CLEAN ENERGY COUNCIL
FUTURE-PROOFING IN
AUSTRALIA'S ELECTRICITY
DISTRIBUTION INDUSTRY PROJECT

CLEAN ENERGY COUNCIL

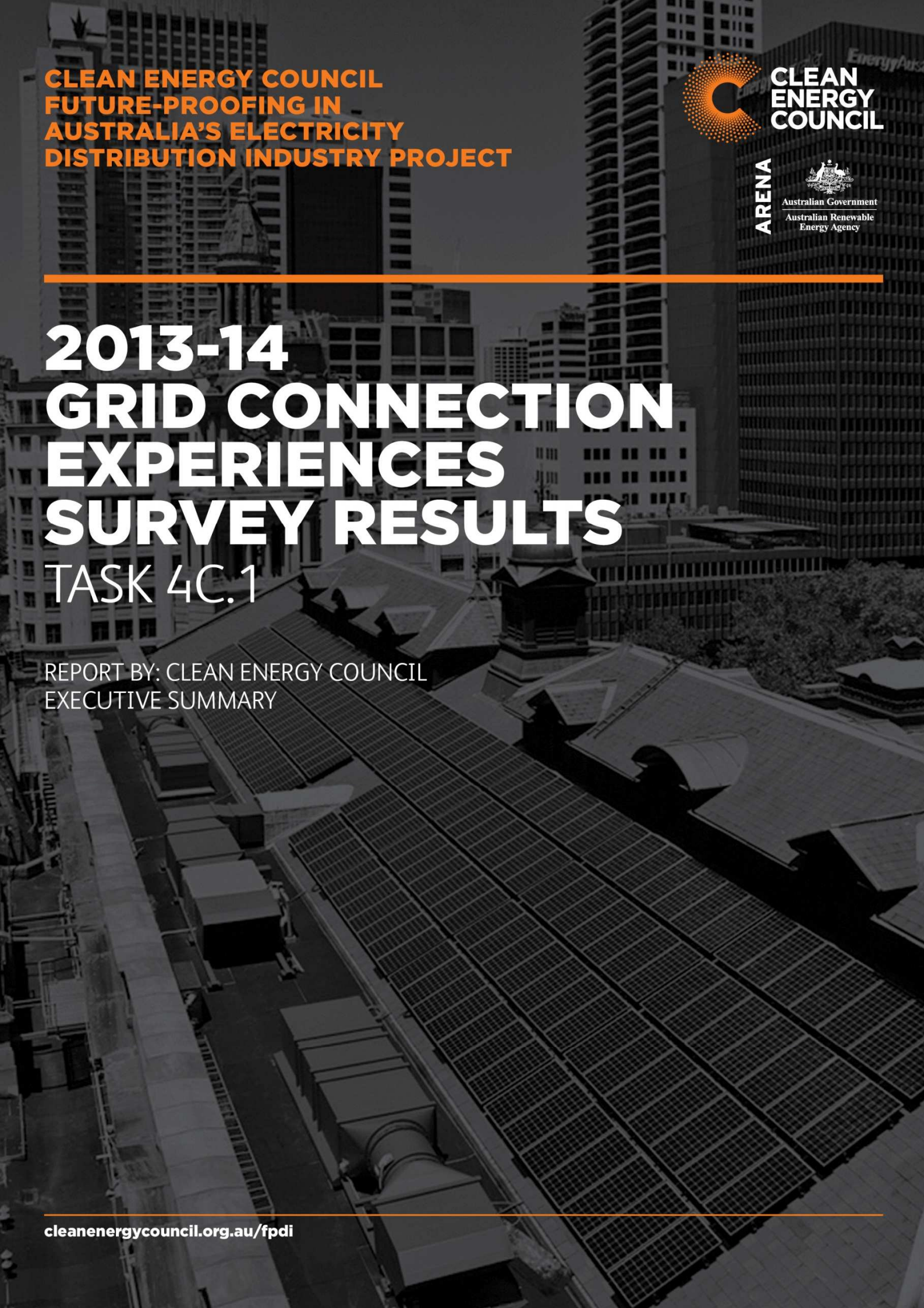
ARENA

Australian Government
Australian Renewable Energy Agency

2013-14 GRID CONNECTION EXPERIENCES SURVEY RESULTS

TASK 4C.1

REPORT BY: CLEAN ENERGY COUNCIL
EXECUTIVE SUMMARY



cleanenergycouncil.org.au/fpdi

1 Executive Summary

This project collects the results of the largest and most comprehensive surveys of experiences of connecting generation to electricity distribution networks to date in Australia. The CEC undertook these surveys during 2013 and 2014 in response to increasing concerns raised by member organisations involved in the development and grid-connection of a diverse array of generation technologies.

