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

CLEAN ENERGY COUNCIL

ARENA

Australian Government
Australian Renewable Energy Agency

STOCKTAKE OF WORK UNDERTAKEN TO DATE

TASK 2A

REPORT BY: CLEAN ENERGY COUNCIL

Contents

Shortened Forms

Short	Long
AEMC	Australian Energy Market Commission
AEMO	Australian Energy Market Operator
AER	Australian Energy Regulator
APVI	Australian Photovoltaic Institute
ARENA	Australian Renewable Energy Agency
CEC	Clean Energy Council
COAG	Council of Australian Governments
CSIRO	Commonwealth Scientific and Industrial Research Organisation
DE	Decentralised Energy
DSM / DSP	Demand Side Management / Demand Side Participation
DMIS	Demand Management Incentive Scheme
DNSP	Distribution Network Service Provider
DKIS	Darwin-Katherine Interconnected System
ENA	Energy Networks Association
ERP	Emerging Renewables Program
ESAA	Energy Supply Association Australia
FPDI	Future Proofing in the Australia's Electricity Distribution Industry
IRG	Integrating Renewables with the Grid
ISF	Institute for Sustainable Futures
NEM	National Electricity Market
NER	National Electricity Rules
PV	Photovoltaic / Solar Power
RIT-D	Regulated Investment Test for Distribution
RIT-T	Regulated Investment Test for Transmission
SV	Sustainability Victoria
SWIS	South West Interconnected System
TEC	Total Environment Centre
VNM	Virtual Net Metering

Foreword

The Clean Energy Council (CEC) is the peak body representing Australia's Renewable Energy Industry. Australia is certainly a world leader in renewables. With some of the highest on-grid penetrations of solar PV in the world, electricity consumers are now driving an irreversible change. In conjunction consumers have been consistently reducing electricity consumption, challenging established understandings of the market.

The industry is clearly in a state of transition. Although its outcomes are not yet clear the transition process itself is presenting significant challenges and the industry is constantly under the research microscope.

This report makes an attempt at summarising some of the key influential research papers which look at the electricity sector in transition. The stocktake intends to provide information to industry stakeholders to allow them to capture the extent of work undertaken and to identify research gaps which could be addressed.

Although it is produced in the context of a CEC-led project, it is not intended to be limited in use. The CEC hopes that it could also be a useful tool for government agencies and regulators to assist in making informed decisions on policy and review processes. A stocktake exercise like this would never fully capture the extent of the work behind every article it incorporated. However, the CEC hopes that it provides a useful starting point for further work by anyone investigating the prevailing drivers and issues currently surrounding grid integration of renewable energy technologies.

About the FPDI Project

The CEC, in conjunction with its members and other key stakeholders, has scoped a comprehensive program of work that will begin to address current and emerging challenges. With the objective of enhancing the flexibility and resilience of Australia's electricity distribution systems and the installations connected to them, the CEC-led Future Proofing in Australia's Electricity Distribution Industry (FPDI) project will analyse existing and emerging issues associated with the increased penetration of renewable embedded generation and storage.

Ultimately the project seeks to build the foundations to facilitate the effective and efficient integration of renewable energy systems for Australia's electricity distribution industry. A subsequent goal is to ensure that the benefits of the transformation of this key industry toward a renewable energy future are accessible by the sector's various stakeholders.

The project's detailed scope of work includes technical, economic and regulatory analysis, forums, knowledge gathering and dissemination of the project outcomes. This approach is intended to create the environment for well-rounded stakeholder engagement throughout the project that will reinforce project outputs and target specific beneficial outcomes from each aspect of the project.

Further details of the project, its scope, governance and objectives can be found on the CEC website[1] in the FPDI Project area.

Acknowledgements

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.

The CEC thanks all those who are constantly contributing to the debate on the future or Australia's electricity sector and the FPDI project Steering Committee for their time and effort in providing crucial guidance and review of this work. These stakeholders include ARENA, Alternative Technology Association, Australian Energy Regulator, CSIRO, Department of Industry, Energex, Energy Networks Association, Energy Retailers Association of Australia, Marchment Hill Consulting, Pacific Hydro Pty Ltd, AusNet Services and University of Technology Sydney.

[1] www.cleanenergycouncil.org.au

1 Executive Summary

Australia's electricity distribution industry is undergoing significant change. Although there are many factors influencing this change, increasing uptake of renewable and distributed generation is central to it. Adapting to such significant change is never easy for an incumbent industry. While electricity is no exception, its status as a key source of the economy's energy has led to much research and discussion.

Understandably, significant effort has been placed on research and reform regarding the integration of renewable energy, storage and demand management into Australia's distribution networks. Numerous stakeholders have been involved in this work. They include research institutions, government agencies, network operators and various independent stakeholders. Many have made strong contributions which are seen to be critical to the reform process.

This report has been created to capture the background and objectives of many of these reform activities. It is intended to summarise key information from considered studies or reports while directing the reader to them to obtain further information if desired. Importantly, it does not seek to critique these works but has been prepared to understand how they relate to the broad objectives of the FPDI project in order to ensure that this project builds on prior outcomes.

This report should be read alongside ARENA's: *Integrating Renewables into the Grid Stocktake Results.* This study looked specifically at works which "*address or inform one or more objectives that relate to integrating renewable energy into Australian distribution networks*"[2].

Funded by ARENA, the study receives a special mention because it provides a comprehensive summary of works focussed on the lessons learned in relation to the above objective. Although there are similarities, this present study includes works which focus on policy and research in relation to the objectives of the FPDI project. These may not be specific to the experiences with integrating renewables and may consider other factors related to the electricity distribution industry.

This work does not duplicate the stocktake report and readers should also interrogate that report for further information. Energy Networks Association has been engaged by ARENA to

[2] Marchment Hill Consulting, Integrating Renewables into the Grid: Stocktake Results, p. 2, available: http://www.ena.asn.au/publications/arena-stocktake-project/

continue the Stocktake project[3] to facilitate ongoing information sharing of experiences with the integration of renewable energy in Australian distribution networks.

