation model relying on transmission and distribution for deliver
	Institutional arrangements, rules and regulations, installation and electrical requirements favour centralised generation over DG
	Energy supply has historically been much cheaper relative to other costs than it is now and promotion of alternate energy sources is weak
	Environmental concerns have created an impetus for renewable generation of all sizes but not the financial incentives
Recognising the potential of DG	Access to information on the possibility of alternative energy sources is not readily available to domestic consumers
	DG developers also face the issue of where to start with the steps required to establish embedded generation
Regulatory, technical and scale hassles	Standards, codes of practice and supplier accreditation schemes are inconsistent and potentially onerous
	The DG connection process is still difficult even with the DG regulations.
	Micro DG faces high installation costs and high costs for locally sourced component
	Obtaining resource and building consents for DG is costly, difficult appears to be over-the-top for small scale generation
	DG developers may struggle with the tax implications of developing DG
Financial viability of DG	DG developers may be reluctant to sell direct to the wholesale (spot) market
	There is no access to a liquid and transparent forward electricity market
	DG developers face the prospect of forward selling their electricity to competitors
	Capital costs for DG may be high relative to the price of network supplied electricity
	Adopting new technology can be extra costly and risky
	Few electricity retailers offer to buy back excess output from micro DG
	The length of payback for DG may be too long for house owners
Capturing network and transmission benefits	Distributors do not necessarily pass back benefits of higher security, investment deferral or avoided transmission charges
	Distributors may lack the incentive to invest in support of DG

9. DG in New Zealand – specific examples

In this section we report the most pertinent material reviewed on research into DG initiatives, barriers and progress in New Zealand. This section aims to provide concrete examples for some of the barriers discussed in the previous section, and is based on material provided by EECA and from our own research. Several examples from this section have been cited in the discussion of the barriers section 6 above.

We begin the section by reviewing the barriers to DG as expressed in the feedback from a relatively new fund available to encourage DG development initiated by EECA. We then review some of the barriers to specific forms of DG in New Zealand demonstrated in the literature. Lastly, although it is of indirect relevance to DG, we reflect on some consumer attitudes to energy efficiency.

EECA's DG Fund

Since 2008, EECA has operated a DG fund to identify and support DG projects. It provides funding for feasibility studies and aims to facilitate DG projects that have the potential to becoming financially viable but have failed to attract investment as a result of undue barriers. Other aims include testing the DG market to demonstrate potential niches for DG projects, and building up a body of evidence and knowledge on the barriers facing DG uptake.

The fund aims to assist with the feasibility stage of a project, and therefore requires developers to demonstrate that their project is sufficiently advanced past the concept and the pre-feasibility stage. The fund's emphasis is on assisting non-traditional developers such as community groups, farming groups/individuals, and local government.

EECA's budget was $310,000 in 2008/09, funded from baseline and operational funds from EECA and the Ministry of Agriculture and Forestry. Up to 75% of the total feasibility study costs of a project are able to be funded, or $20,000, whichever the greater.

In the first year, the two-stage process solicited a large response at the initial EOI stage, with over 100 projects submitted. 39 projects were shortlisted to the RFP stage. Projects that were not approved for evaluation were largely due to insufficient data being provided, or not being sufficiently advanced to the feasibility stage. In the end, 17 feasibility studies were financed and included different DG technologies such as wind, hydro, geothermal, biogas, and heat recovery engines.

In the second year, 2009/10, the fund has a single-stage RFP process. Further, since the first year of the fund, priority areas were identified for the fund. These priority areas are based on criteria relating to industry (related to tourism, diary, or other primary export sector), ownership (community owned or led) or geographical situation (potentially able to defer or delay distribution line upgrade/maintenance in remote sties).

The groups of stakeholders of interest in the fund are all embedded consumers.

To date, 31 projects have been supported to undertake feasibility studies, and all former recipients of the fund have been surveyed. Of interest in this present report are the survey responses (12 in all) provided to us that reveal barriers to DG projects. These barriers included:

1. Financial barriers
    - securing finance for high up-front capital costs, especially for smaller community projects due to a lack of security;
    - projects being economically marginal; and
    - costs being augmented due to lines companies
2. Regulatory barriers

Obtaining resource consents (particularly for wind) was cited as a source of time waste and financial harm.

3. Industry barriers

The respondents, when asked what barriers existed to DG in general (as opposed to their project in particular), cited, in addition, the issue of negotiating favourable terms for selling electricity compared with the prohibitive capital costs. Network companies were said repetitively to be unhelpful in both process and in offering 'fair' prices. Lines companies were cited as a barrier in themselves, and certain companies lack experience in DG connection processes. Established generator retailers were also said to have a lack of incentive in paying for DG, due to the competition aspect that DG represents.

A lack of human resource to advance and work on projects was also cited as a barrier.

In a more general sense, the survey responses demonstrate a certain resentment of the barriers, whether they are financial (needing to justify the project's return), or regulatory (needing to obtain consent under the RMA). Many DG investors seemed to be surprised by the extent of the barriers they faced, and even more so in the sense that these barriers appeared to be unjustified in their view given the fundamental 'good' they thought they were creating by undertaking a DG project.

The findings from the fund tend to support the general barriers in the literature on specific forms of DG, in particular, PV and wind, as discussed below.

Barriers to wind generation

In 2007, wind contributed just 2% of the total electricity supplied in New Zealand according to MED, in stark contrast to EECA estimates of a potential of 23%. Barry & Chapman (2009) examine the development of wind development in New Zealand and identify two precise barriers to the uptake of wind. The types of wind-investors referred to in the article are grid-connected.

These include the strength of local opposition when faced with large scale wind farms, and an insufficient number of investors (Barry & Chapman, 2009). The tendency has been towards large-scale developments, yet the accompanying levels of public opposition and insufficient government intervention in particular and an unsupportive policy environment in general has lead to an erratic investment flow (Barry et al., 2009).

The study conducted by Barry and Chapman is partly based on a survey of rural residents. One of the key barriers to large wind farms, not excluding the three listed below, is that of the negative public attitudes due to the noise and visual externalities. In contrast, attitudes are more favourable concerning small wind farms.

This difference in attitude presents an opportunity for the development of small-scale wind according to the authors. However, specific barriers exist that restrict small scale development, including:

- Development costs – smaller wind farms have higher installation costs than larger farmers yet do not have the economies of scale to realise cost savings. The high upfront cost is the major barrier according to a rural landowner survey reported by Barry et al. Further, the grid is sparse, so it is technically difficult to integrate small wind farms to the grid. In the background, and partly driving the cost is the difficulty in importing wind turbines.
- Unstable market for generated output with difficulty in selling output to the relatively small number of large, vertically integrated companies. This is coupled with the unstable spot price and the difficulty of hedging against spot market exposure.
- Resource consent process. As for large wind farm developments, small scale projects have difficulty obtaining a resource consent (although it may take less time compared with a large developer) and face a relatively higher cost in getting through the RMA process compared with a large project.

Hydro generation

Anecdotal evidence from the DG feasibility fund has evoked the difficulty in obtaining a RMA consent for a hydro project, despite the solid economic basis. For example, feedback from one investor whose project involved a cost of generation of 5-6 cents per kWh nevertheless met with barriers. These were reported by him to be roadblocks raised by the regional council as well as difficulties raised by DOC, both of which had discouraged the investor to the point of almost abandoning the project in preference of overseas options.

Solar generation

A recent report prepared for MED provides a comprehensive review of the solar electricity landscape in New Zealand and discusses the future potential for PV in the future (IT Power Australia Pty Ltd, 2009).

The New Zealand PV sector is characterised by a majority of small and diverse companies, with an increasing number of PV brands available compared with the past. There is limited local manufacture. The barriers discussed refer mainly to domestic and commercial investors connected to the low voltage electricity network via grid interactive inverters.

The report describes a rather ad hoc situation for the installation of PV in terms of certification of professionals trained to install these systems. The majority of installers are reported to be able to work on only extra low voltage stand alone power systems due to the requirement to have a registered electrician for voltages over 120 VDC. Many of the people in the industry are self taught, with the expected variety of quality and system performance.

Industry surveys undertaken by SEANZ (SEANZ, 2007) and by the authors indicate a typical annual market deployment rate between 420 – 750 kWp with some 15 – 25% growth in 2008.

Apart from two large grid installation projects in 2008, the remainder of the solar PV deployment is mainly small off-grid or fringe of grid remote homes with system sizes between 0.5 kWp – 2kWp. There have been a number of larger off-grid installations since 2007, for example on Little Barrier Island, or a system near Wanaka.

Of interest in the report are the many barriers that affect or have the potential to affect PV uptake in New Zealand. These include:

- High up front costs of investing in PV, which, for off-grid systems, are compared to either the cost of connecting to the grid (or if grid connected, the cost of ongoing electricity bills). Value is not usually given to the environmental benefits from PV, or to the potential increased home value or future energy savings from PV. Businesses, however, seem to be more aware of the environmental benefits of solar PV, for example, shown by the Auckland International Airport (51 kWp)
- Poor awareness of PV and a lack of understanding of how technology may be applied.
- An absence of means to identify competent system designers or installers and a lack of awareness of the standards for PV system installation. Further, a lack of skilled workers was noted as reducing the ability of companies to offer safe and reliable systems.
- Electricity buyback arrangements are complicated and costly for grid-connected generators, and for generators choosing to sell to a retailer, there is no way to ensure a fair price is received, nor is there an obligation for a retailer to purchase electricity.
- Building approval processes are long and increase the cost for many installations.
- Lack of energy rating scheme that applies to PV.

- Small market size and a lack of competition amongst suppliers.

*Barriers to microgeneration in New Zealand*A 2006 study prepared for the Parliamentary Commissioner for the Environment considered the uptake and potential of micro-electricity generation[18]. It included micro generation- technology in the small domestic and commercial contexts, and included grid-connected and stand alone microgeneration technologies.[19]

The table below summarise the barriers to DG micro-technologies identified in the report. We can see that the main barriers include first and foremost a relatively high unit-cost of installation and in some cases, maintenance, compared with central-grid electricity. Also of note is the barrier of resource consents; either the fact that they must be obtained, or the delay in obtaining them. The barrier of immature markets, that is, technology not being available, was also cited.