Australia's electricity distribution industry includes a broad mix of stakeholders and business models. A complex overlay of rules, regulations and performance criteria bounds the delivery of safe, reliable and affordable electricity to customers. Electricity is an essential input into almost all factors of production in the Australian economy. The industry's performance against its goal is critical to the economic prosperity of the nation.

In Australia there are some fifteen independent distribution network service providers (DNSPs) operating under differing rules, regulations and legislation. There are many variations of connection process and differing interpretations of the relevant instruments and the obligations of DNSPs during the process. Although connection processes for embedded generators are intended to be rules-based, they are often fraught with challenges and risks for new entrants and the experienced alike.

The purpose of the surveys is to enable industry stakeholders to develop a clearer picture of those aspects of the connection process that are the most challenging and that may require attention to address inefficiencies. The CEC hopes that this information will enable these stakeholders to more effectively target these issues to more efficiently meet market objectives.

This report was produced with funding support from ARENA. ARENA was established by the Australian Government as an independent agency on 1 July 2012 to make renewable energy technologies more affordable and increase the amount of renewable energy used in Australia. ARENA invests in renewable energy projects, supports research and development activities, boosts job creation and industry development, and increases knowledge about renewable energy.

Defining embedded generation

The terms 'embedded generation' or 'distributed generation' have been used broadly to describe electrical generators which are not centrally located within our electricity supply system. The focus of the survey is generators that are embedded within distribution networks (embedded generators[1]) and there are numerous generation technologies, energy sources and generator sizes captured within this context.

[1] As defined by the National Electricity Rules an 'embedded generating unit' is one which is connected within a distribution network and not having direct access to the transmission network.

Although generator sizes are diverse, the relevant rules, regulations and guidelines do make some distinction between sizes and generalisations can be made despite regional differences in these instruments.

In order to analyse results consistency across Australia's differing markets and regions the surveys relied on the Energy Networks Association's "typical classifications" of embedded generation (Figure 1). Although these general classifications may not align perfectly with the guidelines or rules applied in every Australian jurisdiction, they do provide a sound basis from which to design and analyse surveys such as these.

Classification Band	Technical Definition (*)	Typical Installations (**)
Micro	Less than 2kW; AS4777 compliant; installed within a (domestic) customer installation and connected to the low voltage (LV) network via the customer service connection)	Inverter connected plant; Domestic roof top PV, micro wind turbines
Mini	Having a nameplate greater than 2kW and up to 10kW single phase or 30kW three phase; connected to the LV distribution and generally installed within a customer installation; not necessarily AS4777 compliant All Inverter systems must be compliant with AS 4777 (ratings stated in kVA not kW)	Fuel cells; combined heat and power systems (CHP); mini hydro; mini wind turbines
Small	Having a name plate rating greater than 10kW single phase or 30kW three phase but no more than 1 MW and connected to the low voltage(LV)network; not AS4777 compliant	Induction machines - biomass, landfill, small hydro, individual wind turbines, gas & diesel fuelled engine, small hydro; fuel cells; dc storage/inverter feeds
Medium	Having a name plate rating greater than 1MW and less than 5 MW and connected to the high voltage(HV)network	Single or grouped large induction or smaller synchronous machines – biomass, landfill, hydro, wind, solar thermal, gas & diesel fuelled engine drives; Large scale storage plus inverter feeds
Large	Having a name plate rating of 5MW and greater	Single or grouped synchronous or power electronic controlled induction machines - wind farms, hydro, solar thermal, gas & diesel fuelled plant

(*) - Technical definitions of the classes modified by ENA to add a "mini" class to cover domestic type installations between from 2kW up to 10kW single phase and 30kW three phase rating.
(**) – Typical installations description added by ENA.