[3] http://www.ena.asn.au/publications/arena-stocktake-project/

2 Introduction

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. The industry's performance against its goal is critical to the economic prosperity of the nation.

For many years consumers have been the focus of industry outcomes, rather than actively participating. However, consumers are now faced with more choice than ever before on how they consume and generate their own electricity. Consumer responses to steep electricity price increases, and ever-decreasing solar electricity costs have resulted in these choices having a heightened role.

Unsurprisingly the industry is constantly being interrogated from technical, commercial and political perspectives. A large amount of policy reform and research activity has occurred and is expected to continue into the future.

This report summarises some of these works at a point in time and where they are relevant to the objectives of the FPDI project. It considers regulatory reviews, research reports, policy analysis and other analytical studies as agreed with the project Steering Committee.

While being informative in nature to meet the needs of the FPDI project, this work provides a consolidated understanding of recent activities of reform and opportunities for renewable energy, storage and demand management. It will potentially be a useful tool for government and regulators to assist in making informed decisions on policy and review processes. It will also provide a useful framework and evidence bank of the prevailing drivers and issues surrounding grid integration of renewable energy technologies, complementing ARENA's Integrating Renewables with the Grid (IRG) program[4].

The following section summarises the works by their objectives and relevance to the FPDI project. Section 3 then provides a full summary of each work by organisation and year.

2.1 Report summary table

The following table summarises each work considered and notes the main technical, economic and regulatory areas considered by each in order to inform with regards to the scope of the FPDI project.

[4] http://arena.gov.au/initiatives-and-programs/integrating-renewables-in-the-grid/

Author/ Owner	Title	Ref. Section	Year	Status	Purpose	Relevance to FPDI	Outcomes
AEMC	Connecting Embedded Generation under Chapter 5A Final Rule Determination	3.1.1	2014	Closed	Rule Change	**Technical:** The change would require that DNSPs provide clear connection standards. **Regulatory:** The change would make changes to the NER in relation to the connection of some embedded generators. **Economic:** The change seeks to create the opportunities to maximise the efficiency of the connection process.	As of March 2015 the NER will be changed to allow non-registered embedded generators to be treated in the same way as larger generators if desired.
	Distribution Network Pricing Arrangements Draft Rule Determination	3.1.2	2014	Live	Rule change (stage 2)	**Technical:** Considers the existence and magnitude of cross-subsidies between customers. **Regulatory:** Creates the settings to allow more adaptable and consultative pricing arrangements. **Economic:** Seeks to create the framework to allow networks to be priced relative to costs of providing the services.	Rule change should enhance transparency and consultation in price setting, and lead to more cost-reflective tariffs. Rule change consultation is ongoing with the final to be published in November 2014.
	Power of Choice Review	3.1.3	2012	Live	Market review	**Technical:** Considers many of market mechanisms in the NEM and the technologies associated with demand side participation. **Regulatory:** Considers demand and supply-side options for system-wide efficiency by looking deeply at the options which enable consumers to change the way they consume electricity. **Economic:** Key reforms proposed based on an economic assessment considering the impact of reducing peak demand between 2012 and 2022.	Ongoing reform activities are coming out of the review's many recommendations.
APVI	PV Integration on Australian Distribution Networks	3.2.1	2013	Closed	Research survey	**Technical:** Literature review considering matters related to the integration of PV with the grid.	Finds that there are significant differences in practice and expectation of PV connection between

Author/ Owner	Title	Ref. Section	Year	Status	Purpose	Relevance to FPDI	Outcomes
						Regulatory: Considers the available information on the connection process and relevant standards.	states and distribution areas.
COAG	Reform of the Demand Management and Embedded Generation Connection Incentive Scheme – Rule change request	3.3.1	2013	Live	Rule Change	**Regulatory:** A rule change request to the AEMC's proposed Demand Management Incentive Scheme. **Economic**: The purpose of the rule is to provide an appropriate return to DNSPs to incentivise efficient demand management projects as well as improve clarity and certainty regarding how the scheme will be developed and implemented.	Should improve the effectiveness of the demand management incentive scheme. The AEMC will consider this proposal in line with its normal rule change process including opportunities for consultation with interested stakeholders
CME	Australia's Million Solar Roofs: Disruption on the fringes or the beginning of a new order?	3.4.1	2013	Closed	Research	**Economic:** Seeks to understand the impacts of cross-subsidies between customers. Quantifies solar subsidies and network expansion and seeks to balance to the two interests.	Concludes that the extent of the cross-subsidy between consumers with and without PV is unclear. Queries whether DNSPs should have a right to recover revenue lost to competitors from remaining customers.
CIGRE	Capacity of Distribution Feeders for Hosting Distributed Energy Resources (DER)	3.5.1	2014	Closed	Research	**Technical**: Considers issues that limit distribution network capacity globally and solutions for increasing capacity **Regulatory**: Looks at conditions for connection around the world and suggests a more straight forward rule of thumb method.	Distribution networks can increase their embedded generation hosting capacity through various technical means including network reinforcement or modification, or the use of generation units with lower fault current limits.