Summary of barriers to microgeneration

Source	Technology	Comment	Barrier
Wind	Rooftop turbines	Usually used as a grid-connected option acting as an on-site electricity demand modifier	Need to obtain a resource consent Relatively expensive maintenance costs and unit costs Restricted usage conditions due to noise a possible barrier Technology is not available
	Pole-mounted miro turbines	Mostly on remote sites, off grid	Lengthy delay to obtain resource consents High relative cost for on-grid applications Noise externalities High relative cost
Hydro	Micro hydro (impulse turbines)	Mostly off grid; If on-grid, used for demand modification	Requires a suitable stream or river with adequate head; restricted to rural sites

[18] Microgeneration was defined as including generation of electricity, heat, or motive power on a small scale

[19] Microgeneration was defined as any positive generation (or 'fuel' substitution) from 0- 1 MW for heat or 0-300-500kW for electricity.

Solar	Photovoltaic (on-grid)	Off and on grid	Relatively high unit cost (but relatively low maintenance cost)

Consumer attitudes to energy efficiency in general

DG appears indirectly in the debate on renewable energy, to which a considerable amount of resource and energy has been devoted by EECA's ENERGYWISE program. ENERGYWISE is EECA's consumer programme that provides information and funding for householders so they can make the most of energy efficiency, energy conservation and renewable energy.

Respondents to the survey mainly associated renewable energy with wind, hydro, solar and water-generated electricity

House owners may voluntarily choose to obtain a Home Energy Rating, which assesses the energy efficiency performance of a home. It gives a star rating from 0 to 10 stars and requires an assessor to be engaged, for whom a fee is charged and set by the assessor.

As a part of ENERGYWISE research, in 2009, EECA undertook market research into trying to understand the public's attitude to energy efficiency. In an online survey, 803 respondents were surveyed and were asked questions that revealed their attitudes to energy efficiency and the priority and role it takes in their lives[20].

The survey found that although the majority are either ambivalent, open to or committed to using energy wisely, the main driver behind people actually acting on improving the energy efficiency of their home is monetary.

This is despite the fact that people appeared to be motivated by more than just the cost component. Although many (26%) were motivated by the chance to save money, over a third of those surveyed were motivated by environmental concerns. For example, some said they were motivated by a sense of environmental responsibility, or having a healthier living environment.

Of note in the survey however in the group of people who were open to using energy wisely was the importance of a lack of information for consumers that was almost as important a barrier as not having enough money or the type of dwelling when faced with adopting efficient heating. Those who said they could not get clear advice, did not know enough, or did not know what to do made up 28% of the barriers to adopting energy wisely.

[20] *Understanding commitment to action research*. Presentation by Paul Halford, 2 November 2009.

Therefore we might conclude that although financial barriers are the principal impediment to living in a more energy efficient way, informational barriers are also important.

In a similar vein, EECA's Consumer Market Research monitor (conducted every quarter) tracks the attitudes and awareness of the public in relation to energy efficiency. In the last quarter of 2009, of note is the positive support felt for renewable energy by the majority of New Zealanders. In response to the question of agreement or disagreement that renewable energy is something that needs focus in the future, 82% supported renewable energy (either strongly agreeing or agreeing). Also of note is the apparent desire of New Zealanders to learn more about efficient fuel sources. In particular, for small scale renewable energy, the majority of respondents said they wanted to learn more and only 11% on average (across the different types of energy) said they were not interested in learning more.

The importance of income as a barrier in taking up energy efficient improvements is echoed in a survey of the now Home Energy Rating Scheme conducted in 2007. Across the board, income played a large part in influencing the decision to invest in energy efficient measures in the home, with middle or higher income people less likely to invest because they prefer to invest in more tangible things or are willing to pay extra for slightly higher bills[21]. This survey further underlined the interest in obtaining energy information, and the importance of the cost of investment to homeowners.

With respects to a Home Energy Rating, homeowners generally supported such a rating but only a minority (one third) thought that it should be mandatory.

A further report prepared for EECA in 2005 addressed the barriers to energy efficient housing in New Zealand, and supported the findings of the Energywise survey[22]. Based on surveys conducted in low and zero energy houses, the main barriers perceived by people to building a low energy house were (in order of frequency) the perceived or real cost, a lack of industry expertise, lifestyle disadvantages, lack of specific information, and a lack of willingness by the industry to use the technologies (Stoecklein, 2005).

In the report's discussion of the intervention methods required to overcome these barriers, we note that reported results from a UK survey on barriers for sustainable buildings also raised cost as the main barrier and in particular the lack of fiscal incentives offered to offset the cost.

[21] Maximising the potential take-up of HERS (July 2007)

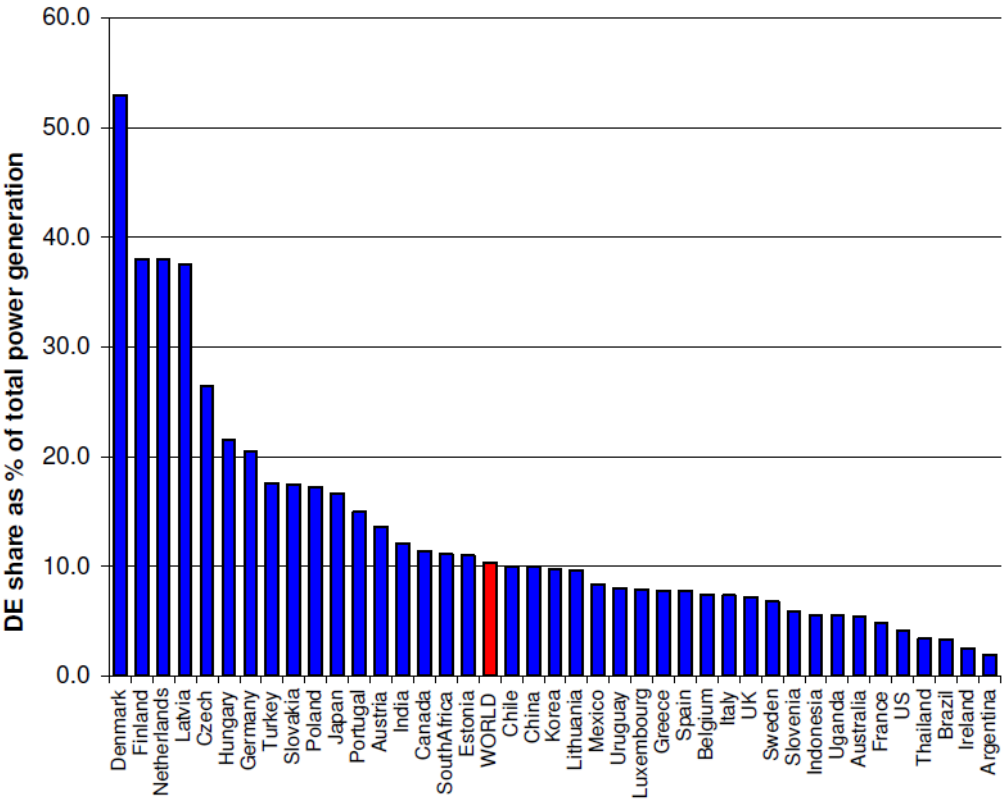
[22] Survey participants were selected through public advertisement in mainstream newspapers according to some building performance criteria. 28 applications were selected, and these represented households with above-average income levels.

10. Barriers to DG in overseas markets

In this section we review the barriers and impediments to DG discussed in section 7 as demonstrated in overseas markets. It is difficult to make general comparisons about DG penetration due to the wide range of variables that affect its uptake between countries. These variables may include the geographic characteristics; resource endowments; climate; population density; energy market structure; policy; and regulatory context.

The considerable difference of distributed energy penetration can be seen in the following graph.

Figure 2 Proportion of total power generation from decentralized capacity



Source: World Survey of decentralized energy (WADE) (2006)

New Zealand does not feature on this table. Even our largest neighbour, Australia, is well below average. Common to all these markets is the drive for carbon-reduction or environmentally responsible policies that has driven attention to DG. Also common to these markets, unsurprisingly, is the influence of the central generation model that drives barriers to DG. Some countries appear to be more advanced than others in overcoming the barriers to DG, or at least in formulating well-intentioned policy to do so, such as the UK or California.

Countries with very high DG deployment are located in Northern Europe; the high DG deployment there may be influenced by their colder climates, their particular focused government policy on heat supply or their response to issues of fuel dependency and energy scarcity. Denmark in particular has been relatively successful in developing DG, The influences are complex in nature, but it seems that even in a very different market, such as Indian and China, DG can have relatively high penetration thanks to its flexibility (CSIRO, 2009)

The following sub-sections discuss the barriers in California, the UK, Australia, Ontario (Canada), and Nord Pool, with a focus on Denmark. Due to the specificities of these countries, in some cases the barriers discovered are very specific and concentrate on only one subset of DG, for example, micro DG in the UK.

The barriers in Table 1 above were considered when examining the DG landscape in each country in order to identify points of comparison with New Zealand.

Further, we have kept in mind the different viewpoints of, and impacts on, the five categories of developers or investors discussed above.

10.1. California

Regulatory bodies

California's energy markets were opened to competition in 1998, when the State's investor-owned facilities turned their private transmission power lines over to the system operator, the California ISO[23], to manage.

The California Energy Commission (CEC) is the State's primary energy policy and planning agency. A part of its role consists in forecasting future energy needs and promoting energy efficiency, which includes supporting renewable energy. Privately owned electric companies are regulated by the California Public Utilities Commission (CPUC). The CPUC is responsible for assuring California utility customers have safe, reliable utility service at reasonable rates, protecting utility customers from fraud, and promoting the health of California's economy.

Background

California is served by about 75 load-serving entities (LSEs). Six of those are investor-owned utilities, and 48 are publicly owned utilities. The investor owned utilities send

[23] Independent System Operator

power through some 200,000 miles of overhead transmission lines and an additional 70,000 miles of underground lines.

The most significant change to the industry was made in 2001, called Rule 21, which is the CPUC's interconnection policy that enables eligible wholesale generators to interconnect distributed generation systems to the electrical grid[24].

Rule 21 aimed to address interconnection issues by developing standard interconnection rules.

Since the 1980s, the use of DG resources has increased dramatically in California due to policies related to interconnection, net energy metering, and procurement, as well as programs related to advancing the integration of clean, DG resources, such as the California Solar Initiative (CSI) and the Self-Generation Incentive Program (SGIP). Compared to the rest of the Untied States, California has a significant amount of DG installed on the grid, particularly solar. In 2002, more than 2,000 MW were classified as DG, and emergency backup generators added 3,000 MW to this[25].

DG driven by renewable energy policies

Closely related to DG development, is the drive for renewable energy generation. The State has a Renewables Portfolio Standard (RPS), which requires electric corporations to increase procurement from eligible renewable energy resources by at least 1% of their retail sales annually. The target was 20% by 2010, and California lawmakers are currently developing legislation to increase this to 33% by 2020.

