

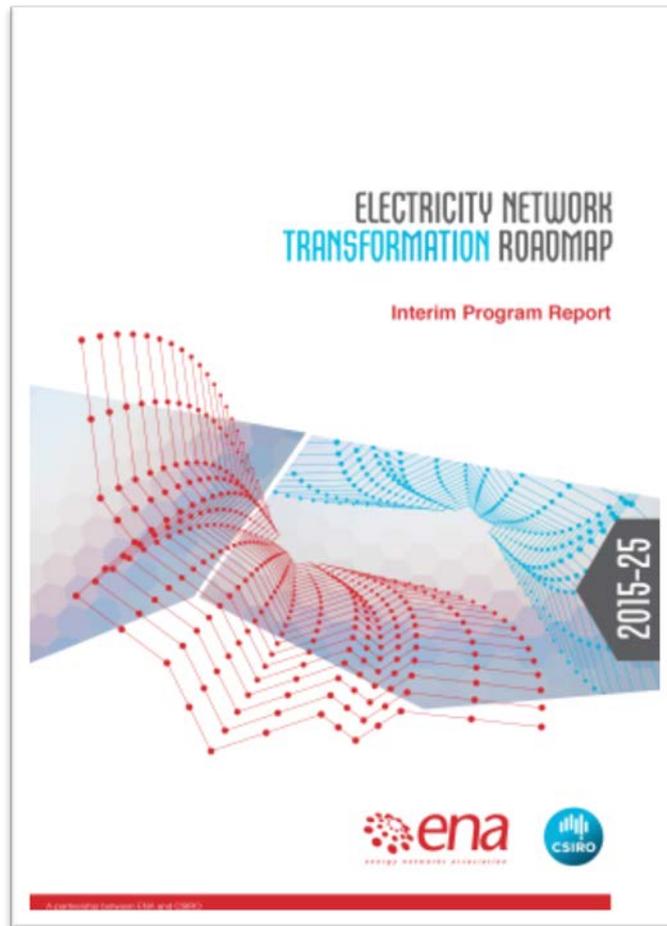
# ELECTRICITY NETWORK TRANSFORMATION ROADMAP

2015-25

**Stage 2 Overview – May 5<sup>th</sup> 2016**  
Introduction by Mark Paterson  
NTR Program Director



# Our work in Stage 1...



## Key findings of Stage 1

**CSIRO's updated Future Grid Forum scenario analysis** remains a plausible basis for the Roadmap to identify potential 'no regrets' actions. It indicates the following context:

- Australia faces a broad spectrum of potential energy futures that vary greatly in the adoption of new technology, the mode of customer engagement, and the role of the electricity network.
- Customer bills outcomes are slightly lower than forecast in 2013, reflecting the role of storage in facilitating economic integration of solar PV and other distributed generation.
- Solar PV take-up is dominating embedded generation and tracking to the high end of the 2013 projected share, while battery storage cost trends have further improved.
- The updated scenarios continue to reflect electricity networks performing an evolving range of critical roles by 2050 that support diverse energy use and services for customers.

**Potential electricity customers in 2025** are likely to evaluate an expanding range of electricity solutions based on their different needs and desires. Based on anticipated preferences, the following customer segments are plausible in 2025:

Five residential end-user segments across a *vulnerable—engaged—empowered* spectrum. These are Service dependent, Be my agent, Hands on, Tech focused and Autonomous.

Four commercial and industrial end-user segments across an *essential—engaged—empowered* spectrum. These are Vulnerable, Passive, Active and Autonomous.

These segments enable exploration of strategic options and are not meant to be perfect 'predictions' of customers in 2025. It is expected that participation in a specific customer segment will not necessarily be directly coupled to household income or enterprise financial status, as new business models and financing options evolve.

**Integration of distributed energy resources** will require a careful operational response to challenges such as voltage management, frequency regulation and network stability. However, such resources could also provide the solutions to support network challenges and improve network efficiency. To do so, Australia will likely need regulatory frameworks, enhanced standards and commercial responses that unlock the potential of storage, demand response services and power electronics solutions.

**Advanced business model responses** by energy networks may focus on 'Platform Enabled' services, supported by *key operating principles* - namely, being able to integrate all types of generation; enabling consumers to provide services back to the grid; offering enhanced or optional services; being agnostic about supply; and facilitating retail markets.