Author/ Owner	Title	Ref. Section	Year	Status	Purpose	Relevance to FPDI	Outcomes
CSIRO	Change and Choice	3.6.1	2013	Closed	Research survey and modelling	Broad-reaching recommendations related to the technical, regulatory and economic implications of future scenarios of very high embedded generation penetration.	Concludes that the current market conditions will be required to change in the long term including removing barriers to networks investigating alterative network development and asset management strategies.
ENA	Enabling Embedded Generation	3.7.1	2014	Closed	Research	**Technical:** Identifies challenges with forecasting, voltage, losses, power quality, and safety which need to be addressed. **Regulatory:** Considers the benefits to the grid of embedded generation. **Economic:** Aims to demonstrate that embedded generation provides a benefit to the grid, while the generator also derives a benefit from the grid.	Concludes that there are benefits and costs resulting from the integration of embedded generation which need to be managed through improved information and tariff reform (for example).
	Value of Grid Connection to Distributed Generation Customers	3.7.2	2014	Closed	Research	**Economic:** Considers the value of network connection to solar customers, and the value of solar customers to the network.	Concludes that customers with rooftop PV systems pay less than other customers for the services they receive from the grid. Encourages tariff reform to correct this and avoid cross subsidisation between different grid customers.

Author/ Owner	Title	Ref. Section	Year	Status	Purpose	Relevance to FPDI	Outcomes
ESAA	Residential Electricity Tariff Review	3.8.1	2014	Closed	Market review	**Technical:** Considers scenarios with increased PV, electric vehicle and smart appliance uptake. **Economic:** Considered a range of different tariff designs, consumption and generation patterns and equity, efficiency and transparency outcomes.	Concludes that there is no single tariff that produces ideal outcomes but that the outcomes depended on factors like metering and the nature of the market in each state.
Grattan Institute	Shock to the System: dealing with falling electricity demand	3.9.1	2013	Closed	Market review	**Technical:** The report details electricity use trends in Australia since the 1960s. **Regulatory:** Considers the monopoly nature of network businesses, their spending patterns and the impact of peak demand on costs.	Urges for change to network business regulation as the reasons for costs increasing are structural.
	Fair pricing for Power	3.9.2	2014	Closed	Market review	**Economic:** Suggests tariff reforms including capacity charges for networks and peak demand pricing where that measure would reduce investment in the network.	The report finds that a capacity based network charge would better reflect the cost of building and running the network. It also recommends a new peak time of use tariff in areas where infrastructure upgrades are required to meet peak demand.
TEC / ISF	Calculating the network value of local generation and consumption	3.10.1	2014	Closed	Research	**Regulatory:** Considers how options for valuing distributed generation could be implemented. **Economic:** Considers options for valuing distributed generation.	It identifies that VNM is technically feasible and would provide a cost-reflective method of pricing. Recommends further investigation into methodologies for valuing distributed generation.

Author/ Owner	Title	Ref. Section	Year	Status	Purpose	Relevance to FPDI	Outcomes
	Restoring Power: Cutting bills & carbon emissions with Demand Management	3.10.2	2013	Closed	Research	**Technical:** This report considers methods for DM that will assist customers to reduce electricity demand. **Regulatory:** This report seeks to provide a practical agenda for reform to tap into benefits from DM.	The report recommends five key measures for cleaner, more affordable electricity. TEC have submitted a rule change to adjust the DMIS settings.
	Virtual Net Metering in Australia: Opportunities and Barriers	3.10.3	2013	Closed	Research	**Technical:** Looks at types of VNM, the features of the different types, barriers to VNM, and provides recommendations to progress this type of metering. **Regulatory:** Outlines VNM and its benefits in the Australian context. **Economic:** Considers the options for wheeling charges.	Finds that there is no regulatory barrier to VNM. However, it is unlikely to progress without a Rule change to specifically allow it.
ISF / SV	Decentralised energy: costs and opportunities for Victoria	3.10.4	2011	Closed	Research	**Technical:** Maps opportunities for decentralised energy against planned network expenditure. **Regulatory:** Identifies a range of barriers/challenges needed to be addressed to access the estimated benefits. **Economic:** looks at drivers of network investment, and ways to calculate and locate avoidable network investment.	Found that there is substantial untapped cost-effective potential of DE in Victoria. Generated a mapping tool to identify the locations for embedded generation or demand management which could tap into this benefit.
TEC	Demand Management Incentive Scheme Rule Change Request	3.11.1	2013	Live	Rule change (stage 0)	**Regulatory:** Rule change proposal aimed at greater utilisation of demand management, including energy efficiency, peak load management and distributed generation. **Economic:** In the long term the aim is to reduce unnecessary network investment and to reduce greenhouse gas emissions.	The proposed rule change does not mandate networks to undertaken demand management activities. The main incentive scheme proposal will be more than offset by lower investment in current and future regulatory periods

3 Report summaries

3.1 Australian Energy Market Commission

3.1.1 Connecting Embedded Generators under Chapter 5A Rule Change

Date: 13 November 2014
Organisation: AEMC
URL: http://www.aemc.gov.au/Rule-Changes/Connecting-embedded-generators-under-Chapter-5A
Purpose: Rule change
Focus area: Regulatory
Location: NEM

Relevance to FPDI: Regulatory.

Objectives: The rule determination outlines changes to the rules which create an opportunity for non-registered embedded generators to connect via a more defined connection process. The rule change will allow embedded generators to select their preferred connection process out of Chapter 5 or Chapter 5A of the National Electricity Rules (NER).

This reform would allow generators to choose a process which best suits their needs, which should lead to more efficient investment in embedded generation.

Key considerations: The rule change responds to a range of issues related to the experiences of connecting generators raised by the Clean Energy Council (CEC) including: information transparency; connection costs; extended timeframes and high risk contractual arrangements.

In addition, it raised a number of issues related to the inconsistency in the drafting of Chapter 5A in the context of the rest of the NERs.

Outcomes: The final rule will enable the option for a selected connection process to be used by the connecting generator, while retaining the current format for Chapter 5A. This change would allow those embedded generators for which there is no 'basic' or 'standard' connection arrangements to select their preferred process. The change would allow larger (generally) embedded generators to fully investigate the economic impact of the connection arrangements prior to committing to their investment by accessing the more defined Chapter 5 connection process.

The change also extends and clarifies information DNSPs are required to publish.

Timeframes for outcomes: The rule change will be implemented from March 2015.