The California Public Utilities Commission (CPUC) and California Energy Commission (Energy Commission) have endorsed this change and the CPUC has been analysing the possible strategies on the cost, risk, and timing of meeting a 33% RPS. A preliminary report released in June 2009[26] identified the 33% goal as ‘highly ambitious’. In order to conduct the implementation analysis, four unique renewable resource cases were developed, all of which remain at the prospective phase.

One of the resource cases was the High Distributed Generation (DG) Case, which assumed limited new transmission corridors could be developed to access additional renewable resources needed to achieve a 33% RPS. In reality, extensive, smaller-scale, renewable generation is interconnected to the distribution system or close to transmission substations.

[24] Rule 21 describes the interconnection, operating and metering requirements for generation facilities to be connected to a utility’s distribution system. Rule 21 refers to the rules of the utility, and not the rules of the CPUC, and lists tariffs for each of California’s large investor owned utilities (IOUs). The CPUC has taken over the leadership of Rule 21 from the CEC since 2008, and this process appears to be in train according to the CPUC website.

[25] CEC *Distributed Generation Strategic Plan* (2002)

[26] California Public Utilities Commission « 33% Renewables Portfolio Standard Implementation Analysis Preliminary Results » June 2009

The largest barrier to adoption of the high DG case seemed to be the cost. The cost of a high DG case was evaluated at almost double that of the costs of the reference case, which represented the State's current renewable path, heavily dependent on new technologies, such as central station solar thermal. This high cost may be influenced by the fragmented nature of the PV industry, with a large number of small developers installing PV and natural gas engines provided by large equipment suppliers. The high cost of the DG case was due to the heavy reliance on solar PV resources, which are more expensive to install than wind and central station solar.

The examples from California illustrate that although DG's potential is recognised, it is not currently a significant energy resource; the current DG penetration is 2.5 percent of total peak demand in California. Due to low penetration rates, DG installations do not have a large impact on, nor are they integrated with, the State's electric and natural gas infrastructures. As a result, many projects are highly customized and rely on incentives.

Barriers to DG in California

The DG industry is still a nascent one that survives despite some difficult market conditions. There are numerous institutional, industry and market barriers that have impeded the growth and adoption of DG to date.

A search through the three main regulatory bodies with regards to electricity in California yielded a great deal of information on DG, an in particular two reports which have informed this section.

The California Energy Commission in 2002 released a DG Strategic plan, and in 2010, a report was prepared for the CPUC on the impacts of DG. This latter report indicates that as yet there are no noticeable impacts on the distribution and transmission infrastructures, based on performed studies[27].

The CEC defined DG in its strategic report as "electric generation connected to the distribution level of the transmission and distribution grid usually located at or near the intended place of use".

The primary barrier to entry for DG technology was the lack of interconnection standards in 2002. The barriers below therefore apply to grid connected entities.

For DG projects under 20 MW prior to 2001, interconnection involved working with the individual local utility companies providing distribution depending on the procedures at the different utilities. There was no uniform size limit among the utilities regarding interconnection to the distribution grid. Different and sometimes conflicting series of requirements were a challenge to DG facilities, as well as a high level of uncertainty on interconnection costs. Among the types of issues encountered by DG projects were:

[27] http://www.cpuc.ca.gov/PUC/energy/DistGen/impactreport.htm "Impacts of Distributed Generation. Final Report" prepared for CPUC by Itron, Inc. January 2010.

- high application fees
- requirements for interconnection studies
- interconnection hardware
- operational constraints
- utility imposed testing (pre-operational and operational)
- standby and backup rates
- demand ratchets

Three main barriers

The 2002 strategic report identified three types of barriers[28]. These included:

- Technical barriers: including technical standards for interconnecting DG to the grid; testing and certification procedures for interconnection equipment
- Business practice barriers: including standard business terms and practices for a utility review of interconnections
- Regulatory barriers: lack of regulatory tariffs and incentives for DG

In addition to these, the strategic report pointed to the importance of addressing the barrier of market behaviour, consumer education, and cost barriers.

Based on discussions with a variety of consumer groups, developers, and financing institutions, the CEC believed that regulatory uncertainty in California was a major concern for those considering the deployment of distributed generation. Utility rate design was described as 'confusing, at best, including issues surrounding standby charges, interconnection fees, exit fees, and grid management charges'.
The timing of legislative mandates regarding rate design and the ultimate implementation of those policies also carry confusion and uncertainty to DG stakeholders[29].

[28] These barriers drew on material from a previous (2001) report by Alderfer, R. Brent et al. *Making Connections: Case Studies of Interconnection Barriers and their Impact on Distributed Power Projects*, NREL (National Renewable Energy Laboratories) SR-200-28053, May 2000.
[29] A specific issue discussed in the 2002 report was the 2001 decision by the state to suspend direct access, which effectively removed the incentive of DG users to sell excess power to other retail customers. At that time (2002), market rules did not accommodate export into wholesale or retail markets.

An example of regulatory uncertainty mentioned in a CEC roadmap report[30] was the California ISO rules (for example, high DG aggregation requirement and metering requirements) which highly discourage DG and cogeneration customers from participating in wholesale markets[31]. To balance this uncertainty, it appears that rules and regulations have been developed and implemented that encourage some forms of DG through subsidies, incentives, and recognition of DG in procurement and planning processes[32]. We describe some of these in the following section "Policies in support of DG".

A series of questions and issues were raised in the 2002 report, all of which are highly pertinent for DG development and are reproduced, for completeness, in the table below. The 2002 report does not answer all of these, as its purpose is to set out a strategy to address solutions in the future.

Issues for DG in California
Interconnection issues
Can interconnection rules be standardized throughout California? *Can interconnection be made more user-friendly to the end-use consumer?* *Can a substantial amount of DG be interconnected in both radial and networked distribution systems?* *Are there safe, reliable and cost-effective interconnection solutions for radial and networked distribution systems?* *Can interconnection solutions be deployed in a timely manner?* *Can engineering studies for interconnection be eliminated, standardized, or streamlined?* *Is a single DG unit compatible with end-use equipment or other DG equipment?* *Can qualified interconnection systems be certified so that they may be installed with minimal field-testing?* *Have potential DG installations been postponed or abandoned due to existing interconnection rules or costs?*
Environmental

[30] CEC *Distributed Generation and Cogeneration Policy Roadmap for California*. March 2007.

[31] California Energy Commission. March 2007. DISTRIBUTED GENERATION AND COGENERATION POLICY ROADMAP FOR CALIFORNIA. www.energy.ca.gov/2007publications/.../CEC-500-2007-021.PDF

[32] For example, the CPUC introduced new feed-in tariffs available for the purchase of up to 480 MW of renewable generating capacity from small facilities throughout California. These "feed-in tariffs" present a simple mechanism for small renewable generators to sell power to the utility at predefined terms and conditions, without contract negotiations http://www.cpuc.ca.gov/PUC/energy/Renewables/feedintariffssum.htm

issues
What are the local population and environmental impacts from DG technologies and how can these impacts be minimised or mitigated? *What are the regional population and environmental impacts of DG technologies and how can these impacts be minimized or mitigated?* *What are the environmental life-cycle impacts of DG compared to central station power plants?* *What technologies and emission controls are needed to make air emissions from DG as clean as those from central station power plants by 2007?* *What would be the best way to promote waste-to-energy DG projects that help improve air/water quality and reduce greenhouse gases?*
Grid Effects issues
What are the beneficial/detrimental impacts of high-penetration DG on the T&D system and how may they be quantified and assessed for value? *What are the limits to the level of DG that the grid can absorb without adverse impacts?* *What are the limitations on bi-directional power?* *Should the design of new distribution feeders consider DG?* *Can the concept of microgrids be made practical? Can they be effectively utilized?*

In the 2010 report, many of the same issues in the above table were identified, including reliability and transmission issues, and interconnection issues related to grid operation and system capacity.

Even though Rule 21 began addressing a number of issues associated with DG implementation in California, a number of issues remain to be addressed in 2010, including[33]:

Policy Issues:

- Movement from uniform towards utility-specific interconnection rules
- Repositories for Certification of DG equipment and dispute resolution records
- Consistency of utility-related cost collections to ensure equitable cost sharing between customer and rate payer
- Possible changes in distribution design criteria to allow for high penetration of PV associated with new housing developments (and more generally change the acceptable level of voltage drop on the distribution system)

[33] Itron *Impacts of Distributed Generation* (CPUC) January 2010

- Streamlining of interconnection requirements between conflicting FERC/CAISO transmission and CPUC/IOU distribution rules
- Appropriate mechanisms to inform developers of sites more suitable for DG than others
- How utilities can share distribution grid information without compromising security issues

Technical Issues:

- Broadening of IEEE 1547 standard to incorporate Rule 21 technical items
- Metering and data transmission for more complex DG systems
- Additional protection needs associated with power export from DG systems
- Islanding and micro-grid issues
- Determining appropriate level of backup protection (to protect the grid from possible problems caused by DG systems) and identifying appropriate party responsible for costs
- Certification of interconnected DG systems, sunset dates for certification and resolution of "recall" issues associated with previously certified systems already installed
- Establishing a uniform measure of DG penetration as a percent of peak demand.

These two lists demonstrate the extent of barriers still in existence in California. We now briefly discuss some of the policies in place to begin to overcome these barriers, and then summarise the barriers in Table 2

Policies in support of DG

Rule 21 notwithstanding, the CPUC has oversight of policies and programs related to DG resources in California's investor owned utility (IOU) territories. The CPUC regulates DG on both the customer and wholesale fronts. It administers DG incentive programs for the customer side (also referred to as 'onsite generation' or 'self generation'). Below, we list some of the most prominent DG initiatives enacted by the CPUC[34], which are pertinent to domestic, commercial, embedded and SPS customers.

California Solar Initiative: California's customers receive upfront incentives when they install solar electric systems on homes, businesses and public sites under the California Solar Initiative. Customers in the San Diego Gas & Electric

[34] http://www.cpuc.ca.gov/PUC/energy/DistGen/index.htm

territory are currently eligible for incentives for solar water heating technologies. The CPUC is currently considering a proposal for a state-wide solar water heating incentive program.

Self Generation Incentive Program: California's electric utility customers receive incentives when they install wind turbines, fuel cell cells, or storage system in conjunction with wind turbines or fuel cells under the Self Generation Incentive Program.

Emerging renewables program: Incentives for small (under 30 MW) wind and fuel cell systems are offered under the Energy Commission's Emerging Renewables Program.

On the wholesale side, the CPUC oversees a variety of policies related to wholesale DG, which means in this context customers exporting onto the electrical system. These programs are available for power plants, including customer-owned generators, in selected territories of California, and include FITs for small renewable energy generation, CHP tariffs, and special credits. For example:

Net Energy Metering tariffs enable customers to generate energy that offsets their electric load at retail rates.