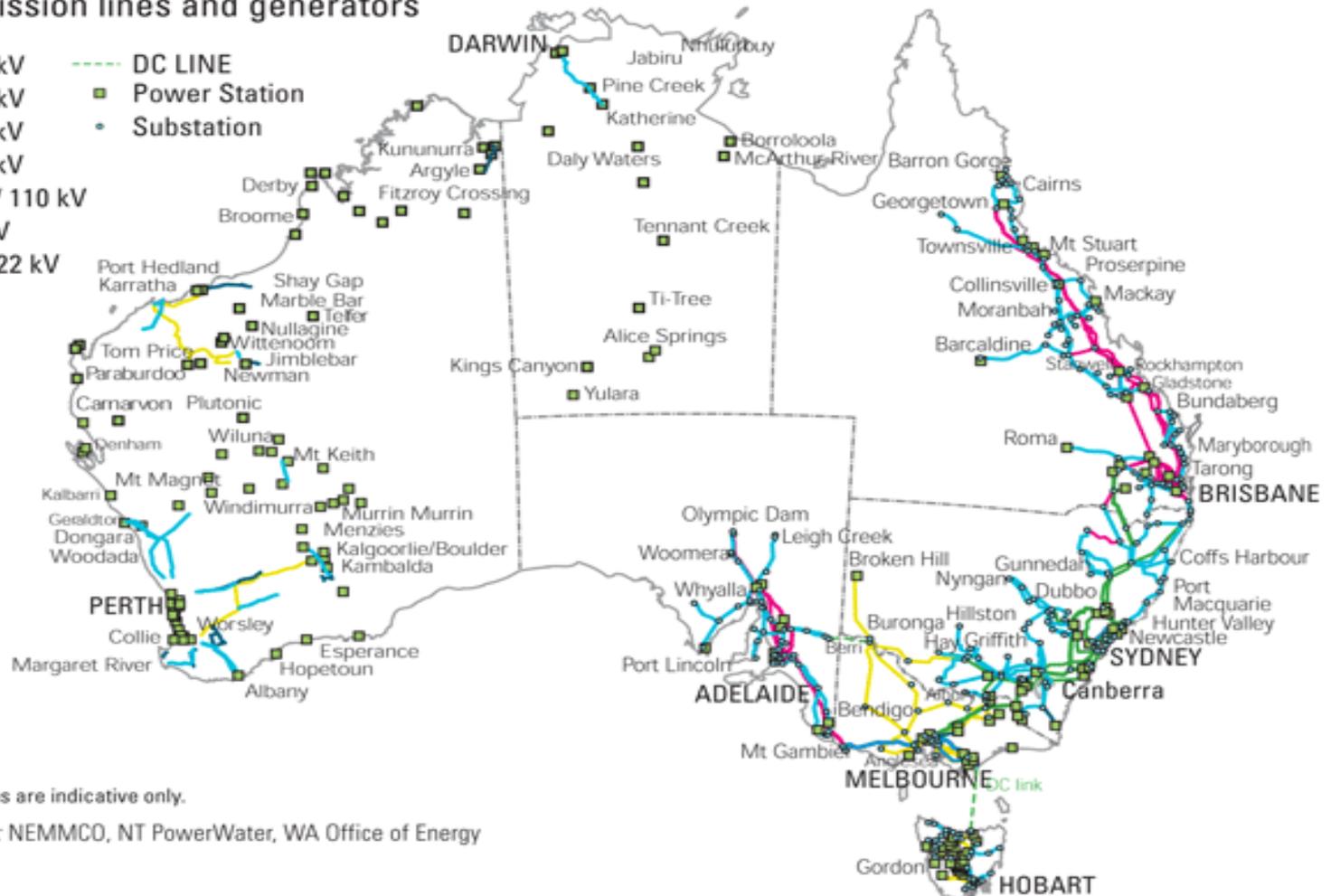
**Dynamic tariffs and incentives** will play a critical role in achieving efficient investment, lower bills and minimising unfair cross-subsidies. A 'First Wave' of reforms will include fixed cost recovery and demand based tariffs. Then, a 'Second Wave' may help customers participate in new options or markets, which are likely to be location-specific and dynamic in real time.

**Elements of Australia's energy regulatory framework** are robust. However, a managed transition from ad hoc - approach to regulatory reform is required to support flexibility and contestability, the introduction of new approaches to risk allocation, and the transition to purpose regulation. Seven guiding principles are proposed.

# Powering the world's largest island...

## Transmission lines and generators

- 500 kV
- 330 kV
- 275 kV
- 220 kV
- 132 / 110 kV
- 66 kV
- 33 / 22 kV
- DC LINE
- Power Station
- Substation



Locations are indicative only.

Sources: NEMMCO, NT PowerWater, WA Office of Energy

# In the Disruption Generation...



iTunes



TESLA

NETFLIX



## Decentralisation



Transition from a one way, centralised *system*, to a two way, more decentralised *system*