Figure 1: General classifications of embedded generator sizes and typical installations as set out by Energy Networks Association[2].

It is clear from Figure 1 that even generalised classes of embedded generation display much diversity. Although broadly based, the surveys considered the following four classifications:

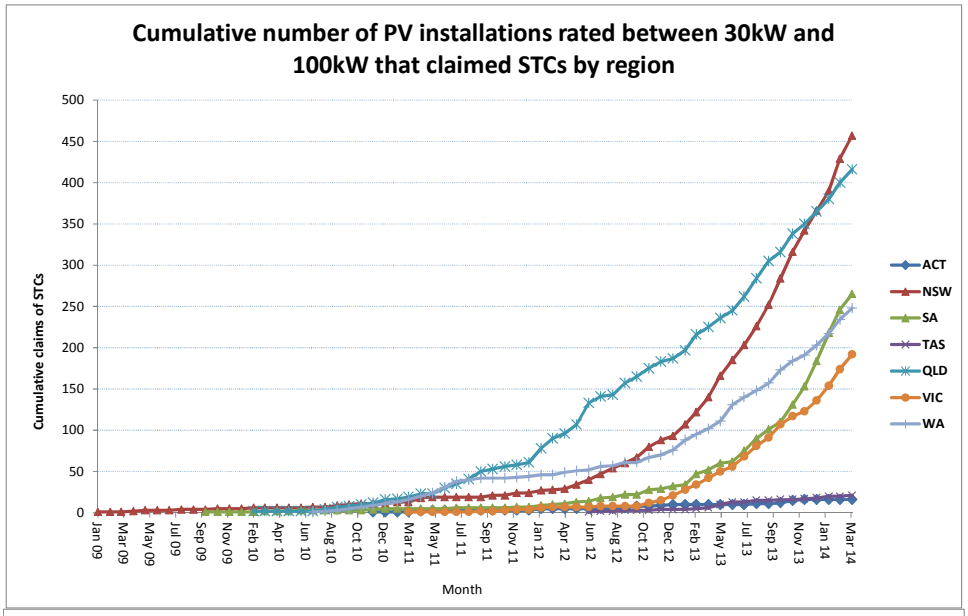
- *Mini embedded generators,* which generally have a low impact on the distribution network and are expected to be connected through a very streamlined process;

- *Small embedded generators,* that generally have a small, location-specific impact on the distribution network and are expected to connect through a streamlined process;

[2] Energy Networks Association, 2011, *ENA Guideline for the preparation of documentation for connection of Embedded Generation within Distribution Networks,* p. 8. available: www.ena.asn.au.

- *Medium embedded generators,* which are typically high-voltage-connected generating units that can have a large impact on the distribution network and are therefore expected to connect through a negotiated process that fully accounts for this impact; and

- *Large embedded generators,* which are typically registered to operate in wholesale markets and are expected to connect through a negotiated process that accounts for local and system-wide issues.



