Energy Efficiency and Conservation Authority
Te Tari Tiaki Pūngao

EECA Report on the Costs of Small Scale Generation

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Important note

The analysis contained in this report has been undertaken at a high level using a broad set of assumptions. It is important to note that this report is only one source of information on the matters discussed in it, and differing views may be held on the material and conclusions set out. Persons considering or making decisions on these matters, or on any aspect of them, must make their own enquiries and form their own views based on all information and advice available to them.

Neither EECA nor the author accept any liability for loss or damage occurring as a consequence of reliance on any information and/or analysis contained in this report.

Introduction

1. This paper briefly reviews unit costs for a range of small scale electricity generation technologies up to 15 MW in capacity. Unit cost for a generation project can be defined as the price of electricity required to recover all costs over the life of the project while providing an acceptable financial rate of return. Unit costs are often used to compare the relative economics of different generation technologies.

2. Unit costs were derived using data from a number of reports commissioned by EECA and other organisations, supplemented by information from generation equipment suppliers.

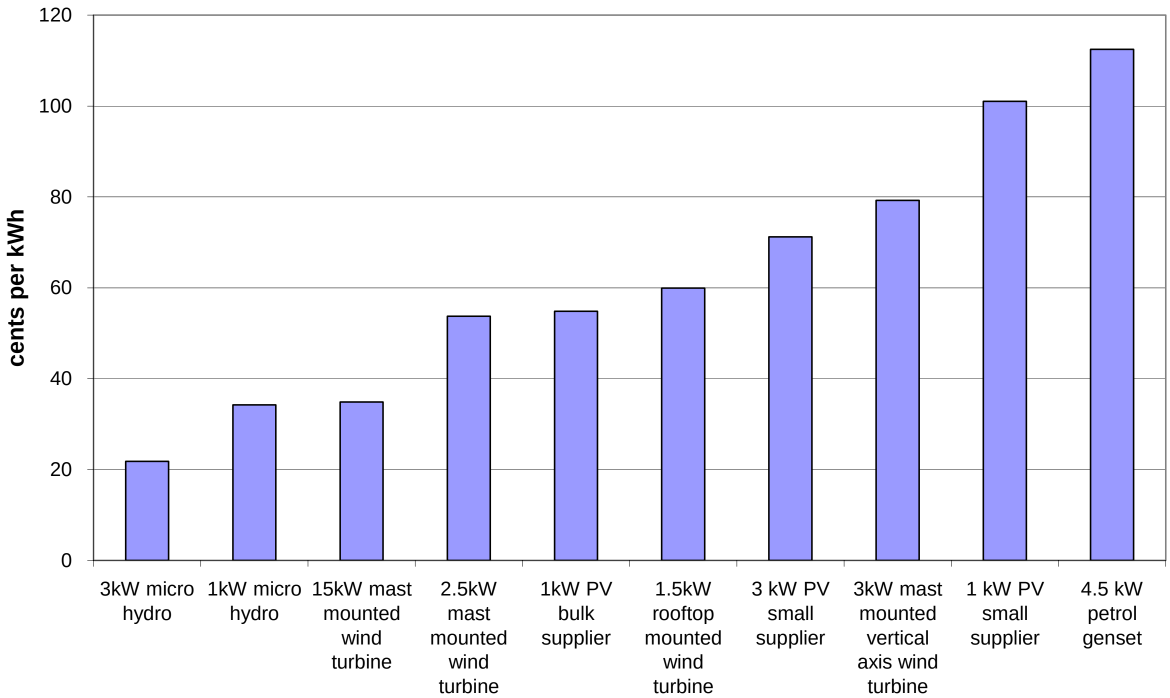
3. Distribution generation can be up to, very roughly, 50 MW in size. We have not provided unit costs for distributed generation greater than 15 MW as these will start to approach unit costs for grid connected, centralised generation.

4. Unit costs for a particular project will be sensitive to a multitude of factors, such as, capital cost, operating costs, energy resource cost and quantity, tax treatment and cost of capital. For this reason **unit costs presented in this paper should be regarded as indicative only**, and may be higher or lower in practice.

Unit costs for grid connected household generation

5. Household scale generation is typically less than 10 kW in size. Unit cost estimates for a range of grid connected household generation technologies are shown in Figure 1. The analysis assumes a real discount rate of 5%, depreciation has been ignored[1]. Other assumptions are detailed in Appendix 1.

Figure 1: Indicative unit costs for household scale distributed generation



[1] This may in some circumstances result in an over estimate of unit costs.

6. Key observations from this analysis include:

- Unit costs are not competitive with current retail electricity rates (around 21 cents per kWh[2]);
- Unit costs show strong economies of scale for all technology types;
- Micro wind unit costs vary significantly according to the type of design (e.g. horizontal axis vs. vertical axis), reflecting the immature nature of this technology;
- Solar photovoltaic (PV) costs are lower if suppliers are able to arrange bulk supply contracts; and,
- Micro hydro is currently the lowest cost option.