## Customer Expectations



Expectations are changing for many customers

## Storage

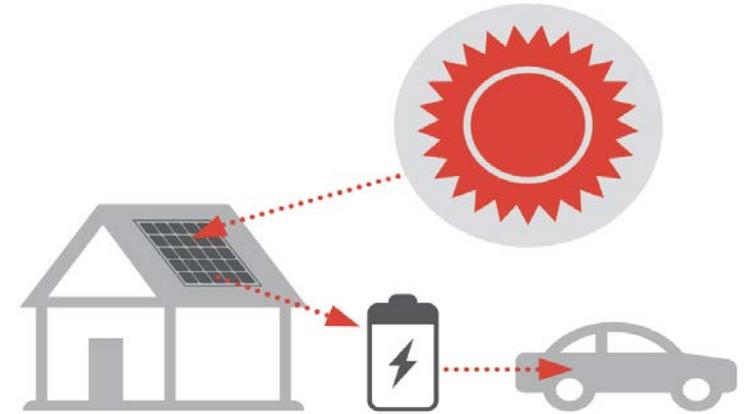


Storage is becoming more affordable and has many possible applications

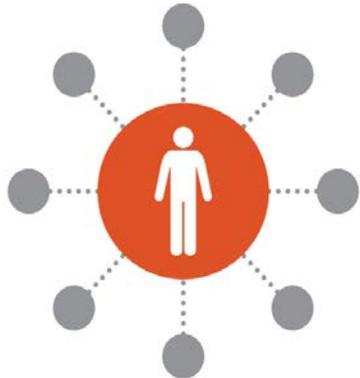
# 2050 Future Grid Forum Scenarios



Set and forget



Leaving the grid



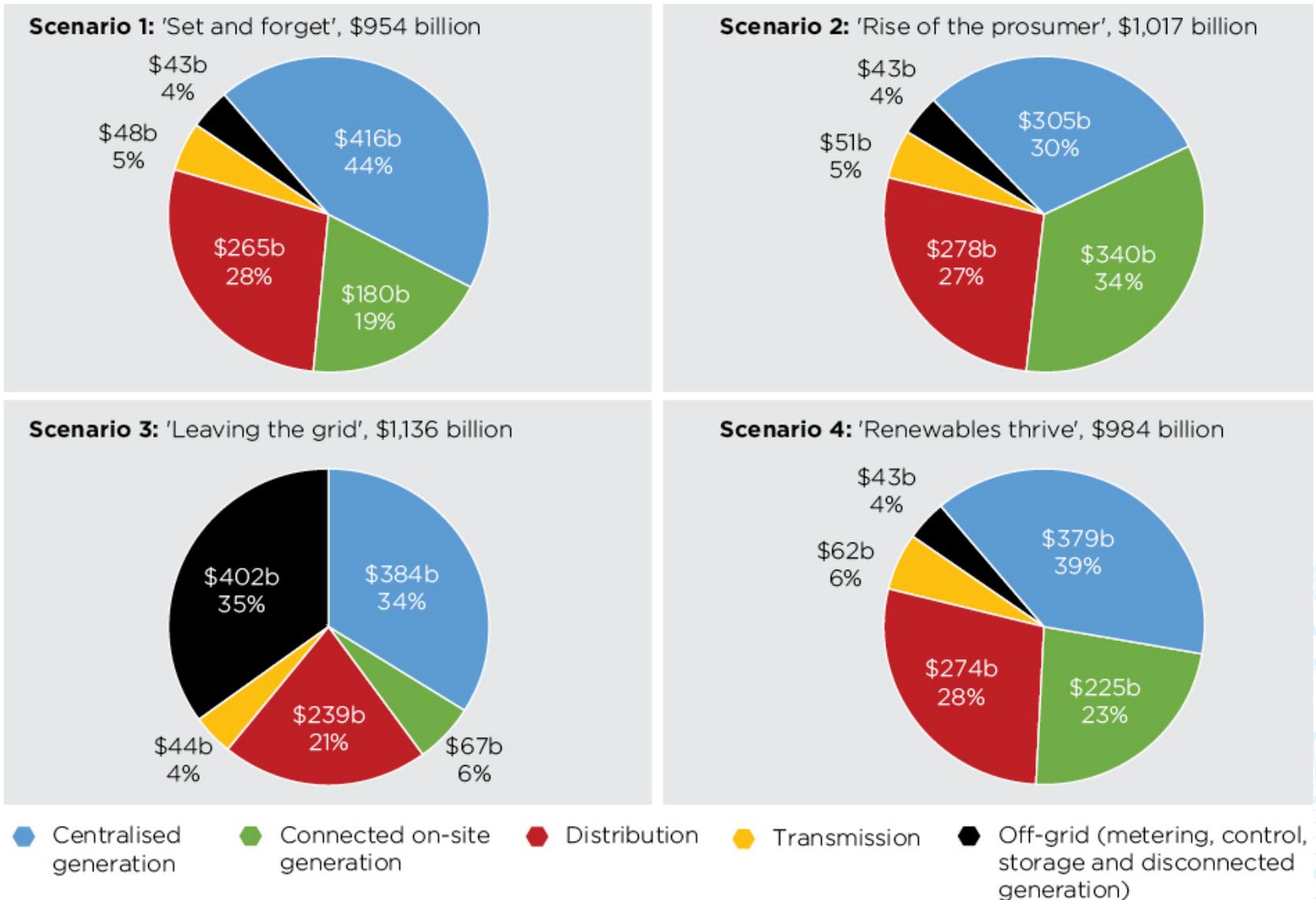
Rise of the 'Prosumer'

**Customer-centric model**  
where customers consume, trade,  
generate and store electricity.



Renewables thrive

# 2015 Refresh of the scenarios demonstrated the diversity of potential futures



# Roadmap Outcome

Australia's electricity systems in 2027 are resilient to divergent futures and characterized by:

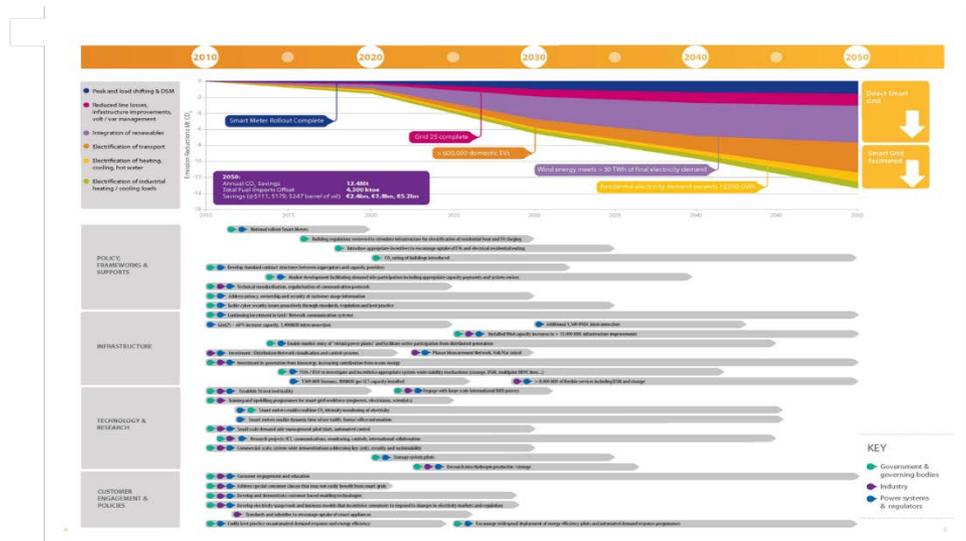
- The 'balanced scorecard' of long-term customer and societal value creation;
- Whole-of-system efficiency, reliability and safety; and,
- Millions of end-users participating in and sharing the benefits of whole-of-system optimisation through open, vibrant markets and appropriate protections.