3.1.2 Distribution Network Pricing Arrangements Rule Change

Date: 28 August 2014
Organisation: AEMC
URL: http://www.aemc.gov.au/Rule-Changes/Distribution-Network-Pricing-Arrangements
Purpose: Rule change
Focus area: Regulatory
Location: NEM

Relevance to FPDI: Regulatory. This is a draft rule change determination from AEMC.

Objectives: The draft determination outlines changes to the rules on how distribution network businesses develop and structure pricing. The objective of the change is that network prices better reflect the costs of providing network services to individual consumers.

Cost reflective pricing will increase market efficiency and allow consumers to make more informed decisions about their energy use.

Key considerations: Because network prices are currently not cost reflective, some consumers currently pay more than the costs caused by their usage while others, in particular those that use a greater proportion of their energy at peak times, pay less than the costs caused by their usage.

Issues of unfair customer pricing arise from air conditioner use at times of peak demand, solar panel network costs, solar panel orientation and contribution to peak demand, and off peak energy use by recipients of hardship assistance.

Results: Network pricing structures have not kept up with the increased diversity in how people use energy. Advances in technology both on the consumer's side of the meter and the network's side of the meter have given consumers and network businesses more options in how energy is provided and consumed.

Anticipated outcomes: The draft determination seeks to provide LRMC based cost-reflective prices so that retailers are charged network prices that reflect the different ways in which their customers use the electricity network.

As a result of this rule change, DNSPs will be subject to a new network pricing objective and pricing principles requiring cost reflective pricing to customers. There will be more transparency and consultation with consumers and retailers in the development of prices; and prices will be finalised earlier.

Timeframes for outcomes: Submissions will be considered prior to final determination in late November 2014. Submissions close on 16 October 2014. There will be a public forum on this draft determination in Sydney on 22 September 2014.

3.1.3 Power of choice review

Date: November 2012
Organisation: AEMC
URL: http://www.aemc.gov.au/Markets-Reviews-Advice/Power-of-Choice-Stage-3-DSP-Review
Purpose: Market Review
Focus area: Regulatory
Location: NEM

Relevance to FPDI: Regulatory. Looks at Demand and Supply side options for system wide cost efficiency.

Objectives: The overall objective of the AEMC's Power of Choice review is to ensure that the community's demand for electricity services is met by the lowest cost combination of demand and supply side options.

The final report in this review sets out their recommendations for supporting market conditions that facilitate efficient demand side participation (DSP). DSP options in this report include actions such as energy efficiency, peak demand shifting, changing consumption patterns, and consumers generating their own electricity.

Key considerations: The Power of choice review identified opportunities for consumers to make more informed choices about the way they use electricity. Options include information, education, technology, and flexible pricing options - to allow more efficient consumption decisions.

The review has also addressed the market conditions and incentives needed for network operators, retailers and other parties to maximise the potential of efficient DSP and respond to consumers' choices.

Results: Three key reforms can help achieve the efficient demand-supply balance in the market:

- Rewarding DSP in the wholesale market;
- Providing appropriate consumer protection arrangements and gradually phasing in efficient and flexible pricing options; and
- Introduce competition in metering services and develop a framework for smart meters and their services.

The report's many recommendations are described in detail and grouped into one chapter each of the report. Those chapters are:

- Consumer awareness, education and engagement
- Consumer information - access to electricity consumption data
- Enabling technologies (metering)
- Demand side participation in wholesale electricity and ancillary services markets
- Efficient and flexible pricing
- Distribution networks and DSP
- Distributed Generation
- Energy Efficiency measures and policies that impact or seek to integrate with the NEM

The AEMC engaged Frontier Economics to provide a high level estimate of the potential benefits that could be realised under the recommendations. Ultimately, the realisation of such net benefits will depend upon consumer choice and behaviour. As an example of the findings, Frontier Economics estimated that economic cost savings of peak demand reduction in the NEM is likely to be between $4.3 billion to $11.8 billion over the next ten years (net present value, 2013/14 to 2022/23) which equates to between 3 per cent to 9 per cent of total forecast expenditure on the supply side.

Anticipated outcomes: Detailed rule changes were not attached to the report. Instead the AEMC provided draft specifications of rule change proposals and an implementation plan for the recommendations.

The proposed recommendations are for the COAG Energy Council (formerly the Standing Council on Energy and Resources) to consider, and if agreed, to be implemented where appropriate through rule changes and other changes to other regulatory mechanisms.

At the time of writing, a number of these reforms are being progressed through various channels.

3.2 Australian PV Institute

3.2.1 PV integration on Australian distribution networks

Date: September 2013
Organisation: Australian PV Institute (APVI, formerly Australian PV Association)
URL: http://apvi.org.au/pv-integration-on-australian-distribution-networks-literature-review-2/
Purpose: Research
Focus area: Technical / Standard
Location: National

Relevance to FPDI: Technical. Considers the connection of PV to the grid.

Objectives: This report looks at the unprecedented growth in the PV market, particularly grid connected residential systems. The Australian Photovoltaic Institute (APVI) was engaged by ARENA to investigate the associated impacts on grid integration. This work contributes to Task 14 of the International Energy Agency's PV program; High PV Penetration in Electricity Grids.

This report is a literature review, which serves as a background document for a survey of Distribution Network Service Providers (DNSPs) across Australia focussing on experiences with and strategies for dealing with high penetration of PV.

Key considerations: The review includes an overview of electricity distribution in Australia, the amount of PV installed, Australian standards, state-based regulations, and DNSP policies regarding system connection. It also considers submissions and presentations made by DNSPs to government inquiries and industry conferences.

Results: The report finds that there are significant differences in practice and expectation of PV connection between states and distribution areas. For example, technical standards that DNSPs must comply with are determined individually by each state and territory. Also policies written by DNSPs for PV connections are all different, including variations in the size of system allowed.

Submissions by DNSPs to government processes focus on the following four main areas; the impact of PV on peak demand, technical challenges in connecting, management strategies and metering options.