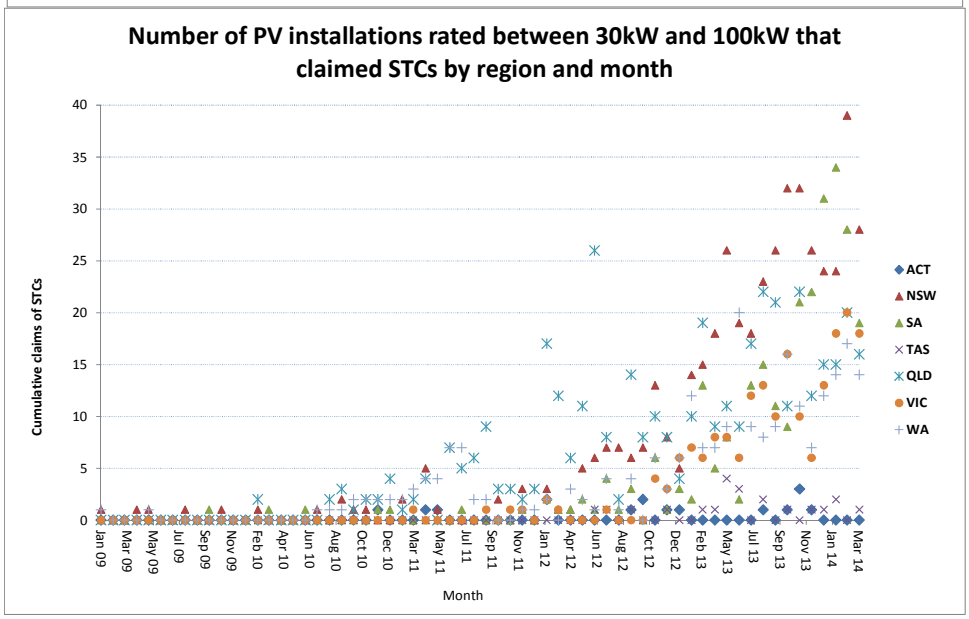


Figure 2: Cumulative and monthly installation rates of commercial scale solar in different regions as recorded by the Clean Energy Regulator[3].

[3] Courtesy of Warwick Johnston, Sunwiz, www.sunwiz.com.au.

Although there has been remarkable growth in renewable embedded generation (primarily solar PV) in recent years, the surveys did not seek to segregate any particular technology. Rather, the surveys made no presumptions about generating technology. That is, the survey reflects the intent of the relevant instruments for the connection process to treat technologies equally.

While it is difficult to fully capture the scale of the connections of embedded generators, the small scale and large scale components of the Renewable Energy Target policy have created a database of the installation rates of embedded generation. This database is managed by the Clean Energy Regulator[4] and shows that by November 2014 some 3.7 GW of solar PV was installed on 1.3 million households and businesses across Australia.

There has also been significant growth in commercial-scale solar in a very short timeframe. The same data shows that by May 2014 the installation of solar PV systems rated between 30 kW and 100 kW was increasing dramatically (Figure 2). This analysis assumes that those who claimed Small Technology Certificates (STC) from the Clean Energy Regulator did so as quickly as possible. Although there may be a delay up to 12 months in applying for STCs following operation of the generator, one month would be expected to reflect prudent business practice. Longer delays are extremely unlikely as they would reflect unsound business practices occurring across the solar PV installation industry.

Connection processes across Australia

Figure 3 below shows the diversity in defined negotiated connection processes as defined within various rules and regulations that applied during the survey period.

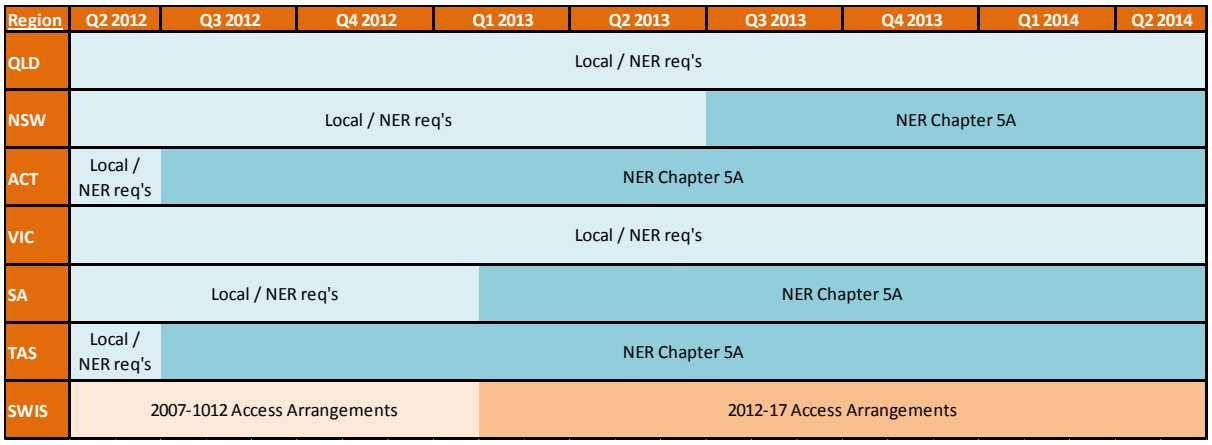


Figure 3: Comparison of the processes as applicable for negotiated connections in each region of Australia during the survey period (various online sources).