# Roadmap Structure / Inclusions

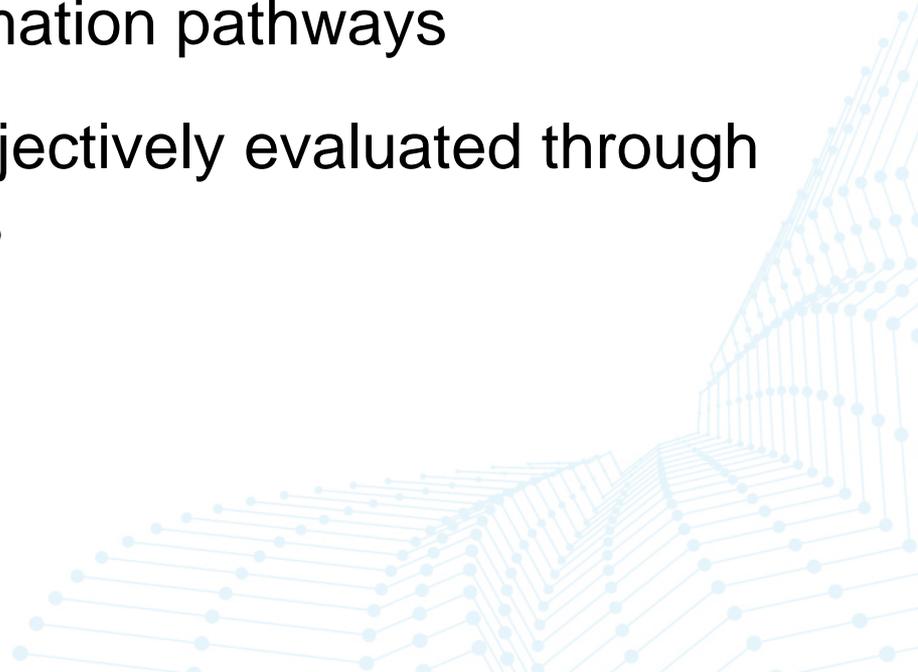
The 2017-27 Roadmap will concisely set out:

- An integrated set of 'no regrets' actions spanning all Domains (or 'swim lanes');
- The sequence, interrelationships and milestones for actions across the decade; and,
- Nominated primary and secondary responsibilities for each action.



# Design Process maximises Collaboration

- Program orientation: Human-centred design, Whole-of-system optimisation and Balanced Scorecard outcomes.
- Shared long-term scenarios inform strategic design of the Roadmap ‘from the future back to the present’
- The process maximises a diversity of expert perspectives in the development of transformation pathways
- Pathway options are then objectively evaluated through detailed quantitative analysis



# Domains & Work Packages

## A. Customer Orientated Networks (WP 1 & 2)

- Transformation Drivers
- FGF Update
- Customer Reorientation

## B. Revenue and Regulatory Enablers (WP 3 & 4)

- Business Models
- Regulatory Frameworks – Risk Sharing; Scope of Service; Customer Protection

## C. Pricing and Incentives (WP 5)

- Cost-Reflective Pricing
- “Second Wave” Incentives
- Value of New services including Micro-grids, Ancillary Services

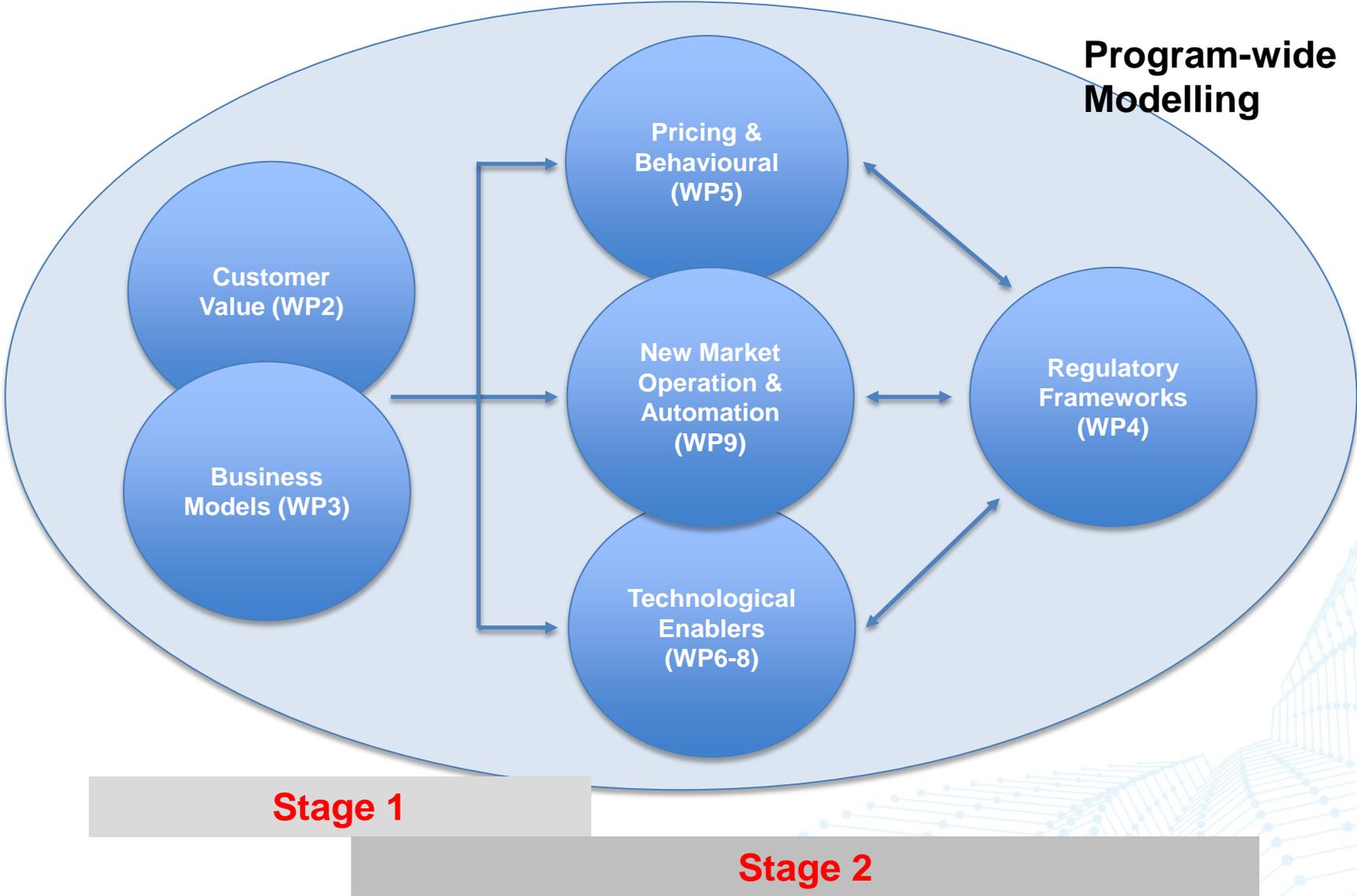
## D. Technological Enablers (WP 6 – 8)