3.3 COAG Energy Council

3.3.1 Reform of the Demand Management and Embedded Generation Connection Incentive Scheme – Rule change request

Date: December 2013
Organisation: Standing Council on Energy and Resources (SCER)
URL: http://www.scer.gov.au/workstreams/energy-market-reform/demand-side-participation/dmegcis/
Purpose: Rule Change
Focus area: Policy / Technical
Location: National

Relevance to FPDI: Regulatory. A rule change request to the AEMC's proposed Demand Management Incentive Scheme. Further information on the rule change is here: http://www.aemc.gov.au/Rule-Changes/Demand-Management-Incentive-Scheme

Objectives: SCER has submitted a rule change proposal as part of its demand side participation work program, which seeks to amend the existing National Electricity Rules (NER) governing the development and implementation of demand management and embedded generation connection incentive schemes (DMEGCIS). It is intended to strengthen the incentives for DNSPs to undertake demand management projects that deliver a net benefit.

The purpose of the rule is to provide an appropriate return to DNSPs to incentivise efficient demand management projects as well as improve clarity and certainty regarding how the scheme will be developed and implemented.

Key considerations: Specifically the rule change request seeks to improve the effectiveness of the incentive scheme through separating the current DMEGCIS into a Demand Management Incentive Scheme (DMIS) and a Demand Management and Embedded Generation Connection Innovation Allowance (Innovation Allowance).

The rule change then seeks to introduce a new objective for the DMIS and new principles to guide the development and application of the scheme, and to provide scope for the AER to compensate DNSPs for lost profit arising from eligible demand management projects. It also seeks to require the AER to develop a guideline for how incentive payments will be determined.

Results: The AEMC will consider this proposal in line with its normal rule change process including opportunities for consultation with interested stakeholders. For additional information, see the AEMC website.

3.4 Carbon + Energy Markets

3.4.1 Australia's million solar roofs: Disruption on the fringes or the beginning of a new order?

Date: December 2013
Organisation: Carbon + Energy Markets (Bruce Mountain, Director, and Paul Szuster, Consultant)
URL: http://cmeaustralia.com.au/public-reports/
Purpose: Research
Focus area: Policy / Regulatory
Location: National

Relevance to FPDI: Economic. Quantifies solar subsidies and network expansion and seeks to balance to the two interests.

Objectives: Investigates the uptake of domestic PV systems and considers the balance between lost revenues for network service providers, and avoided network expansion.

Key considerations: Investigates whether unexpectedly rapid expansion of the domestic solar PV sector has been a windfall for householders. It evaluates the profitability of PV investment to households by valuing the subsidies rooftop PV has received presents preliminary estimates of the impact of rooftop PV on wholesale electricity markets and on networks.

Results: The report finds that householders might have profited unreasonably given that the rate of return was 9.8%.In total around $8.2 bn. will be paid in capital and production subsidy for 900,000 rooftop systems (at the time of publication).

Household PV can reasonably be expected to have an impact on wholesale electricity prices, given their high penetration in the day time, but the extent to which PV avoids the need for network augmentation is unclear.

The extent to which there is a cross-subsidy between energy users that do not have PV and those that do is unclear.

The 900,000 households with PV are contributing around $250m per year less income to monopoly network service providers, but are not compensated for the reduction of future network expansion.

The question remains whether network service providers should have the right to recover revenue effectively lost to competitors, from its remaining captive customers.

Anticipated outcomes: More work should be done by Australia's governments, regulators, consumers and academics to understand the public interest impact of distributed generation in general and rooftop PV in particular.

3.5 Council on Large Electric Systems (cigre)

3.5.1 Capacity of Distribution Feeders for Hosting DER (Distributed Energy Resources)

Date: June 2014
Organisation: Council on Large Electric Systems (cigre)
URL: http://cigreaustralia.org.au/assets/ITL-SEPT-2014/3.1-Capacity-of-Distribution-Feeders-for-hosting-Distributed-Energy-Resources-DER-abstract.pdf
Purpose: Research
Focus area: Policy / Regulatory / Economic
Location: NEM and International.

Relevance to FPDI: Regulatory and technical. Considers distributed energy resources globally, and challenges for distribution networks.

Objectives: This report seeks to study the limits of distribution feeders for hosting distributed generation and the derivation of practical guidelines for the connection of embedded generation.

Key considerations: The study looks at global distribution networks and their performance given the significant uptake of embedded generation. It also considers technical evaluation practices adopted by distribution companies all over the world, in order to identify suitable rules and methodologies,

Finally the report considers currently available means for increasing distribution network hosting capacity

Results: Technical issues that limit the capacity of distribution networks to host embedded generation include the thermal ratings of network components, voltage regulation, short circuit level and power quality considerations, while additional constraints may arise from islanding considerations and the possibility for reversal of power flows.

Globally, distribution networks carry out studies to evaluate whether a new connection will violate network ratings. Several countries apply a limit to either the transformer capacity or the thermal limit of MV feeders, and the limits vary between 50% and 100%. Simplified screening criteria could be based on generation to load or short circuit contribution ratios (incorporating safety factors).

Distribution networks can increase their embedded generation hosting capacity through some of the following means: network reinforcement; use of units with lower fault current or fault current limiting devices to reduce short circuiting; voltage regulation through readjusting settings for on load tap changers, step voltage regulators and other devices; controlling the power factor of the reactive output of embedded generators; and modifications to allow bidirectional power flow.

3.6 CSIRO

3.6.1 Change and choice: The Future Grid Forum's analysis of Australia's potential electricity pathways to 2050

Date: December 2013
Organisation: CSIRO
URL: http://www.csiro.au/Organisation-Structure/Flagships/Energy-Flagship/Future-Grid-Forum-brochure.aspx
Purpose: Research
Focus area: Policy / Regulatory / Economic
Location: NEM

Relevance to FDPI: Technical, regulatory and economic. Considers the long-term implications of plausible futures in 2050 on the electricity supply system.