Off grid generation

7. Unit costs shown in Figure 1 are for grid connected generation only. Off grid generation will be more expensive, due to the need for batteries and possibly back-up diesel generation. Never-the-less, in some circumstances, off grid generation can still provide an economically attractive solution where local distribution network costs can be avoided.

Future costs

8. Solar PV and micro wind are still relatively immature technologies and future costs are likely to reduce with learning and innovation. For example, Hydro Tasmania have forecast that solar PV costs will fall by 55% by 2030[3]. This assumed a conservative evolution of solar PV technology and ignored the potential for more abrupt shifts in technology and cost.

The importance of market niches

9. While the vast majority of household generation remains uncompetitive with the retail price of electricity, there is the potential for niche markets for this technology to drive growth. New houses remote from an existing distribution network are one example of an economically viable market niche. Early adopters form another niche market. Anecdotal evidence from the New Zealand industry and overseas empirical data[4] indicates that a proportion of consumers will be early adopters of household generation. They will have a “willingness to pay” for this technology, perhaps due to their valuation of its environmental benefits or enthusiasm for innovative technology.

10. Efforts to reduce undue barriers to uptake - even though unit costs are high - will help support crucial market niches, allowing the development of a more mature market to be brought forward.

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[2] Ministry of Economic Development. (2008). *Schedule of Domestic Electricity Prices: Updated to February 2008*. Available at http://www.med.govt.nz/templates/MultipageDocumentTOC____34234.aspx

[3] Hydro Tasmania. (2007). *Grid Connected Domestic and Small Scale Renewables in New Zealand, Business as Usual Uptake Projections to 2030*. p. 38.

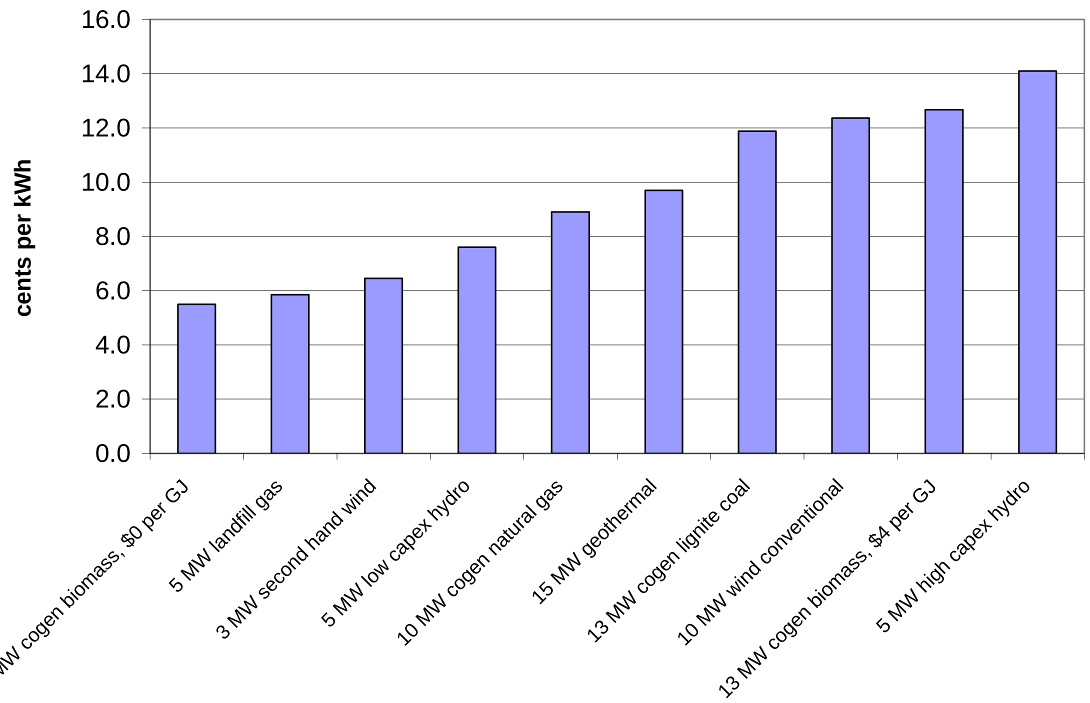
[4] Energy Saving Trust, Econnect, ElementEnergy. (2005). *Potential for Microgeneration Study and Analysis*. p. 208.

Unit costs for mini-scale generation

11. We define mini-scale generation as generation typically sized between 10 kW to 10 MW and probably connected to a local distribution network. Investors in mini-scale generation will usually include lines companies and non-traditional developers such as local councils and independent generators. There is presently around 241 MW of generation between 10 kW and 10 MW in size[5], roughly 2.5% of New Zealand's total installed electricity generation capacity.

12. Unit cost information for a number of "typical" mini scale generation technologies are shown in Figure 2. The analysis assumes a real post tax discount rate of 8%, in line with Electricity Commission's modelling for their Statement of Opportunities[6]. Other assumptions are detailed in Appendix 1.

Figure 2: Indicative unit costs for mini scale distributed generation



Comparison with centralised generation costs

13. The unit cost of large scale, grid connected, centralised generation vary widely with technology, carbon price, resource quality and so on. Least cost options have unit costs of around 8.0 to 8.5 cents per kWh[7].