- Standards, operating platforms
- Advanced Power System Operations, Reliability and Security
- Grid-side technologies and innovation
- Future Workforce requirements

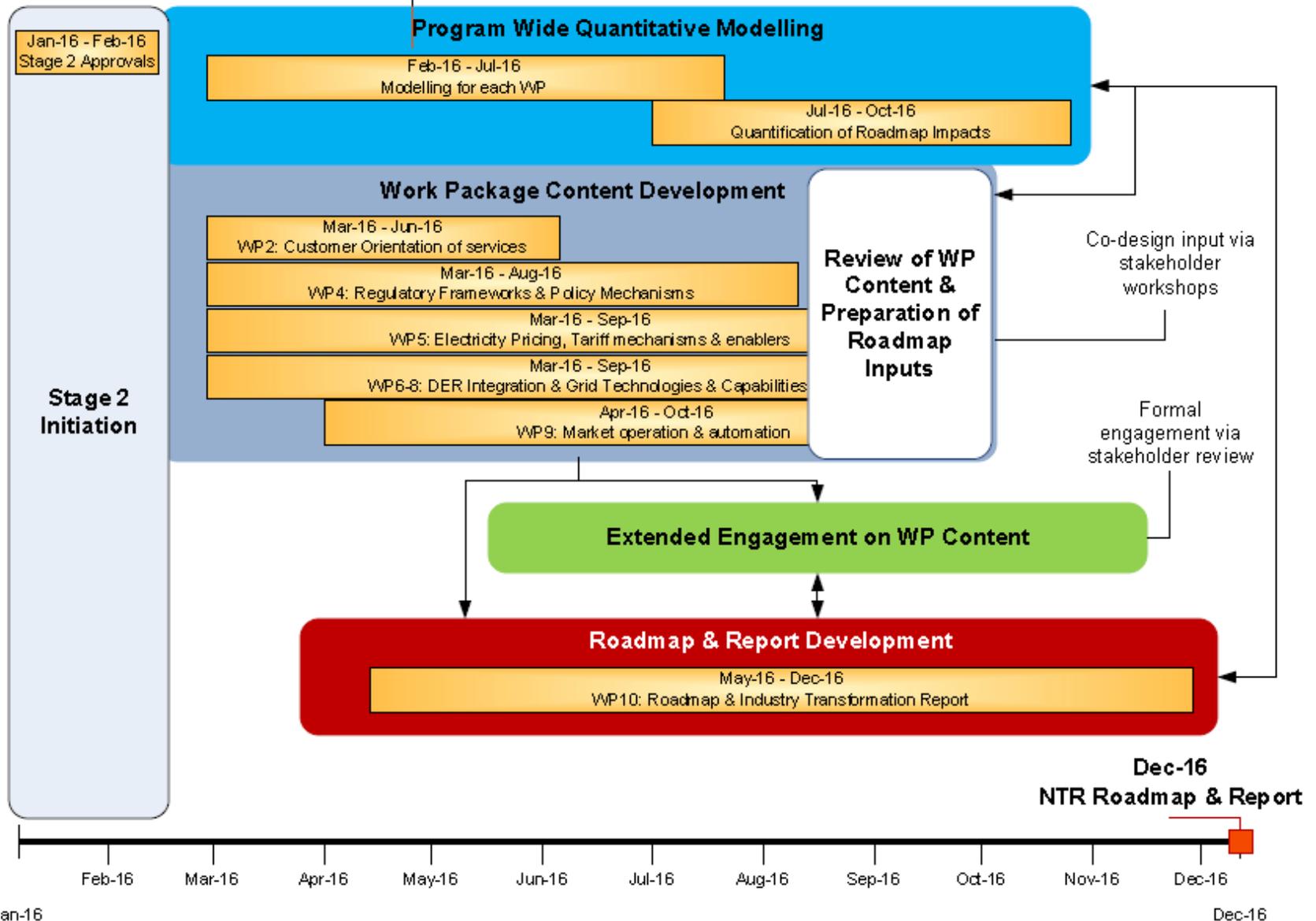
## E. Next Generation Platform (WP 9)