Objectives: Through extensive stakeholder engagement the Future Grid Forum developed and explored "*potential scenarios for Australia's energy future in order to support the decision making process around what comes next*"[5].

Key considerations: Estimates the future shape and implications of the electricity load curve under alternative scenarios of the adoption of storage at the end-user end, air conditioning control, different levels of penetration of solar panels and other on-site generation and industrial demand response.

Results: Provides the following options for managing the electricity sector's transition: Improve institutional capability in demand forecasting; Remove barriers to introducing cost-reflective pricing; Encourage network businesses to investigate alternative network development and asset management strategies while reviewing the appropriateness of current market frameworks; Review Australia's electricity consumer social safety net;

[5] http://www.csiro.au/Organisation-Structure/Flagships/Energy-Flagship/Future-Grid-Forum-brochure.aspx

Develop bipartisan agreement on the long-term greenhouse gas emission target and implementation mechanism.

Estimates future residential and large commercial/industrial retail prices to 2050 under alternative scenarios for the electricity sector and provides financial modelling of the cost of disconnecting from the grid.

On-site electricity generation is projected to reach 18-45 percent of total generation by 2050; Disconnecting from the grid will likely be economically viable sometime in the next two decades if battery costs fall; Retail electricity prices are projected to rise due to declining utilisation of networks and due to the cost of introducing low emission generation technology. Energy efficiency will be important in ameliorating the impact of price increases on electricity bills. Distribution unit costs could increase 2.8 c/kWh (all else being equal) if climate change increases the risk of extreme peak demand events.

Anticipated outcomes: Provides critical information to support the debate on the impact of long term trends in the electricity sector. By separating the sector into stakeholder groups the report provides steerage to differing sectors on the extent of change they potentially facing in the long term.

3.7 Energy Networks Association

3.7.1 Enabling embedded generation

Date: April 2014
Organisation: Energy Networks Association (ENA)
URL: http://www.ena.asn.au/wp-content/uploads/2014/04/ENABLING-EMBEDDED-GENERATION-Turning-Australian-electricity-on-its-head_Web.pdf
Purpose: Research
Focus area: Policy / Regulatory
Location: National

Relevance to FPDI: Regulatory. Considers the benefits to the grid of embedded generation.

Objectives: This short report from the ENA accepts that energy supply systems around the world are being transformed by embedded generation. The report aims to demonstrate that embedded generation provides benefits to the grid and also that the grid offers benefits to embedded generation.

Key considerations: Australia's distribution networks have been designed to deliver electricity in a one way fashion from centralised generators to consumers. Significant uptake of embedded generation means that electricity flows have been disrupted, and this presents technical challenges but has some benefits to the grid.

Results: Embedded generation can reduce transmission and distribution losses in the grid, and can potentially defer network augmentation. It can also provide voltage support and improve power system resilience. Where the generation is renewable, it also reduces emissions.

The grid provides benefits to generators, including access to markets, increased reliability in the event of intermittency voltage quality support and other technical services.

Integration challenges include increased uncertainty in demand forecasting, voltage fluctuations, network losses, decreases in power quality and the introduction of harmonics, safety issues and fault management.

Efficient integration of embedded generation will require tariff reform such that prices are cost reflective. There also needs to be better information on network constraints.

3.7.2 Value of Grid Connection to Distributed Generation Customers

Date: November 2014
Organisation: Energy Networks Association (ENA)
URL: http://www.ena.asn.au/wp-content/uploads/2014/11/OGW-Report-Value-of-the-Grid-final-17-Nov.pdf
Purpose: Research
Focus area: Policy / Regulatory
Location: National

Relevance to FPDI: Economic. Considers the benefits to distributed generation customers of connecting to the grid.

Objectives: This report from the ENA considers the dramatic increase in the rate of solar PV system uptake, and the value to solar PV customers of remaining connected to the grid.

Key considerations: The report investigates the value of grid connection to solar PV customers, as well as the value of solar PV systems to the grid. It undertakes some case studies of customers with solar PV systems in Sydney, NSW. It looks at what that customer pays for grid electricity, what they customer can sell solar power for, and what services the customer receives. The case studies conclude that the customer would pay hundreds of dollars annually to the network to get the services which are provided for free.

Results: The report finds that remaining connected to the grid provides value to the customer through continuity of supply; market access; and power balancing and quality services. It also acknowledges that solar PV provides a service to the grid in reducing peak demand (and therefore reducing investment in grid expansion).

The report finds that customers with rooftop PV systems pay less than other customers for the services they receive from the grid. It encourages tariff reform to correct this imbalance and avoid cross subsidisation between different grid customers.

3.8 Energy Supply Association of Australia

3.8.1 Residential electricity tariff review

Date: January 2014
Organisation: By Deloitte for the Energy Supply Association of Australia (ESAA)
URL: http://www.esaa.com.au/policy/residential_electricity_tariff_review
Purpose: Market review
Focus area: Policy / Regulatory
Location: National

Relevance to FPDI: Economic. Considers tariff designs.

Objectives: This report reviews the merits of different electricity tariff designs by examining the effectiveness, simplicity, stability, equity and likely consumer acceptance of a range of current and potential tariff designs.

Key considerations: The tariff designs considered include standard Australian household prices (low fixed charge and flat usage charge); Inclining Blocks; Declining Blocks; Time of use pricing (peak, off-peak and shoulder); Critical Peak Pricing/Rebates; Capacity Tariffs; Seasonal Pricing; and Controlled Load tariffs.

Scenarios considered included continuing Solar PV uptake, time-controllable distributed generation and storage uptake, electric vehicle uptake, and longer term changes to energy use such as new appliances and changes in load profile due to lifestyle changes like more people working from home.