Mini wind

14. Two unit costs for mini wind have been provided:

- A nominal 3 MW wind farm with second hand turbines[8]. Second hand turbines offer lower capital costs, though these are partly off-set by higher maintenance costs.

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[5] New Zealand Centre for Advanced Engineering. (2007). *The Economic and System Impacts of Increased DG Connection within New Zealand's Electricity Networks*.
[6] Electricity Commission. (2008). *2008 Statement of Opportunities, Draft for Consultation*. p. 92.
[7] *Ibid*. p. 95.

- A nominal 10 MW wind farm based on conventional technology. Costs are based on a recent survey of wind farm costs by Connell Wagner[9] and take into account increased prices due to wind turbine manufacturing constraints. Connell Wagner caution that unit costs for small wind farms tend to vary widely relative to large wind farms.

15. Christchurch based Windflow Technology Ltd[10] offer an innovative two bladed wind turbine design. This type of turbine has reduced structural mass and hence provides lower unit capital costs compared to conventional designs. It's small unit size (500 kW) also makes it particularly suited for smaller wind farm projects.

16. The competitiveness of mini wind will strongly depend on the quality of the wind resource exploited. Our unit costs have assumed a reasonable high quality resource capable of providing a capacity factor of 40% (very roughly equivalent to a wind speed of 8 - 9 m/s).

Hydro

17. Mini hydro capital costs are very site dependent and highly variable. Units costs assuming a high and low capital cost have been provided.

Cogeneration

18. Unit costs for cogeneration plant fuelled with woody biomass, coal and gas have been provided. Cogeneration can be defined as the simultaneous generation of useful heat (e.g. for an industrial process) and electricity in a single process. The analysis only considers cogeneration suitable for relatively large industrial sites by New Zealand standards.

19. Unit cost calculations have optimistically assumed that the cogeneration plant will provide process heat to its host industrial site on a 24 hour basis for the majority of the year. Process heat demand can be highly seasonal for some industries in New Zealand (e.g. diary factories). A cogeneration plant will be most efficient and cost effective when supplying both electricity and process heat. Periods when there is little or no process heat demand will therefore tend to reduce the economic viability of cogeneration.

20. The competitiveness of cogeneration will also depend on the cost of fuel. For gas fuelled cogeneration will have assumed prices for gas and carbon that is probably reasonably optimistic over the expected life of a project. Two unit costs for woody biomass fuelled cogeneration have been provided assuming the price of woody biomass is:

    - 0 $ per GJ. This would correspond, for example, where there is access to a plentiful supply of wood waste for which there are no economic alternative uses.

    - 4 $ per GJ. This corresponds to a relatively low cost supply of woody biomass sourced from forestry residue.

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[8] For example, refer http://www.energy3.co.nz/

[9] Connel Wagner. (2008). *Transmission to Enable Renewables, Economic Wind Resource Study*. Appendix B.

[10] Refer to http://www.windflow.co.nz/front-page.

Network costs and benefits

21. The unit costs presented above do not take into account the economic impact of distributed generation on the local distribution network and transmission grid. Unlike centralised generation, distributed generation can offer benefits to the local distribution grid that can improve the economic viability of a particular project. This will depend on the location of the distribution grid and the extent to which it can reliably provide generation during network constraints.

Other technologies

22. Figures 1 and 2 do not cover all possible types of small scale generation. There are a number of technologies which are either novel or for which EECA does not have sufficient information to present a credible analysis. This includes:

- Reciprocating gas or diesel engines used for emergency supply or peak lopping;
- Small scale cogeneration for households and commercial buildings;
- Micro and mini hydro employing centrifugal pumps;[11]
- Biogas from sewage works; and,
- On farm biogas generation.[12]

[11] Small Hydro SHE Enterprises. (2007). *Micro-Hydro Schemes in the Far North District*. p32.
[12] Refer http://www.naturalsystems.co.nz/BioGenCool.html

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Appendix 1: Key Assumptions

	Grid connected household generation	**Mini-scale generation**
Discount rate	5% real pre tax	8% real post tax
Depreciation	Ignored	Diminishing value rates from IRD
Tax rate	Ignored	30%
Hydro	Capacity factor 50% Asset life 25 yrs	Capacity factor 50% Asset life 40 yrs
Wind	Capacity factor 30% Asset life 20 yrs	Capacity factor 40% Asset life 20 yrs
Solar PV	Capacity factor 15% Asset life 30 yrs	NA
Petrol genset	Capacity factor 60% Asset life 15 yrs Fuel price $1.65 per litre	NA
Land fill gas	NA	Capacity factor 90% Asset life 15 yrs
Geothermal	NA	Capacity factor 85% Asset life 25 yrs
Woody biomass cogeneration	NA	Capacity factor 90% Asset life 20 yrs Fuel price $0 and 4 per GJ
Natural gas cogeneration	NA	Capacity factor 90% Asset life 20 yrs Fuel price $7 per GJ Carbon price $30 per tCO_2
Coal (lignite) cogeneration	NA	Capacity factor 90% Asset life 20 yrs Fuel price $2 per GJ Carbon price $30 per tCO_2