- Transactive Energy models
- Institutional frameworks

# Relationship between Stages 1 & 2



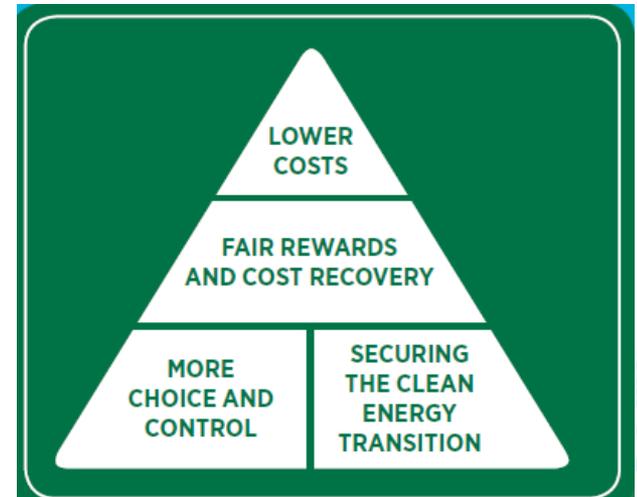
# Stage 2 Integrated Schedule

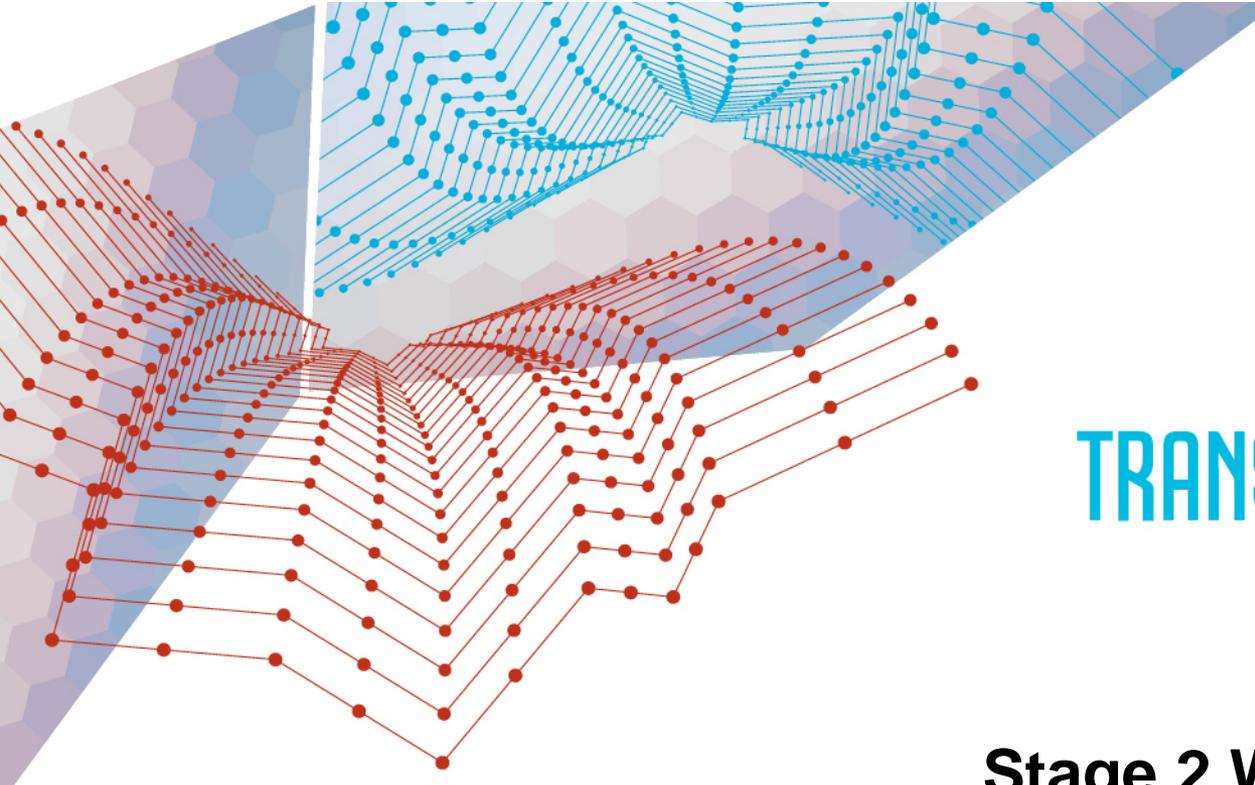


# Questions?

Australia's electricity systems in 2027 are resilient to divergent futures and characterized by:

- The 'balanced scorecard' of long-term customer and societal value creation;
- Whole-of-system efficiency, reliability and safety; and,
- Millions of end-users participating in and sharing the benefits of whole-of-system optimisation through open, vibrant markets and appropriate protections.