Results: The report found that there was no single tariff that optimised equity, efficiency, simplicity and transparency; rather this depended on other factors like metering technologies and the nature of the market in each state.

Capacity tariffs are consistently the strongest performing tariffs in terms of cost reflectivity as well as revenue stability for network businesses in the face of current and expected disruptions to the electricity sector investigated in the report.

Controlled Load tariffs are well-suited to the market scenario involving increased uptake of electric vehicles. Controlled Load tariffs generally aid cost reflectivity by restricting the use of certain appliances and charging customers less at off peak times when the cost of supplying electricity is lower.

Time of Use Tariffs do not exhibit the same level of precision as Capacity Tariffs in relation to reflecting underlying costs. In particular, they do not specifically target the high marginal costs or high variable generation costs associated with using electricity at critical peak times.

3.9 Grattan Institute

3.9.1 Shock to the system: dealing with falling electricity demand

Date: December 2013
Organisation: Grattan Institute
URL: http://grattan.edu.au/report/shock-to-the-system-dealing-with-falling-electricity-demand/
Purpose: Market review
Focus area: Policy / Regulatory
Location: Focus on NEM with some mention of SWIS, DKIS.

Relevance to FPDI: Economic. Provides discussion of network charges and argues for changes to network business regulation.

Objectives: This report considers the reasons behind energy price rises despite falling demand in the Australian energy market. It is specifically concerned with investigating over-investment by distribution companies.

Key considerations: Electricity use is declining which spreads distribution costs over fewer users and units, driving up costs. The report details electricity use trends in Australia since the 1960s and provides reasons including energy efficiency of homes and appliances and declining manufacturing.

Network costs are not related to capacity or use and so reduced demand does not result in lower prices as it would in a traditional market. This means that energy users who are achieving efficiency outcomes have seen power bills go up rather than down. The report also investigates peak demand and the effect this has on infrastructure investment.

Results: This report concludes that "*The reason electricity bills have grown in the face of falling consumption lies in the structure of the electricity market and the way it is regulated*".

The report suggests that the answer to the issue of rising prices is reform in three policy areas, namely:

- *Ensuring cost efficient network investment.* Allow the Australian Energy Regulator (AER) to set lower rates of return to network businesses and ensure network reliability improvements are subject to a cost benefit test.

- *Ensuring efficient network tariffs.* This will be assisted by the roll out of smart metering and allowing consumer choice with electricity use management.

- *Writing down network values.* This would mean recognising the need for networks to compete with non-network alternatives and reducing the value of the regulated asset base accordingly. The cost of network write downs will be borne by one of three of consumers, network business owners (where the businesses are privately owned) and Governments.

Anticipated outcomes: Future Grattan Institute research will explore the relative merits of alternatives with a view to providing policy recommendations.

3.9.2 Fair pricing for power

Date: July 2014
Organisation: Grattan Institute
URL: http://grattan.edu.au/wp-content/uploads/2014/07/813-fair-pricing-for-power.pdf
Purpose: Market review
Focus area: Policy / Regulatory
Location: National

Relevance to FPDI: Economic. Argues for tariff reform to reduce power prices. This report is the third in a series of Grattan reports on power prices.

Objectives: This report builds on the work in two previous Grattan reports (including the previous report discussed in this document – *Shock to the System: Dealing with falling electricity demand*) and proposes structural and operational network tariffs that will lower power prices.

Key considerations: The report describes changes in the way electricity and the network is used, including smart meters, air conditioners and rooftop solar. It looks at incentives for network investment and the political and institutional challenges associated with tariff reform.

The report also investigates a pathway to tariff reform.

Results: The report finds that a capacity based network charge would better reflect the cost of building and running the network. It also recommends a new peak time of use tariff in areas where infrastructure upgrades are required to meet peak demand.

The introduction of these two new tariffs will give all consumers the incentive to use electricity more efficiently. This will reduce pressure on network companies to invest in new infrastructure, and thus bring power prices down.

3.10 Institute for Sustainable Futures

3.10.1 Calculating the network value of local generation and consumption

Date: April 2014
Organisation: Prepared for the Total Environment Centre by the Institute for Sustainable Futures
URL: http://www.advocacypanel.com.au/media/docs/Calculating-the-Network-Value-of-Local-Generation-and-Consumption---Stage-1-Final-Report-70870cf6-ac81-4be3-96f1-25c63e569141-0.pdf
Purpose: Research
Focus area: Policy / Regulatory
Location: National

Relevance to FPDI: Regulatory / Economic. Considers options for valuing distributed generation.

Objectives: This report follows on from the Total Environment Centre's discussion paper on Virtual Net Metering (VNM). It looks at ways to value distributed generation, including methodologies for calculating the benefits of avoided network costs. It then analyses potential market pathways including transaction pathways for VNM, and the logistics of metering and billing.

Key considerations: This report considers the value of distributed generation.

It describes two ways to value distributed generation. These are via a Distributed Energy Credit, which is available to all distributed generation regardless of customer linking, or via a VNM system where the generation is linked to the purchaser of the energy.

Methodologies for calculating the value of VNM include volumetric time of use, existing tariff, capacity payment, and locational constraint.

Results: The report finds that the availability of credits through either VNM or a Distributed Energy Credit system will significantly improve the business case for distributed generation. It finds that VNM is potentially a more cost-reflective method; however the business case outcome will be sensitive to the calculation methodology that is adopted.

Anticipated outcomes: The report recommends further investigation into methodologies for calculating the value of distributed generation. It also suggests consultation with network businesses to ensure support for the eventual approach.

A next step is to develop a proposal to examine metering, retail and network regulatory requirements and confirm any required Rule Changes associated with the preferred framework.