Renewable Energy Credits (RECs) are "created" by a renewable generator simultaneous to the production of electricity and can subsequently be sold separately from the underlying energy. It gives the holder a claim on the renewable attributes of one unit of energy generated from a renewable resource.

Table 2: Summary of barriers - California

Barriers and impediments - summary for California	
Barrier	**Description of barrier**
Status quo prevails	No direct example in the reports examined, however the relatively higher cost of DG technologies and the low penetration of DG in the market are suggestive of the status quo prevailing.
Information impediments	For grid-connected customers, utility rate design information is confusing and there are issues regarding interconnection fees, and grid management charges.
Regulatory /scale hassles	Regulatory uncertainty exists; a lack of regulatory tariffs and incentives for DG exist, and ISO rules discourage DG customers from participating in wholesale markets.
Cost and value of establishing DG	DG technologies are relatively more expensive to establish and source. The PV domestic market is highly fragmented.
Capturing network and transmission benefits	A lack of incentives exist for grid connected DG. A lack of regulatory tariffs appears to demonstrate that transmission benefits are not fully captured.

10.2. United Kingdom

DG is defined in the United Kingdom by the Office of the Gas and Electricity Markets (Ofgem) [35] as *any generation which is connected directly into the distribution network, as opposed to connecting the transmission network (up to and including 132 kV voltages), as well as Combined Heat and Power (CHP) of any scale.*

Background to DG in the UK

The national grid first started operation in the 1930s and developed rapidly through the 1950s and 1960s. Until the 1990s there was a continuous process of building large power stations that were located near the fuel source (coal or nuclear), but relatively far from the concentrations of load both geographically and electrically. When the industry was re-examined in 1990, newly privatised generation companies saw new opportunities in generation. Interest in DG was driven in part by the government’s low carbon energy policy and saw a surge in CHP. At this time, financial incentives were introduced by the

[35] Ofgem (2007) *Review of distributed generation*

government to encourage renewable generation[36]. Until 1990, DG was almost extinct, due to the economies gained by building larger power stations that outweighed the additional transport costs of taking electricity to consumers[37].

DG has grown remarkably since the early nineties. In 1993/4 there was 1.2 GW of distributed, independent generation in England and Wales. This has grown to over 12 GW in the ENA's DG connection activity in UK Distribution Networks report[38] (June, 2007).

The discussion and examination of DG technologies is closely couched and appears to be a direct result of the Government's strategy to pursue low-carbon energy generation.

A review by the Ofgem carried out in 2007 examined, amongst other things, the potential benefits to having a more decentralised energy supply, as well as the barriers to and incentives for DG. Wide consultation and several research reports were drawn upon to complete the review.

The review was done in the context of the Government's Energy White Paper (2007) and the Government's Energy Review Report (2006), which highlighted the challenges faced by climate change and identified the potential carbon dioxide reductions possible from the increased use of DG.

Barriers identified in the UK

Three general key market and regulatory failures affecting DG were listed in the Ofgem review:

1. Market value for carbon. The implication is that DG technologies and opportunities are not correctly priced in the market, reducing uptake.
2. Regulatory barriers meaning that aspects of the regulatory framework are designed for centralised generation and prevent DG from developing.
3. Informational barriers. No one source of easily understandable information exists on DG opportunities.

Distribution companies in particular continue to face difficulties with DG growth, which continue to act as barriers to DG. These difficulties of a technical nature are due to the

[36] Currently, support for renewable generation is provided by the Renewables Obligation scheme. This requires electricity suppliers to source an increasing proportion of the electricity they sell from renewable sources (www.ofgem.gov.uk/Pages/OfgemHomes.aspx)

[37] Institution of Engineering and Technology (IET) (2006) *Distribution Generation* Sourced from: www.theief.org

[38] ENA (2007) Distributed Generation Connection Activity in the Great British Distribution Networks. The data presented was accurate at June 2007 and information is collected by distribution network operators to illustrate connection activity.

'status quo' impact of the centralised system meaning systems are badly designed for DG. In particular, distribution companies face three difficulties:

1. The management of power flows – ensuring the thermal ratings of circuits are not exceeded by normal running arrangements and specified contingencies

2. Voltage control – ensuring the supply voltage to customers is maintained within the regulations

3. Ensuring system fault levels remain within the rating of equipment[39]

The following table summarises the main barriers found from the literature examined in the UK electricity market. Further detail and examples of these barriers, in particular for microgeneration, follow the table.

[39] IET *Distributed Generation* Source: www.theiet.org/factfiles

Table 3: Summary of barriers - UK

Barriers and impediments - summary for UK	
Barrier	**Description of barrier**
Status quo prevails	The regulatory system was designed for centralised generation. Consumers have high resistance to using new technology to meet their personal energy needs.
Information impediments	Potential users have low awareness of DG options.
Regulatory /scale hassles	Financial incentives exist but are seen as hard to access. Lack of accreditation scheme contributes to discouraging DG suppliers/installers. Obtaining permission for DG technologies is difficult and creates time delays and costs in new community developments.
Cost and value of establishing DG	DG technologies tend to have higher capital costs and they are disadvantaged as long as the true cost of carbon is not considered. Rewards for selling excess electricity are small and difficult to access.
Capturing network and transmission benefits	Identified as a key barrier by Ofgem is the lack of incentive to reward small generators for exporting their excess electricity.

The UK Department of Energy and Climate Change have identified barriers similar to those that exist in New Zealand. The focus in the UK literature is on microgeneration, and is therefore pertinent to consumers and small commercial entities.

Microgeneration

For individual consumers, barriers to installing energy-efficient upgrades (including insulation as well as DG microgeneration) included the high cost, the hassle, and concern about the payback period.

Also with regard to microgeneration, the Ofgem review discussed four barriers pertinent to microgeneration, and also listed action taken to reduce the barrier, as summarised in the following table.

Table 4: Barriers to microgeneration (U.K)

Barriers to microgeneration in the UK	
Barrier	**Policy action**
Cost constraint	Direct grant funding for micro generation installations in homes, communities, public and private sectors (£86 m to 2009). Guidance for obtaining financial benefits from microgeneration is published on the internet.
Technical constraint	No requirement for micro generators to get permission to connect to the network for generators up to 16A/phase.
Regulatory constraints/ opportunities	The Code for Sustainable Homes was published in 2006 and is designed to stimulate demand for microgeneration. Permitted development rights have been extended to householders since August 2007.
Development of the microgeneration industry	Funding for microgeneration research and development is available by the Department for Business Innovation & Skills (BIS), and route maps for each microgeneration technology have been developed by the BIS and industry.

Another report on microgeneration in England, Wales, and Scotland by elementenergy (2008) revealed barriers perceived by consumers and compared them to investment decision making logic taken by a large scale energy generator[40].

The report cited barriers mainly to do with the cost consideration, both for the initial capital costs and the maintenance costs. Consumers had a relatively low willingness to pay for initial costs compared with industry investors, and this barrier is exacerbated by path-dependency behaviour with respect to current energy consumption and general inertia in making the decision to buy microgeneration.

Other barriers at the consumer level included the lack of incentives for landlords of private sector rented houses to invest in microgeneration as they do not derive the on-going benefits.

Investor attitudes to microgeneration

A survey of investor attitudes contained within the elementenergy report with regards to targets for microgeneration announced by the government in 2006 revealed that investments in most low carbon technologies did not provide significant dividends to shareholders. Instead, investors plan for capital growth of shares as the companies themselves grow but particularly as the sector becomes more popular. An ambitious

[40] elementenergy (2008) *The growth potential for Microgeneration in England, Wales, and Scotland.*

target leads to expectations of high sales and therefore improved prospects, which particularly helps companies trying to raise equity-based funding[41].

Licensing and market barriers

Currently, the complexity of market arrangements are uniform and are not tailored to the particular characteristics of an energy scheme. The fact that all suppliers must be registered with the system operator, the National Grid (NGET) means that onerous requirements for information submissions must be met as set out in industry codes[42], which are a burden for small generators with fewer resources to devote to meeting such requirements. Generators that produce over 100 MW in Great Britain must be licensed, and must comply with the Grid Code, whereas generators under 100 MW can apply for licence exemption and are permitted to sell directly to suppliers.

Technical barriers

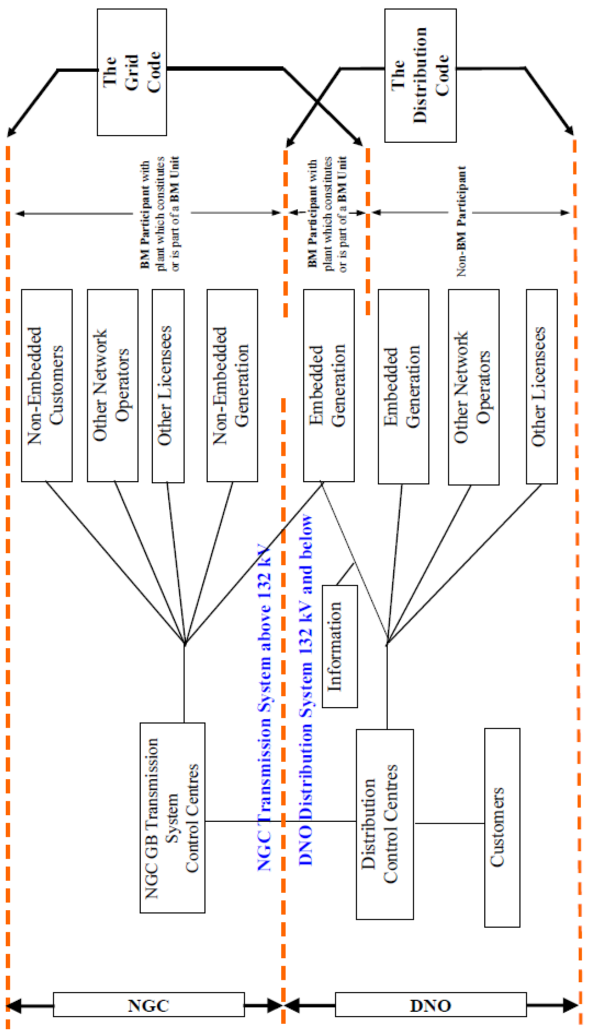
Licensed generators must comply with the Grid Code but smaller generators connected to a distribution system need only meet the Distribution code requirements[43]. The guide to the distribution code boundaries are shown in Figure 3 below.