[4] http://ret.cleanenergyregulator.gov.au/REC-Registry/Data-reports

1.1 The grid connection experience surveys

This report summarises the outcomes of two separate surveys conducted by the CEC during 2013-14. Both surveys were targeted at the CEC's membership base, which predominately consists of renewable energy project developers of all sizes and technology types. They were nationally focussed and made no distinction between different Australian regions or networks.

These surveys are specifically targeted at connecting embedded generators, and have not yet considered the perspectives of DNSPs. There are two reasons for this approach: the first being that the CEC was aware of work being done by the Australian Photovoltaic Institute, which was surveying DNSPs; and the second simply respecting the monopoly position of DNSPs in the process. Connecting generators generally have little bargaining capacity and rely solely on the DNSP as the gatekeeper to accepting a connection.

2014 Mid-Scale Negotiated Connection Experiences Survey

The CEC's 2014 connection experiences survey was targeted at embedded generators who had negotiated connections with a DNSP within the preceding two years. The period from May 2012 was deliberately chosen to capture the period of growth and learning across the industry. It also maximises the value of the results as there is little value in looking at a period when experience was low and negotiated connections were far less frequent.

This survey was restricted to generation rated below 5 MW. While the survey did not make any further division of sizes, it specifically sought embedded generators who had negotiated connections. The survey therefore relates to mini, small and medium scale embedded generators.

Although the survey results did not quantify an exact number of connections undertaken by respondents, the do provide information to estimate the average number of installations for each response. Table 1 shows this data, demonstrating the extent of the experience captured by the survey. The survey also identified that 30% of these projects were still in the connection process and had not yet received a connection agreement.

Some of the responses received related to experiences across regions and this is captured in Table 1. However, to avoid double-counting the installations these cross-regional respondents were ignored when summing the total installations.

Responses		NEM Total	Non-NECF Regions	NECF Regions	SWIS
< 30 kW	Responses:	53	34	25	6
	Installations:	1,005	635	290	65
	Completed:	703	445	205	37
> 30 kW	Responses:	40	21	25	7
	Installations:	610	280	180	153
	Completed:	427	196	126	130

Table 1: Summary of responses received and estimated numbers of projects considered by the survey.

Table 2 also shows the same series of survey responses, demonstrating the generator size classes that the responses from NEM regions related to.

Category	Non-NECF Regions		NECF Regions		
	Vic.	QLD	SA	Tas	NSW
Mini	37	22	9	0	20
Small	14	12	8	0	20
Medium	3	1	0	1	1

Table 2: Summary of responses for different generator classes across NEM regions (note: NSW includes the ACT).

Making the distinction between negotiated connections allows the survey to segregate the experiences of those embedded generators who had connected under streamlined 'basic' processes (mainly mini embedded generators rated below 5 kW). This approach assumes that those who connected under a basic connection have not experienced significant difficulties. If they had then they would have been negotiating their connection (in which case they might have completed this survey).

The survey did not focus on the connection of a single project, but drew on the experiences generally over the two years preceding the survey. This is appropriate considering that respondents may have been involved in the connection of many generators in the period.

Respondents were asked to consider a broad range of typical connection process characteristics and give answers based on a rating scale provided for each question. The questions were designed to allow the respondent to express their views on aspects of the process and the impact that the process may have had on their businesses. Respondents were also encouraged to provide further qualitative and quantitative information if possible. The survey also tried to gain an understanding of the priorities of the respondents when they navigate the connection process. Understanding which aspects of the process are being

prioritised can provide insight into those aspects that present the highest risk for connecting generators. For example, a respondent that has been prioritising negotiating lower connection costs is likely to believe that these costs are unreasonable.

The survey also sought to understand which aspects of the connection process should be prioritised to make improvements.

This survey collected a statistically significant number of responses thus providing a rich source of information. This survey is the largest of its kind to date, which is unsurprising when considering the heightened activity in commercial scale solar over the survey period (Figure 2).

There are numerous ways in which the survey response data could be dissected and presented. However, in order to remain consistent with current connection process rules or guidelines across Australia, the analysis in this report divides responses in the following ways:

- The South West Interconnected System (SWIS), regions of the NEM that have ratified the National Energy Customer Framework (NECF) and regions that have not yet ratified NECF., and;

- Generators larger than 30 kW (small and medium embedded generators) and generators smaller than 30 kW (mini embedded generators).