# ELECTRICITY NETWORK TRANSFORMATION ROADMAP

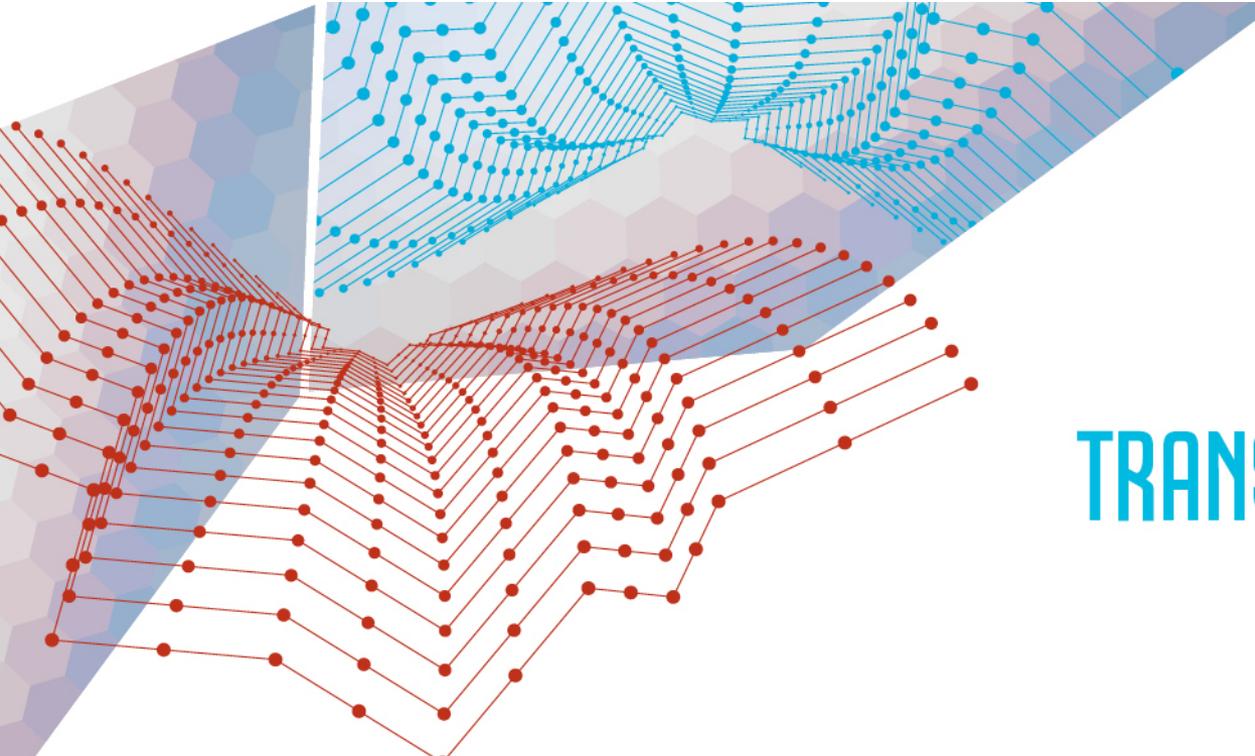
2015-25

## Stage 2 Work Package Overview



# Key Information for each Work Package





# ELECTRICITY NETWORK TRANSFORMATION ROADMAP

2015-25

## Work Package 2/3 – Customer Re-orientation of services

Mark Paterson, NTR Program Manager



# Overview of WP2/3

Customer orientation is central to the entire Roadmap project design.

WP2/3 collaboratively explores the following questions to inform the creation of services and solutions that diverse future customers value.

In particular, it explores:

- Future customer segmentation
- The diversity of services that future customer segments may value
- How business models and industry partnerships might evolve to deliver this value



Scope

Approach

Engagement

# Stage 2 Deliverables

## 1. Customer value, products and services

Building on Stage 1 work already completed, increase the granularity of findings on the outcomes, products and services that future end-users will likely value.

- Particularize the services and solutions likely to be provided to and from customers;
- Map the respective services and solutions to broad categories of benefit including customer benefit, network optimization and wholesale energy market benefits; and,
- Map the respective services and solutions to the business model options identified in NTR Stage 1.



Scope

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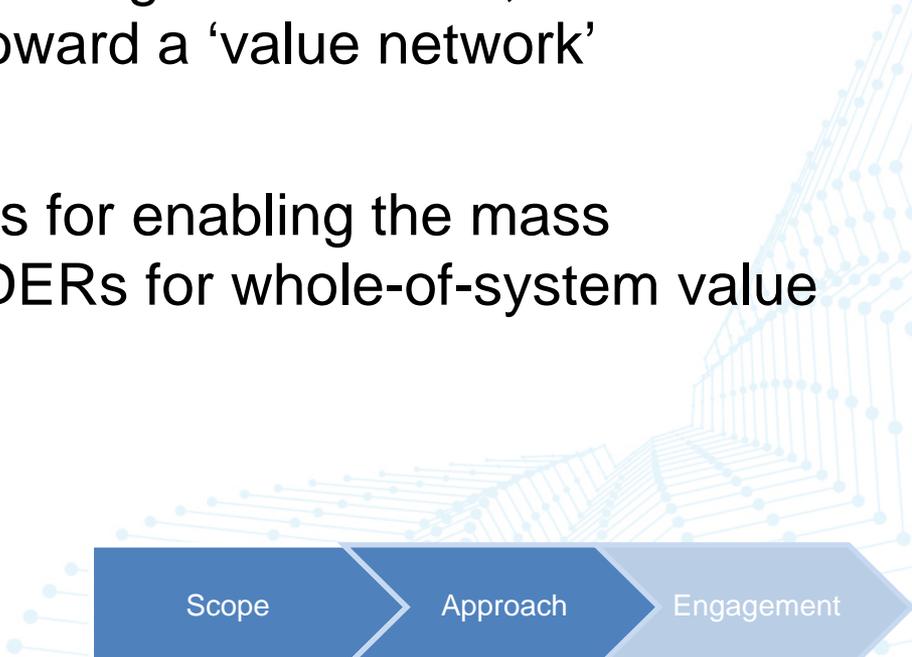
Engagement

# Stage 2 Deliverables

## 2. Future Business Model Opportunity Analysis

Drawing upon international experience and examples from the electricity and other industries, identify:

- Relevant international business model innovation trials, successes and failures relevant to Australian NSPs;
- Implementation Issues in evolving from a linear, monopolistic supply chain toward a 'value network' architecture
- The key architectural options for enabling the mass participation of customers' DERs for whole-of-system value creation.