[41] elementenergy (2008) *The growth potential for Microgeneration in England, Wales, and Scotland.*

[42] See http://www.nationalgrid.com/uk/Electricity/Codes/

[43] Licensed electricity distribution businesses, or Distribution Network Operators (DNOs), are obliged under Condition 21 of their licences to maintain a Distribution Code detailing the technical parameters and considerations relating to connection to, and use of, their electrical networks.

Figure 3: Grid Code and Distribution Code Boundaries in Great Britain



The appendix of the Distribution Code outlines connection requirements for DG according to the voltage generated. For example, an excerpt from the Code relevant to embedded generators follows:

> ***Embedded Generators*** *connected at or below 20kV and with an output not in excess of 5MW shall, as a minimum requirement, comply with the requirements of Item 3, DGD Annex 1 Engineering Recommendation G59/1, "Recommendations for the connection of private generating plant to the Public Electricity Suppliers' distribution systems".*
> ***Embedded Generators*** *connected at a higher voltage or of a larger capacity shall comply with the general principles of Item 4, DGD Annex 1 Engineering*

Recommendation G75/1 "Recommendations for The Connection of embedded generating plant to public distribution systems above 20kV or with outputs over 5MW", subject to the particular requirements of the ***DNO*** *necessitated by the Adjacent* ***DNO's Distribution System*** *conditions, which will be made known by the* ***DNO*** *during the connection application process DPC7.3 "Provision of Information"*

Arguably, a potential DG supplier faces some difficulty in navigating through the complex requirements of the code of which the above excerpt is a minor example. Many detailed informational requirements are also listed in the code.

Barriers to DG are beginning to be addressed through cooperative work programs led by Ofgem and the Department for Innovation, Business and Skills (BIS). The Distribution Working Group (DWG) manages four work programme areas including horizon scanning, network design, active network management, and facilitating small-scale generation[44].

Policy measures and responses

Recent (2007) government policy to stimulate the take up of certain DG technologies include the zero-carbon new homes policy, rewards for low-carbon investments (for example, the Low Carbon Buildings Programme) and the Enhanced Capital Allowance Scheme.

Microgeneration in particular has been targeted by the Government in its 'Warm Homes, Greener Homes' strategy for household energy management (2010). The strategy is part of the Government's aim to reduce carbon emissions from the household sector by 29% before 2020[45]. Concrete parts of the strategy pertinent to DG include making energy companies consult with local authorities to support community scale infrastructure such as district heating networks using CHP[46], and providing financial aid to install smart meters and microgeneration DG.

This strategy also intends to regulate the rental sector by imposing a 'Warm Homes standard' for the social rented sector.

Fiscal incentives also exist, in the form of a reduced value-added-tax (VAT) of 5% applicable to the installation of most microgeneration technologies. Further, private householders who sell surplus power (generated by microgeneration technology) or

[44] Source: ENSG Electricity Networks Strategy Group. http://www.ensg.gov.uk/index.php?article=16. The work program advises on the DNO's regulation that currently discourages the early adoption by consumers of microgeneration and has provided advice on the distributional price control review.

[45] http://www.decc.gov.uk/ Department of Energy and Climate Change

[46] DECC (2010) Warm Homes, Greener Homes: A strategy for Household Energy Management.

Renewable Obligation Certificates (ROCs) to energy retailers are exempt from income tax on that revenue.

From the 1st April 2010, the Government is introducing a FIT regime that will ensure a 5-8% ROI for the installation of renewable micro generation in homes.

CHP currently benefits from a range of policies to promote its update, for example, developers using CHP are exempt from the Climate Change Levy and Business Rates.

Policy measures to date include the implementation of incentives for distribution network (DN) Operating systems to minimise connection costs for new DG, to reduce losses, and to innovate for new DG connections and across the DN generally. Ofgem also supports the Distribution Working Group, a group which is focused on developing DNO networks to grow DG. More detail is available on these measures from Ofgem's 'Review of Distributed Generation' (2007) report.

10.3. Australia: NEM

10.3.1. AEMO (National Electricity Market)

The Australian Energy Market Operator (AEMO) conducts the market through a centrally-coordinated dispatch process that pools generation from producers and delivers required quantities of electricity from the pool to wholesale consumers. One of the specific activities in achieving this includes managing the scheduling and dispatch of generators.

The introduction of the Carbon Pollution Reduction Scheme (CPRS) and the Expanded Renewable Energy Target (eRET) in Australia is currently a significant influence in the energy market. No concrete change to the existing electricity market rules have yet been undertaken, however a period of consultation and reflection is underway. As in other jurisdictions, the principal motivation for DG policy advancement in Australia is the drive to pursue carbon reduction in energy generation.

Recognised potential benefits to, and barriers of, DG (CSIRO)[47]

A major and comprehensive review of the barriers to and benefits of DG in Australia is the report prepared by the CSIRO (Australian Commonwealth Scientific and Research Organisation) as a result of its Energy Transformed flagship program[48].

This report entitled *Intelligent Grid: A value proposition for wide-scale distributed energy solutions in Australia*, (December 2009) outlines the potential contribution distributed energy can make to significantly reduce greenhouse gas emissions in Australia and how these benefits can be realised. The study estimates the value of wide-

[47] This section draws heavily from the CSIRO (2009) report.

[48] Source: http://www.csiro.au/org/Energy-Transformed-Flagship-Overview.html

scale uptake of distributed energy in Australia could be worth as much as A$130 billion in 2010 dollars by 2050.

The barriers to DG are discussed in detail in the CSIRO report and are summarised in the Table 5 below.

Table 5: Summary of barriers - Australia

Barriers and impediments - summary for Australia (NEM)	
Barrier	**Description of barrier**
Status quo prevails	The institutional and legislative framework of the NEM has been developed over many years and has been reinforced by the dominant centralised supply model. The central supply model causes a lack of a pervasive skills base required to deliver distributed energy and diluted incentives to pursue DG. It also complements the central supply model tendency that see highly geared companies financing capital intensive infrastructure paid off over long time periods resulting in low operating costs for energy. Cultural bias towards mains grid energy supply. The 'decision making bias' meaning habits and customs are not favourable to DG (lack of certainty, risk aversion, and reluctance to change habits).
Information impediments	Consumers show decision making bias, and prefer to avoid loss and choose to make imperfect trade offs between incurring costs today to secure benefits in the future. Consumers may face information asymmetries and split incentives, and have difficulty understanding the grid connection process. A lack of understanding by policy makers of the value of energy efficiency. This may be driven by inadequate data, but means it may be difficult to set policy that fully harnesses the value of energy efficiency.
Regulatory /scale hassles	Short term policy horizon for DG means market participants lack incentive and confidence for DG. A building block form of regulation for network businesses does not create strong incentives for dynamic cost efficiency because it links returns directly to the regulated asset base (RAB), or the value of the assets used to provide regulated services. Deterministic planning standards limit the ability for distribution networks to value the benefits of DG and create insufficient competition in the market. Lack of process and technical standardisation may impede efficient connection.

Cost and value of establishing DG	High capital costs mean domestic consumers refrain from adopting DG solutions when they lack access to cheap finance. Technology and market development for DG are immature; therefore costs are inflated and reliability suffers.
Capturing network and transmission benefits	The value of DG solutions is not captured due to incomplete energy prices and also to decision making bias. There is no equitable, transparent valuation of DG and there are uncertain payment arrangements for DG. Energy prices do not reflect environmental and social externalities. In comparison to centralised electricity DG appears relatively expensive and suffers implicitly from a lower driver to undertake DG as it makes financial paybacks longer. Price signals to signal efficient energy consumption are ineffective. The low, flat tariff price signal encourages consumers to prefer sub optimal energy options. Exempt and non-market generators do not have direct access to the wholesale market. Generator output can only be sold to the local retailer or to a customer at the same connection point. The current off-market arrangements do not therefore necessarily capture the value of small generators to the network.

The CSIRO report highlights the central problem for DG that has repeatedly become apparent from examining the literature and from looking at New Zealand and the overseas markets: a centralised supply model dominates by virtue of historical circumstance. The important aspect of the response to this, it is argued, is that the process and methodology for calculating connection costs faced by all new generators are consistent and cognisant of the potential for distortions to occur due to information or negotiating power asymmetry [49].

What we might phrase as path dependency is demonstrated by the way the NEM has developed over many years, with small scale energy and demand management filling niche roles within the dominant centralised supply model.

[49] Currently in the Rules, section K details some of the prudential requirements, capital contributions and prepayments that Distribution Network Service Providers (NSP). It allows a NSP to require an embedded generator or a distribution customer that requires a connection or a modification for an existing connection to establish prudential requirements for connection service and or distribution use of system service. These prudential requirements are left to negotiation between the Distribution NSP and the embedded generator (section 6.21.3). There appears therefore to be a possible barrier to an embedded generator due to the asymmetry of power or influence between itself and what it might negotiate with respects to the more powerful NSP.

The consequences of this central supply dominance appear to be far-ranging. The lack of skills base to develop and implement different DG technologies is largely caused by the complex and disaggregated chain of businesses involved in designing and building the infrastructure that determines energy consumption. The disaggregation of the actors in the energy market means no one business can capture the value from DG, resulting in a dilution of the incentive to pursue DG. As CSIRO notes, the effect is a lack of commercial drive to develop the skills and education that supports the skills required to develop DG.

As a part of the review of barrier studies in Australia, CSIRO (2009) conducted interviews with 47 industry and government stakeholders. This research suggested a hierarchy of issues to be addressed before DG (as a subset of distributed energy), achieves a wide scale uptake. These are:

- Lack of commercial viability as an alternative to mains grid supply.
- Value of DG is not captured where it reduces emissions, or costs that are otherwise socialised, primarily seen as costs of peak demand infrastructure. This also reduces the commercial viability of DG.
- Policy and regulatory uncertainty of DG reduce the confidence and certainty of investors to implement DG.
- Cultural bias of consumers, industry, and government against DG due to a lack of understanding of the value of DG compared with the status quo.
- Immature DG market means that the cost and reliability of DG technologies are sub optimal.

The barriers identified from the interviews were subcategorised into six areas, which either fall directly into or are represented by the categories we have considered in our summary table above.

AEMC and MCE reflections on DG

In its report of October 2009, "A Review of Energy Market Frameworks in light of Climate Change Policies" the Australian Energy Market Commission (AEMC) recognised that there was likely to be a period of substantial change in the operation and design of distribution networks resulting from the introduction of the CPRS and the eRET. Specifically, it said the increased variability of flows on the network may shift the focus of distribution businesses from simply reacting to demand growth to more active management of the network.

Although the AEMC concluded that the existing frameworks did not require amendment, it proposed that the existing Demand Management Incentive Allowance (DMIA) under the Rules should be expanded to accommodate connections of embedded generators[50].