Differentiating between the SWIS and NECF and non-NECF regions of the NEM is consistent with regional differences in applicable rules. Differentiating based on a 30 kW (or 10 kW per phase) threshold is consistent with the scope of the current Australian Standard AS 4777 for the connection of inverter energy systems. In turn, this is consistent with the threshold for a basic connection under Chapter 5A of the NER as applied in NECF regions and a similar division applied in the SWIS.

2013 Large Scale Connection Experiences Survey

The CEC's 2013 connection experiences survey was conducted in late 2013 and targeted large embedded generators. Due to the increased technical aspect and more defined rules for these connections this survey sought responses on a project-specific basis.

This survey only received six responses relating to projects based in two NEM regions. However, this reflects a significant proportion of the recently connected large scale embedded generators in Australia. These responding organisations generally have over 20 employees and a high level of experience with the development of large scale generation in Australian and overseas markets. Although low in number, the responses have provided high value information as a result of this experience.

1.2 Main findings

The inclusion of most Australian regions and mini, small, medium and large embedded generators provides a clear snapshot of the status of the connection process at a point in time. Being the first comprehensive survey of its kind, the results have captured experiences garnered during a period of significant flux. It is easy to understand that the remarkable growth of embedded generation, particularly commercial scale solar PV, over a very short timeframe has caught an incumbent distribution network industry by surprise. Concurrently, new players entering the market have had low experience levels. Learning curves have been steep on all sides.

Different connection processes are applied across Australian regions. Some of these processes have recently been reformed; however these surveys were conducted prior to their taking effect. The results provide strong support for these reforms being introduced and progressed. In addition they provide further support for a continual monitoring and improvement program, which should seek to achieve standardisation of connection processes to the greatest extent possible.

Key findings for mini embedded generators

Mini embedded generator proponents are generally smaller operators having less than 10 employees. Although these businesses generally have experiences with the connection of embedded generation below 30 kW, their strength was with projects rated less than 10 kW[5]. Responses were received from every Australian jurisdiction except for Tasmania, Northern Territory and the Australian Capital Territory.

Only a small portion of survey respondents are content with the connection process. Across the NEM more than 50% of those with experience negotiating the connection of mini embedded generators do not believe that the connection process meets their needs in a fair and certain manner, or as quickly as reasonably possible.

The survey results for mini embedded generators identified an inverse relationship between generator proponent capability building and grid connection experiences. Over the two year survey period grid connections increased dramatically, and should have been reflected in improved experiences due to capacity building. However, more than half of the respondents indicated that connection processes have become harder, rather than improved.

This outcome is concerning. Although it contradicts typical industry development profiles only continued experience will demonstrate whether there is a systemic issue that needs to be addressed in this regard.

Main areas of concern include:

[5] Noting that the generator sizes these respondents work with are generally increasing over time.

- Connection process timeframes, with certainty of timing being a greater concern than the length of time taken;
- Information exchanges, with certainty that information is complete and accurate from early on being the greater concern;
- Connection costs, with clarity of costs early in the process being the greater concern.
- Managing their staff and the expectations of their clients around the uncertainties associated with all of the above.
- Export limitations imposed or preferred by some DNSPs.

Many stakeholders who are involved in the connection of mini embedded generators have an expectation that the connection process should be simple, following defined parameters and timeframes. Although such processes are in place, issues arise when these generators cannot conform to the requirements of those processes. It appears that these special cases, or negotiated connections, are occurring more frequently than the relevant rules or processes have envisaged. As these stakeholders are unprepared for these events they feel that their businesses are facing markedly increased risk.

Key findings for small-medium embedded generators

Although those generator proponents operating in the small-medium classes are generally more equipped operators (with 50% of them having over 10 employees), this increased capacity does not necessarily lead to better experiences.

The vast majority (77%) of these respondents have gained experience with small scale solar installations and are now applying this experience to the installation of 30-100 kW solar PV installations. Although 25% also had experience with embedded generators rated above 100 kW only 10% had experience with medium embedded generation.

These stakeholders are more aware of the rules around connection processes. Only a small fraction of these stakeholders consider the negotiated connection processes to be fair and reasonable. A large proportion of them cite unclear rules and connection processes as a concern.