3.10.2 Restoring Power: Cutting bills & carbon emissions with Demand Management

Date: November 2013
Organisation: Prepared for the Total Environment Centre by the Institute for Sustainable Futures
URL: http://www.tec.org.au/images/reports/Restoring%20Power%20-%20DMIS%20Final%20Report%2020%20Nov%202013.pdf
Purpose: Research
Focus area: Policy / Regulatory
Location: NEM

Relevance to FPDI: Economic. Considers Demand Management options and pathways.

Objectives: This report considers methods for Demand Management (DM) that will assist customers to reduce electricity demand, and thus reduce bills and environmental impact.

While the potential for DM to reduce costs to consumers has been well recognised in Australia for decades, attempts to unlock its potential have been patchy. This report seeks to provide a practical agenda for reform.

Key considerations: Demand Management (DM) is defined as activities that lower or shift the demand for electricity as an alternative to providing additional supply. Activities include energy efficiency, peak load management and distributed generation.

DM is important for Australia because of rising electricity prices, increasing network charges, and emissions reduction.

Results: The report recommends five key measures for cleaner, more affordable electricity:

1. The AEMC to amend the National Electricity Rules to clarify incentives to network businesses for overcoming barriers to efficiency network DM.
2. The AER to establish an effective DM incentive scheme
3. Distribution network businesses to set DM targets
4. Distribution network businesses to report on DM activities and outcomes
5. AER to provide effective and efficient DM performance incentives to network businesses.

Anticipated Outcomes: Total Environment Centre has prepared and submitted a rule change request to the AEMC to enhance the current Demand Management and Embedded Generation Connection Incentive Scheme.

3.10.3 Virtual net metering in Australia: Opportunities & Barriers

Date: June 2013
Organisation: Prepared for the Total Environment Centre by the Institute for Sustainable Futures
URL: http://cfsites1.uts.edu.au/find/isf/publications/langhametal2013virtualnetmetering.pdf
Purpose: Research
Focus area: Policy / Regulatory
Location: National

Relevance to FPDI: Regulatory / Economic. Overview of Virtual Net Metering

Objectives: This paper outlines Virtual Net Metering (VNM) and its benefits in the Australian context. It looks at types of VNM, the features of the different types, barriers to VNM, and provides recommendations for progressing this type of metering.

Key considerations: The paper considers single entity and third party VNM in Australia, as well as international examples including single entity, third party and community VNM.

It also looks at barriers to VNM such as wheeling charges, retail barriers, and process and other barriers.

Results: The report finds that there is no regulatory barrier to VNM. However, it is unlikely to progress without a Rule change to specifically allow it, and to facilitate the uptake of the model with 2nd tier retailers.

This is partly because there are so few Australian examples, and none with wheeling charges.

Anticipated outcomes: The report recommends initiating an industry dialogue on VNM, through feedback on this paper and then a workshop for invited stakeholders. A work program for progressing VNM might include a more detailed study of models, working with the AEMC to develop a methodology for calculating wheeling charges, and a rule change proposal for an appropriate retailing arrangement.

3.10.4 Decentralised energy costs & opportunities for Victoria

Date: November 2011
Organisation: Prepared for Sustainability Victoria by the Institute for Sustainable Futures
URL: http://cfsites1.uts.edu.au/isf/news-events/newsarchive-detail.cfm?ItemId=31169
Purpose: Research
Focus area: Policy / Technical
Location: Victoria

Relevance to FPDI: Technical. Maps opportunities for decentralised energy.

Objectives: This report aims to facilitate greater deployment of decentralised energy (DE) options. It looks at drivers of network investment, and ways to calculate and locate avoidable network investment. This allows a study of the benefits and costs of potential DE in Victoria.

Maps developed for the project are intended to make detailed network data more useful and to communicate the geographical areas in which the greatest benefit from DE products and services can be obtained. The maps will also help policy makers and regulators who wish to understand the dynamics of these benefits and how DE can contribute to beneficial economic and environmental outcomes.

Key considerations: The research included an assessment of the forecast electricity demand trends over the coming decade, and the electricity network infrastructure investment proposed to address these conditions over the coming five year period. This investment was then analysed to identify potentially avoidable network costs driven by growth in peak demand, which could potentially be more efficiently addressed through non-network options such as DE.

Results: The research found that there is substantial untapped cost-effective potential of DE in Victoria, which if implemented strategically, could reduce electricity sector emissions by 6.2% and save electricity consumers in the order of $437 million per annum by 2020.

DE also increases the range of options to tackle future peak capacity and energy generation shortfalls in a more dynamic, cost effective and flexible fashion.

3.11 Total Environment Centre

3.11.1 Demand Management Incentive Scheme Rule Change Request

Date: November 2013
Organisation: Total Environment Centre
URL: http://www.aemc.gov.au/getattachment/bd0c5575-c353-4c35-975b-c33f13271290/Rule-change-request.aspx
Purpose: Research
Focus area: Policy / Technical
Location: National

Relevance to FPDI: Regulatory. A submission to the AEMC's proposed Demand Management Incentive Scheme Rule Change. Further information on the rule change is here: http://www.aemc.gov.au/Rule-Changes/Demand-Management-Incentive-Scheme

Objectives: This proposal adds to previous work by the Total Environment Centre which argues consistently for great utilisation of demand management, including energy efficiency,

peak load management and distributed generation. In the long term the aim is to reduce unnecessary network investment and to reduce greenhouse gas emissions.

Key considerations: This rule change is specifically related to the AER's Power of Choice process, and within that the Demand Management and Embedded Generation Connection Incentive Scheme (DMEGCIS). It is accompanied by a report that the Total Environment Centre had prepared by University of Technology Sydney's Institute of Sustainable Futures (ISF) called *Restoring Power: Cutting bills & carbon emissions with Demand Management*. That report is summarised in this paper.

Results: The proposed rule change will have no direct benefits or costs, as it does not mandate networks to undertaken demand management activities. The main incentive scheme proposed in the Restoring Power report is payable for five years and payable to networks, however will be more than offset by lower investment in current and future regulatory periods.