[50] The DMIA is a scheme by the AER for Distribution Network Service Providers (DNSPs) in ACT and NSW. The scheme is in the form of a demand management innovation allowance and has been developed to apply from July 2009-June 2014. The DMIA aims to provide incentives

This would be aimed at encouraging distribution businesses to deliver cost efficient connections for embedded generators. We note that DG at present largely falls outside the scope of the National Electricity Rules generator technical requirements (CSIRO, 2009).

A recent report (December 2009) from the Ministerial Council on Energy (MCE) was a response to the AEMC's report (October 2009). This response document discussed the importance of implementing climate change policies for the long term benefit of Australia and endorsed AEMO initiatives to facilitate the integration of small embedded generators in the NEM.

In this report the MCE has indicated it wished to:

- Create an equitable market and regulatory environment for all participants which reflects the true costs and benefits of participants in the network
- Promote transparency and simplicity in the market and regulatory procedures
- Consider the possible requirements and procedures to develop the market for the sale of power by small and medium generators
- Consider the future need for system management procedures and technologies necessary to accommodate increasing levels of renewable and distributed generation
- Remove impediments to renewable and distributed generation in energy market regulation in a nationally consistent manner [51]

Following the December 2009 review, a discussion paper prepared by the AEMO "Minimising Barriers to Cost-Effective Small Generator Participation in the NEM" aims to assess whether current arrangements realise the potential value of small generators in the NEM. It is currently a discussion document that aims to elicit NEM participant and stakeholder views on a range of matters related to integrating small generation into the NEM more efficiently[52].

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for DNSPs to conduct research and investigation into innovative techniques for managing demand as a future viable alternative to network augmentation (ACCC, 2008).

[51] Minimising barriers to cost-effective small generator participation in the NEM. Discussion paper. AEMO December 2009.

[52] A small generator (also referred to as an embedded generator) is defined as one that is subject to the AEMO's standing exemption from registration for generating systems (one or more generating units) with a nameplate rating of less than 5 MW (or generating systems between 5 and30 MW with an annual export less than 20 GWh).

The consultation process is in train and submissions are due to be published in March 2010. The key driver of the consultation process is to facilitate the use of existing but underutilised embedded generation and the ability of small embedded generators to export energy at time of peak demand in the NEM. Of note is the limited nature of future changes that may arise from the consultation process. Future action will be limited to issues able to be addressed internally or by a rule change proposed by AEMO to the AEMC.

The consultation document and the consultation process reflect a philosophy of wishing to reduce barriers to small generators, including reducing the bureaucratic AEMO registration process, and making the systems and processes within the AEMO more amenable to small generator participation in the NEM. Specifically, the areas of interest of the process include registration and classification, metering and data requirements, and business models and transaction costs. These correspond to the category of regulatory and scale hassles. We describe two of these below as a further example of the barriers summarised in Table 5 above.

Regulatory hassles for registration and classification

Generators that wish to directly access the energy market and other related NEM markets must register with the AEMO. However, the AEMO's current registration process may impede access to the market for small generators. Additionally, the lack of a standardised approach to the AEMO's registration of small generators necessitates a large amount of manual processing for each application which is onerous for both AEMO and prospective market participants. A possible future decision may be to streamline the registration for small generators, making it faster and less expensive than the current $4000 fee for registration[53].

Regulatory hassles - difficult connection process

Currently, small generators must comply with relevant metering requirements in order to participate in the NEM. Generators that wish to participate in the market must be decoupled from any local load components by implementing a gross metering configuration that measures the total import and export energy flows for the separate generator and customer load components within the customer network.

Given the prevalence of a wide variety of metering configurations in small generator networks, it is necessary to determine what metering arrangements for small generators are appropriate to facilitate their entry into various NEM markets. Metering arrangements may be further complicated by the presence of significant losses within some customer networks. A large number of small generators in this situation are unable to calculate and apply Distribution Loss Factors without the network owner registering as a Network Service Provider (NSP) with the Australian Energy Regulator or applying

[53] Under part J section 6.20.1 of the National Electricity Rules for the NEM (version 33, November 2009) , an embedded generator is charged a fixed annual entry charge by the relevant Distribution Network Service Provider at a connected point

for an exemption from registration as an NSP. This barrier acts as a disincentive to their participation in the energy market and other related markets.

10.4. Ontario, Canada: IESO

In Ontario, the market rules describe distributed generation as "embedded generation". Embedded or distributed generation is defined as *small scale production of power connected within the distribution network and not having direct access to the transmission network*.

Currently, much of the energy produced by generators in Ontario is generated by large centralized plants connected to the high voltage transmission system. Distributed Generation, however, is typically located close to the electricity consumer and have been recognised by the IESO as providing significant contribution to security of supply for Ontario consumers and to achieving the Government's objectives for clean and renewable energy supply[54].

Technologies used for embedded generation in Canada include CHP, solar, wind, biomass and gas. In Ontario, these plants are often located "behind the meter" at sites such as hospitals, greenhouses and industrial sites. Other stand alone embedded generation sites are connected directly to distribution systems and are settled in the retail market.

At the time of market opening in Ontario, it was estimated by the Independent Electricity System Operator (IESO) that there were over 1400 MW of installed capacity of embedded generation in the province that was not participating directly in the IESO administered markets. The capacity factor of these resources is not known, nor is their production pattern. Actual DG penetration, according to the Ontario Power Authority in January 2009, is just 88 WM of installed capacity spread out over 77 projects, much of which is used for back up purposes and not for grid generation.

Generators larger than 500 kW require a licence from the Ontario Energy Board (OEB), which obligates that generator to follow the market rules. For smaller generators, obligations still exist under the market rules that concern embedded generators who are market participants, embedded generators who are not registered, or generator "hosts" such as Connected Wholesale Customers or Local Distribution Companies (LDCs).

Renewable energy as a driver of DG

Through the Integrated Power System Plan (IPSP), the province is committed to doubling renewable energy capacity by 2025.In the context of this renewable energy target, the Ministry of Energy in 2005 requested that the Ontario Power Authority (OPA) and the OEB work together to address barriers to the development of small electricity

[54]Stakeholder Engagement SE-57 Embedded Generation Discussion Paper. IESO (2007) http://www.ieso.ca/imoweb/consult/consult_se57.asp

LECG

generating projects using clean or renewable energy sources that are connected to the electricity distribution system in the province.

In September of 2005, the IESO implemented market rule changes to lower the entry barriers for small embedded generators who wished to enter the wholesale market. These changes involved a lesser standard for providing telemetry to the IESO and reduced requirements for revenue meters.

In November 2006, the OPA launched a Renewable Energy Standard Offer Program (RESOP) for the province, a program that focuses on generators under 10 megawatts connected to the distribution system. The RESOP is not a DG / DE program explicitly, however DG / DE is "coincidentally" eligible. RESOP aims to balance renewable targets with value of electricity to ratepayers and provides for program payments to different types of generation, for example non photovoltaic (wind, biomass and waterpower) at $110/MWh base price. According to the WWF survey referred to below, the RESOP program has a very minor amount of DG contracted in Toronto (6.7 MW in service through 50 contracts in the Toronto Zone) and has therefore not been very successful.

Description of barriers

The most recent description of the barriers to DG in Canada that we found was a stakeholder survey of barriers and benefits of DG in Toronto[55]. We have assumed these will be representative of the barriers to DG in Ontario for the purposes of this section.

The stakeholder survey was based upon 41 in-depth interviews and a literature review. We summarise the barriers in the table below, and include the specific barriers identified by the survey's respondents following that Figure 4,

Overall, the main barrier that drives the others appear to be a lack of a strategic vision and plan for DG development to counter the inherent problems for DG raised by the centralised power generation model.

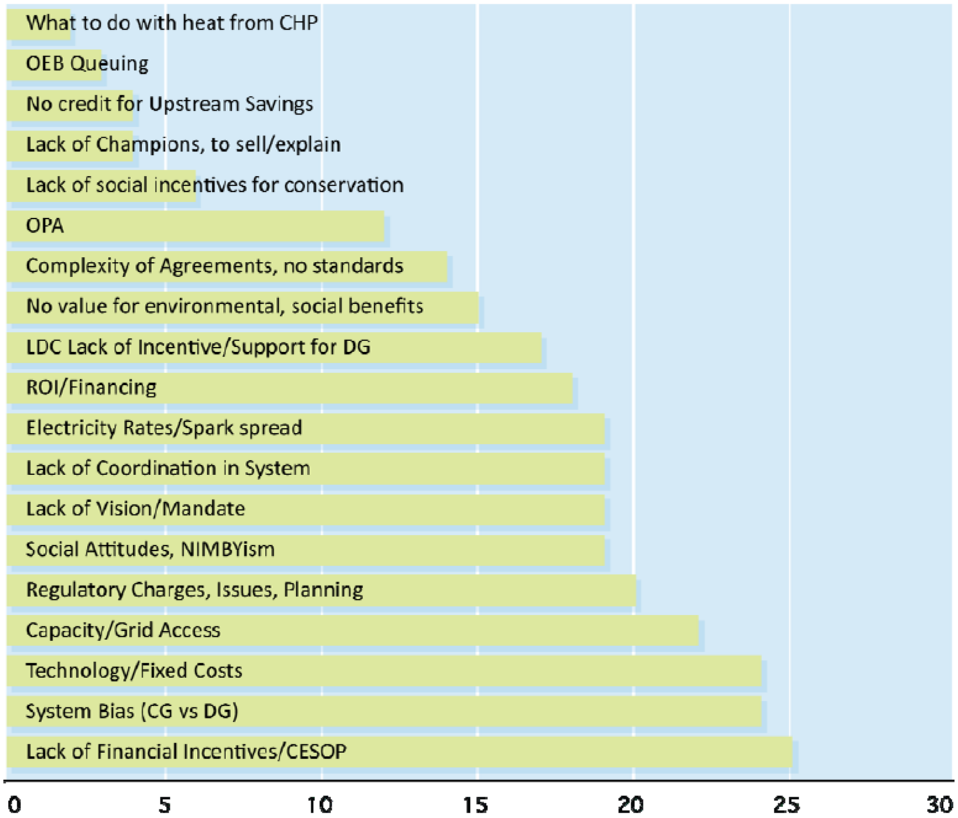
[55] Distributed Generation in Toronto: A Stakeholder Survey of Barriers and Benefits. WWF (2009)

Table 6: Summary of barriers - Canada

Barriers and impediments - summary for Canada (Ontario[56])	
Barrier	**Description of barrier**
Status quo prevails	Ontario has been built on the centralised power generation model. The resulting 'system barriers' privilege the needs of large central generators and extensive transmission and distribution infrastructure.
Information impediments	A lack of information/public education to sell and explain the benefits of DG due to a lack of champions.
Regulatory /scale hassles	Lack of a functioning energy standard offer program to support DG, meaning there is a lack of coordination and strategy across the system to support DG projects. A piecemeal approach to DG policy creates barriers to support individual projects, with a lack of standard connection agreements and policies. High legal, consultant, regulatory costs and lengthy approval processes, with a proportionately higher burden on small proponents. A lack of Lost Revenue Adjustment Mechanism (LRAM) credits for local distribution networks to ensure local distribution companies are not negatively impacted by customers' actions.
Cost and value of establishing DG	A lack of financial incentive meaning the cost of DG projects is relatively prohibitive. Financial barriers exist despite programs like RESOP.
Capturing network and transmission benefits	Environmental benefits and social benefits of DG are not captured in prices. Transmission savings from DG flow to ratepayers, not to DG proponents.