Although there was a general perception of improving connection processes for small-medium embedded generators, a significant portion were of the view that the process had been getting harder over the survey period.

Other main areas of concern include:

- Connection process timeframes, with certainty of timing being a greater concern than the length of time taken;

- Information exchanges, with incomplete information and changes to information during the process having a significant impact on these businesses;
- Connection costs, with uncertainty on costs until very late in the process and the cost of the connection process itself being a key concern;
- The lack of clear and uniform technical standards for connection; and
- Export limitations imposed or preferred by some DNSPs.

Key findings for large embedded generators

Although only a small sample was received for large embedded generators there have not been large numbers of connections of these generators. As a result this sample is considered significant enough to capture the experiences of these generators, in some NEM regions at least.

These respondents were generally larger and better-equipped organisations having over 20 employees. Most of these respondents had considerable experience with distribution grid connection processes, although they might not have dealt with a particular DNSP prior to the project they sought to connect. Despite having considerable experience with connection processes generally, these stakeholders still reported difficulty in navigating the connection process. These connections were generally taking far longer than anticipated with connection offers taking over three times longer than anticipated by the rules, creating uncertainty for these projects. Many of these projects received little to no guidance on timing from the DNSP.

The exchange of information during these connections was highly ineffective. Responses to information requests were frequently incomplete, take significant time or are not filled. In addition the technical requirements for the connection were generally unclear until very late in the process.

Although connection costs generally make up 8-10% of these project's capital costs, the process generally leaves generator proponents with limited capacity to manage their commercial risk through timely analysis and design of the connection arrangements and negotiation of reasonable commercial terms.

Recommendations and priority areas for improvement

The CEC undertook these surveys on the basis that member organisations had notified it of concerns with connection processes. The results have identified that a large proportion of embedded generator proponents have been experiencing issues with connection processes. All survey respondents generally supported continued improvement across a range of connection process parameters.

It is apparent that mini embedded generators that were required to negotiate aspects of their connection were surprised by the need to follow a negotiated process. There is a strong desire to continue the development of standardised connection for these generating systems. This should focus on the identification and standardisation of commonly negotiated aspects of these connections.

For small-medium embedded generators these results confirm those already identified as priorities elsewhere, including:

- The maximisation in information available, both publicly and, where connection-specific, as early in the process as possible and in a timely manner.
- Clarity on connection costs as early in the connection process as possible.
- Clear and consistent technical standards for the connection of embedded generation are required at an Australian Standards level. The revised AS 4777 standard process should be expedited to completion.
- Connection process timeframes and response timeframes need to be more clearly committed and consistently adhered to in order to provide certainty for connecting parties.
- Early visibility of the commercial terms for connection is critical.
- Commercial terms for connection should also be standardised and determined by an independent body in order to ensure reasonable outcomes for both parties.

Large embedded generators would benefit from the above improvements along with the following:

- a more co-operative approach to the connection process;
- improved response timeframes for information requests and provide an Offer to Connect;
- technical requirements for the connection need to be performance-based and readily available;
- commercial arrangements which are reasonable from the commencement of negotiations;
- reasonable commercial terms for the investigation of the connection by the DNSP, along with clear guidance of the associated costs from early in the process; and
- increased access to contestable services in jurisdictions where this is not currently available.

Many of these opportunities for improvement have been previously identified and are already being progressed through avenues such as recent rule changes completed by the Australian Energy Market Commission (AEMC). These findings serve to reinforce the need for those actions while capturing experiences of an industry which is growing and developing very rapidly. Although the AEMC's work will not apply directly to the SWIS, lessons learned from the changes in the NEM should provide a good platform for changes in that market too.

The mid-scale survey has also led to a better understanding of a pressing need to strive for standardisation. The inefficiencies arising from what appear to be bespoke responses to many connections are unlikely to advance market objectives. A much stronger emphasis needs to be placed on working towards the standardisation of connection processes and technical and commercial outcomes on a national level. All parties should seek this outcome to maximise the efficiency of investment in embedded generation and the operation of DNSP businesses.

Finally, these surveys only capture one side of the connection process. Future surveys would be better informed if they capture the experiences and expectations of DNSPs in conjunction with embedded generators.