[56] Certain barriers in this table are also drawn from a presentation on DG in the Ontario Regulatory Context in a DG Task Force presentation by J Sidlofsky (Oct. 27 2008)

Figure 4: Specific barriers identified by respondents



10.5. Norway, Denmark, Sweden, Finland: Nord Pool

Countries like Sweden and Denmark are known for their ability to combine high levels of DG with concentrated sources of generation, showing that the two are not mutually exclusive. Both countries are part of the Nord Pool market (the Nordic Power Exchange), the single power market for Norway, Denmark, Estonia, Sweden and Finland.

The prime driving force for DG comes from initiatives to increase energy generation from renewable energy in accordance with targets set by European Commission.

The Nord Pool market covers non-bilateral electricity trading in the Nordic/NordEl regions in Europe. At present, Nord Pool markets for physical trade include Elspot, a day ahead market in which bidding closes at noon for deliveries from midnight and 24 hours ahead; Elbas, in which bidding closes one hour before delivery; and the Regulating Power Market (RPm), which operates with a timescale of less than one hour. In modelling terms, the main differences between these markets are the timescales from the closing of bidding to the time of delivery.

The main job of the RPm is to provide power regulation to counteract imbalances relative to the planned operation according to the Elspot trade. The RPm is therefore in particular important for DG technologies such as wind power, where the prediction of the production hours ahead is uncertain. The RPm is also important because it values flexibility in generating systems. By encouraging and mobilising flexibility, the RPm can improve the regulation capabilities of the entire power system[57].

Barriers to DG

We discovered a study prepared by Energy Norway in order to investigate and study an efficient long-run integration of DG in the Nordic electricity market. This research and development project entitled DIGINN: "Distributed Generation Integration in the Nordic Energy Market" was established in 2007 and had as its overall objective to develop a set of guidelines and recommendations for efficient long-run integration of DG in the Nordic electricity market[58].

The report from the second stage of this project, entitled 'CODGUNet WP2: Present status of DG in the Nordic countries, existing national and company recommendations' is a survey-based (interview focus group) study which aimed to get better general view of the status and contents of network standards, and focused on the barriers to DG development.

The analysis considered the regulatory context and concrete examples of DG practices, focussing on the main challenges and barriers to DG in the Nordic region.

A general conclusion is that the national practices have grown from local needs and conditions. The combination of the thermal-wind based Danish system with the hydro-based Norwegian-Swedish system enables the complementary use of renewable resources in electricity generation in the Nordic countries[59].

Denmark seems to have further developed DG than the other Nordic countries. For example, Norway and Sweden have limited DG power of 1,500 kW (Komulainen et al., 2002). This fact is said to unsurprising given the low number of independent power producers in Norway, Finland and Sweden, creating less of a need for detailed DG policy recommendations or requirements. For this reason, we concentrate on Denmark.

[57] Hansen et al. Distributed Generation. Riso Energy Report. www.risoe.dk/rispubl/energy-report4/ris-r-)1534p21-27.pdf

[58] http://www.nordicenergy.net/section.cfm?id=3-0&path=4,33

[59] The hydro-dominated systems of Norway and Sweden export electricity to Denmark in wet periods and import when their hydro levels are low. When wind generation exceeds consumption, the excess electricity can be exported to neighbouring countries within the transmission capacity constraints of the interconnectors.

Focus on Denmark[60]

The Danish electricity system is physically split into two areas: the East Danish islands, and West Denmark. Denmark's electricity supply is highly fragmented, due to the historical background of local electricity supply in the early days of electrification.

There are now over 100 DSOs (Distribution System Operators), all of which are legally unbundled and are sub-grouped into the categories of regional transmission companies, distribution network operators and 'transformer unions', which are operators of very small systems.

The Danish Authority in 2005 reported that some 57% of electrical capacity comes from CHP and 31% from renewables. This high penetration of DG appears to have been achieved through regulatory measures that resulted in incentives to promote CHP (heat planning legislation), and a FIT to promote both renewables and CHP[61].

Denmark politically fostered the development and diffusion of wind and CHP units in response to the oil crises. From 1% in 1980 to the current high penetration already cited, the progression of DG has benefited mainly from direct regulation that has a longer 'track record' than in many other developed countries.

Wind farm development for example in the 1980s was financed by local wind turbine associations who had a guaranteed FIT income. In the 1990s, CHP technology grew thanks to a legal requirement that all gas-fired power plants be converted to CHP and that the remaining district heating plants use biomass. The original FIT pricing methodology was based on three time blocks but this has been replaced by a pure price premium[62].

Controllable CHP generation has been fully exposed to price fluctuations since 2005 to create an incentive to adapt to market conditions. Currently, Nord Pool offers a special trading regime for small direct participants to facilitate market integration. Instead of a high annual fee of 15,000 Euros and low variable fees per traded MWh, small direct participants can choose to pay a higher variable fee only and waive the annual fee. This is possible for day-ahead and intraday trading and is said to be highly advantageous for small DG operators pursuing direct marketing.

[60] Material in this section draws on a report by Cali, U et al for Improgres, "Development of interactions between distributed generation and distribution system operators" (February 2009)

[61] www.ens.dk/sw16508.asp Danish Energy Authority www.ens.dk

[62] Due to problems related to excess production in some hours, the three-tier was replaced by a pure price premium in January 2005. This way, support follows the supply through the spot market prices, i.e. it provides an incentive to adjust supply when there is excess production or excess demand. The DG/RES (Distributed Generation and renewable energy) support scheme evolved from a feed-in tariff support to price premiums from 1999 onwards. A special feature of the Danish price premiums for new installations until 2008 was that they were not premiums on top of market prices, but guaranteed a fixed income as a sum of market prices and the support. From 2008, the support has been a pure price premium (Cali, Ropenus, & Schröder, 2009).

DG / Renewable energy generators need to pay shallow connection charges (cost to the nearest network point), but most of the existing DG/RES capacity is exempt from paying generator Use-of-System charges (e.g. costs of grid reinforcement or converter stations).

No very recent explicit information was found pertaining to barriers in the Nord Pool market. The lack of standards and requirements for the connection of different DG technologies , the high cost of DG energy production and immature DG market environment are all cited in 2002 as restricting DG development.

Clearly, DG is more highly developed in certain countries like Denmark, and this would seem to indicate that the barriers have been overcome mainly by the regulatory regime. The success of DG in Denmark is also said to be due to the bottom up approach with large numbers of small firms, municipalities and cooperatives working in close cooperation (Martin, 2009).

Lack of direct DG policy is therefore identified as one of the major barriers. The need has therefore been expressed for a harmonisation of the regulations and standards for DG technology at a national and European level.

11. A framework for establishing the role for government to address barriers

Where the value of a single social benefit can make the difference between an activity going ahead or not going ahead Governments are likely to investigate whether they have a role encouraging the activity or not.

Policy outcomes are critical to the transformation of an industry where it imposes costs on society that are not factored into prices. Policy development is highly mediated by diverse and complex stakeholder interests. To ensure policy outcomes are achieved in the interest of DG, it is clear that policy decision making must be representative, and can transparently account for different stakeholder views[63]. Where a Government elects to intervene in support of the activity there are a number of issues around whether they create winners or losers in the market place. That is a matter of designing the intervention appropriately.

On the face of it DG delivers a number of social benefits, some clearly in line with public policy, notably environmental policy and energy policy. There appears to be a case for Government to take stock of the DG landscape as has been done here and proceed with its usual assessment.

11.1. Market Failure

The core economic rationale for considering whether government intervention in a market is warranted is the identification of a market failure.

Market failure occurs where a market, on its own, will not allocate goods and services in a manner that is economically efficient. Effectively, it is a situation where the level of activity that is desirable for society as a whole will differ from the level of activity that would be undertaken by rational individuals acting on their own.

Market failure can stem from a range of sources, including

1. **Private versus social costs and benefits:** due to externalities, the full costs and benefits of the good do not fall or are not captured by the person purchasing or undertaking the good.

[63] Modified from CSIRO (2009) p 143

2. **Transaction costs:** the information, contracting or policing costs associated with a good are significant and therefore affect the decisions of those considering undertaking the good.

3. **Information gap:** individuals are unaware of the activity, or consumers may not be fully informed of the benefits of the activity.

4. **Property rights:** property rights are uncertain or dispersed, leading to a lack of clarity over who will benefit.

5. **Market constraints**: there are constraints on the efficient functioning of the market, for example capital constraints due to inability of participants to borrow to purchase a good.

6. **Socio-economic considerations:** such as the ability of particular groups in society to access the good is inequitable.

Market failure is not necessarily a result of poor market design or institutional arrangements in the first place. It can be the result of change occurring and markets or institutions not keeping up with new dynamics and new pressures. This is most often referred to as path dependency and is characterised in this paper as "the status quo prevails".

Where market failure exists, there may be a role for government to intervene in the market. However, the presence of market failure and the government subsequently intervening in the market does not ensure that the outcome will be better than in the absence of such intervention. Poor intervention may lead to additional problems of government failure.

11.2. Classifying different types of goods

Economists commonly describe four types of goods, depending upon two key characteristics of those goods:

Rival or non-rival – the consumption of a good by one person prevents or reduces the amount of the good available to be consumed by other persons. For example, a cup of coffee. By contrast, a non-rival good is one where the consumption by one person does not reduce the amount of good available to be consumed by other individuals. E.g. attendance at a concert. Some goods are non-rival up to a point of congestion (e.g. motorways).

Excludable or not excludable - a good is excludable if it is possible to exclude people from enjoying the benefits of the good. Effectively, unless the good is excludable, free riding behaviour will occur (people will wait for someone else to purchase as they can then enjoy the benefits for free) and this will affect whether the socially optimal level of the good is provided

	Excludable	Not - Excludable
Rival	Private good	Common goods
Non - Rival	Club good	Public good

Markets will usually allocate ***private goods*** reasonably efficiently because the costs and benefits primarily accrue to the individual. Examples are clothing, haircuts, and stereos. Private goods may still have positive or negative externalities associated with them, for example smoking. Thus market failure may still occur.

Common goods are those where it is not possible to exclude people from benefiting from the good, but the consumption of one person will reduce the available consumption to others. This gives arise to classic resource problems such as the “tragedy of the commons”. Because an individual is not able to capture the full benefits from the good, they will be reluctant to meet the full costs related to the provision of the good. Policy responses would consider making the good excludable, possibly through the allocation of property rights. An example of a common good is water.

The opposite problem occurs with ***club goods***, which many people can enjoy the benefits from without a reduction in the benefits available to others, and it is possible to limit who enjoys the benefits. These goods lend themselves to group or collective action type responses. Because of the number of people involved, transaction costs related to contracting by private individuals may become significant and therefore lead to consideration of enforced participation mechanisms. An example of a club good is a private concert.

Public goods are those where many persons will benefit equally from the good, and it is not possible to exclude people from benefiting. Because of the incentive issues created by this situation (such as the desirability from the individual perspective of free riding), provision of the good via binding collective action, (e.g. government), may be appropriate.

11.3. Types of government policy responses

The appropriate government policy response will depend on the underlying cause(s) of the market failure.

In very general terms, there are two broad types of policy response:

- regulation; and
- public provision.

The two types of policy response are often substitutable. For example, if the government wanted all seven year olds to receive an education, the government could regulate that all seven year olds must receive an education and the nature of the education that they should receive, and then undertake appropriate monitoring and enforcement to ensure this happens. Alternatively, the government could subsidise the provision of education to seven year olds (through a variety of mechanisms, such as public provision of education, vouchers, school bus services etc) and then encourage children and parents through information campaigns on the value of education to ensure all seven year olds received an education. In reality, the government uses mechanisms related to both regulation and public provision.

11.4. NZ Treasury Regulatory Impact Analysis (RIA)

The NZ Treasury issues guidelines for the preparation of any submission to Government that seeks some form of regulatory intervention. The following passage is an extract from the Regulatory Impact Analysis Handbook[64] and is self explanatory. Suffice it to say that this reinforces the point set out in this report that should the benefits of DG fail to emerge under current arrangements, and should they exceed the costs of reducing the barriers, intervention has to be shown to deliver the highest level of net benefit for Government to consider acting to support it.

> *2.1 The purpose of RIA*
>
> *The government wants to ensure that proposals involving regulatory options are subject to careful and robust RIA to ensure that the problem cannot be adequately addressed through private or non-regulatory arrangements and that a regulatory solution is required in the public interest.*
>
> *The government's RIA framework encourages an evidence-based approach to policy development which helps ensure that all practical options for addressing the problem have been considered and the benefits of the preferred option not only exceed the costs but will deliver the highest level of net benefit.*
>
> *This means providing references and sources for assertions made (such as about the nature of the problem and about the expected viability or effectiveness of policy options), and for all estimates of costs, benefits and risks. Evidence may be*

[64] NZ Treasury NZ Regulatory Impact Analysis Handbook Chapter 2 Undertaking Regulatory Impact Analysis November 2009

> *quantitative or it may be qualitative; in each case the strengths, biases and limitations of the information sources should be explained. Where there are information gaps, for instance where there are no data available to support the analysis, this should be explicitly stated.*

When considering the impacts of the status quo and of the alternative options, it is important to consider these impacts from the perspectives of the various affected parties. Put yourself in the position of the individuals and groups that will be affected, e.g., farmers, shoppers, road users.

11.5. Application to the circumstances surrounding DG in New Zealand

Two key themes have emerged from the work developing this paper:

1. DG developers face a number of barriers to investing and, as a result, unlocking the benefits of it

2. A number of the benefits that come with DG are consistent with mainstream public policy in a number of countries.

The next step is not necessarily leaping to a single and obvious response. An example of such a response to address one of the key barrier groups (financial viability) would be the introduction of a FIT. Broadly, a FIT requires payment to DG owners/developers so their revenue is assured which, in turn, means that the economics are improved and any borrowing can be secured. Most FITs are a subsidy by another name. When designing an FIT several variables have to be determined:

- Who is obligated to pay the DG owner
- The thresholds for who qualifies for the tariff and who doesn't
- How parties who face a cost for supporting DG are compensated for their costs (e.g. lines companies)
- The price (and any other terms and conditions) of the tariff and
- Where the money comes from (e.g. tax, the retailer or consumers)

Ignoring the point that we would not advocate this route without having completed the proper analysis, a FIT has the potential to distort the market while creating winners and losers. Further, the introduction of a FIT in isolation would still leave the fundamental barriers in place. As seen in other jurisdictions the introduction of a FIT may prove to be an exercise in frustration even if it is well designed.

A coordinated policy response should follow several logical steps

1. Cost benefit analysis. The estimate of benefits should explicitly include the contribution DG can make to security of supply and competitive pressure on

prices. These were identified in the Ministerial Review as key drivers for energy policy under the current government.

2. Review market design. Changing the production and delivery model for electricity from a centralised model to a distributed model will require a different way of thinking and changes in expectations amongst all stakeholders including consumers (large and small) generator/retailers, Transpower, lines companies and the regulators themselves.
3. Review the regulatory environment across both contestable and non-contestable businesses to see that they are appropriately accommodative of DG.
4. Consider the case for intervention. The case for intervention per se should be made before specific mechanisms are targeted or work to change market arrangements is initiated. This section sets out a framework for doing this theoretically and practically.
5. Consider which interventions have the best outcomes.

By way of conclusion we include three quotes found during research that seem to affirm the approach taken in this paper. The first is a discussion about the role of the regulator dated 2007. The second is contained in the CSIRO (2009) report previously referred to. The third is taken from an academic paper on DG. These quotes are consistent with the view presented in this paper that the case for DG has only recently found substance and widespread recognition. If that is the case Government would be well placed to take a closer look at the paradigm for producing and distributing electricity.

"Regulation clearly has a role in certain circumstances. One is market failure. That might be caused by inadequate price signals, where there is a natural monopoly and it is impossible to have competition, and/or where the information asymmetry is such that people really can't function fully as independent consumers. When the economic and social benefits provided by regulation exceed its likely economic and social costs—if there is a net-plus to the deployment of regulation as opposed to not regulating—then intervention is merited. Example might include the existence of significant market power for a product, where consumer protection requires some form of regulation and where clearly specified government-mandated social policies are most efficiently carried out by regulation"[65]

"It is important to note that due to a disaggregated centralised energy supply chain in Australia no one business in this supply chain can capture the full value of distributed energy. This acts to dilute the incentive to invest, and has the potential to result in significant investments that do not achieve socially efficient energy supply. How this is best overcome is not simple, but ultimately enabling distributed energy is like the bringing together of many complementary policies. Split incentives, access to finance,

[65] Ashley C. Brown Executive Director, Harvard Electricity Policy Group

Walking the Tightrope: Balancing Competing Interests in Pursuit of Good Public Policy February 23, 2007 *renewable energy policies, energy prices, skill and industry capacity from architects through to builders and trades people, can all impact on the uptake of distributed energy and must be addressed simultaneously."*[66]

"Under the current centralized generation paradigm, electricity is mainly produced at large generation facilities, shipped though the transmission and distribution grids to the end consumers. However, the recent quest for energy efficiency and reliability and reduction of greenhouse gas emissions led to explore possibilities to alter the current generation paradigm and increase its overall performances. In this context, one of the best candidates to complement or even replace the existing paradigm is distributed generation where electricity is produced next to its point of use"[67]

[66] CSIRO Intelligent Grid A value proposition for distributed energy in Australia 2009

[67] Martin, J *Distributed vs. centralized electricity generation: are we witnessing a change of paradigm?* An introduction to distributed generation (May,2009)

12. Appendix

12.1. Survey questions on DG

EECA's energy wise survey 'the research monitor' is a monthly survey conducted on a sample size of 250 per month over a three month period (thus a sample size of 750 responses per quarter) on the awareness, attitudes, and behaviour of New Zealanders in relation to energy efficiency, conservation, and renewable energy. The same questions are asked over a three month period, and then may be changed.

In March 2010, EECA had the opportunity to survey the public using specific questions on DG. LECG assisted EECA in formulating these questions. The answers to these questions may help to support the conclusions on DG barriers contained in this report.

DG questions for survey	
Question	**Reason for the question/motivation**
What does the term home generation or 'microgeneration' mean to you, if anything?	Ascertain the awareness of consumers to the concept of DG
Have you thought about micro/home generation?	As above
Did you know it is possible to use micro/home generation to offset your power use?	As above
Do you know what your options are?	Ascertain consumers' awareness on the types of DG technology available to them
Micro/home generation includes for example solar panels and combined heat and power (CHP). Do you know how to get information on these?	Ascertain the awareness of consumers on the availability of information of DG to them
If you had better information, would you be interested in micro/home generation?	A key question: ascertain their desire to pursue the idea of DG
Why would you be interested in installing a form of home/micro generation?	Ascertain the motivations behind installing DG, for example, environmental concerns, or cost motivations

Are you a renter? Or a landlord? If a renter, would you be interested? If a landlord, would you be interested? If not, then why?	The response would be predictable, but of use to confirm the different motivations between a renter or landlord
What matters to you in choosing a form of micro/home generation?	Ascertain what concerns exist in acting on DG, for example, safety concerns, predictability, cost variation
Are you aware of any schemes offered by your retailer or anyone else to encourage you to consider micro/home generation?	Ascertain consumers' awareness on the opportunities that exist for selling electricity back to retailers, and at what price, if they are aware

12.2. References

ACCC. (2008). *Demand management incentive scheme for the ACT and NSW 2009 distribution determinations*: ACCC.

Barry, M., & Chapman, R. (2009). Distributed small-scale wind in New Zealand: Advantages, barriers and policy support instruments. *Energy Policy*, *37*, 11.

Cali, U., Ropenus, S., & Schröder, S. (2009). *Development of interactions between distributed generation and distribution system operators*: IMPROGRES.

IT Power Australia Pty Ltd. (2009). *Assessment of the Future Costs and Performance of Solar Photovoltaic Technologies in New Zealand*: MED.

Komulainen, R., & Kumpulainen, L. (2002). *Present status of DG in the Nordic countries, Existing National and company recommendations*: VTT Processes, System and models.

Stoecklein, A. (2005). *Energy efficient housing in New Zealand*: BRANZ.