Scope

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# Stage 2 Deliverables

## 3. Emerging business model options for transmission networks

- Global scan of emerging TNSP business models with consideration of relevance to the Australia context.
- Summary of business model features likely to emerge in the Australian context.

## 4. Customer Engagement Handbook

- Set of industry-endorsed approaches that best support consistent, high-quality and effective engagement by energy network businesses with their end-users.
- Outlines the opportunities to foster transparency and trust, and the importance of systematic evaluation of customer engagement for continuous improvement.

Scope

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# WP2/3 Engagement Opportunities

- Building on Stage 1 workshops, Stage 2 will further explore future customer value opportunities in mid-late June 2016 (likely week commencing 13 June).
- We expect a morning workshop with the afternoon focused on workshopping future regulatory options and pathways (Work Package 6).
- Subsequent webinars may also be scheduled through July – August 2016 on an as needs basis (expect >2-weeks notice).
- **To register your interest in this Work Package, please contact:**

**Mark.Paterson@csiro.au**

Scope

Approach

Engagement



# ELECTRICITY NETWORK TRANSFORMATION ROADMAP

2015-25

## Work Package 4 – Regulatory Frameworks and Mechanisms

Garth Crawford  
Executive Director, Economic Regulation



# Objectives

## A framework where:

- Consumer interests are protected by vigorous competition between an active set of commercial players with the opportunity to deliver enhanced customer and commercial value through building and seeking out economies of scope and scale.
- A lighter handed framework of economic regulation is applied to a reduced set of services, enabling greater flexibility and innovation while delivering outcomes that - because of alignment of incentives - benefits consumer and networks interests.
- Where common assets underpin the delivery of these services (and universal service obligations) are efficiently funded through a well-understood, stable regulatory compact.

Scope

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## Key themes

### Expected to include:

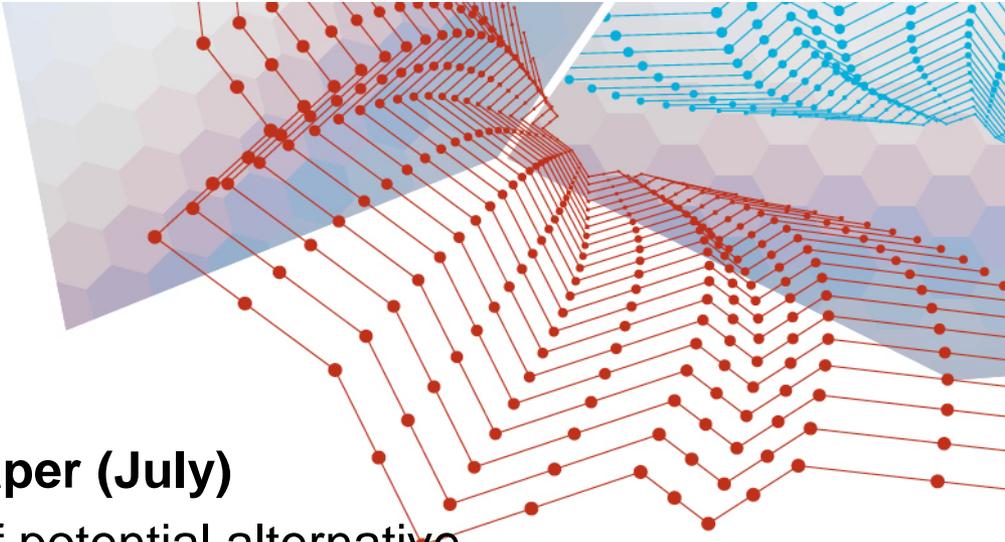
- How can economic regulatory frameworks appropriately recognise **new and emerging competition** (and potentially reduce its scope in response)?
- The **boundaries of regulation and competition, the scope of regulated services** and the impacts of changing consumer demands, new technologies, and markets
- The **allocation of risk** between networks and customers in the future regulatory compact for long-term common infrastructure (i.e. including consequences of changing risk allocations)
- Examining emergent **differing energy regulatory models** affecting networks and their roles (e.g. NY REV, CPUC, UK RIIO approaches), including how regulatory models can promote network innovation.

Scope

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Engagement

# Outputs



- 1. Future Regulation Working Paper (July)**
  - Expert report on the ‘menu’ of potential alternative regulatory models, identifying their pros and cons, and identified on the basis of which would provide the best prospect for transitioning to new business models
- 2. Investor perspectives workshop (July)**
  - Facilitated meeting with investor reps, policy-makers and consumers to provide investor input on issues of cost recovery, predictability
- 3. Desktop study on innovation (July)**
  - Report on international network innovation incentive schemes and policies

Scope

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# Engagement

## Opportunities for input

- Consultation on draft Future of Regulation Working Paper mid-late June 2016 (likely week commencing 13 June).
- Consultation on draft Regulation and Network Innovation Desktop Study (early July)

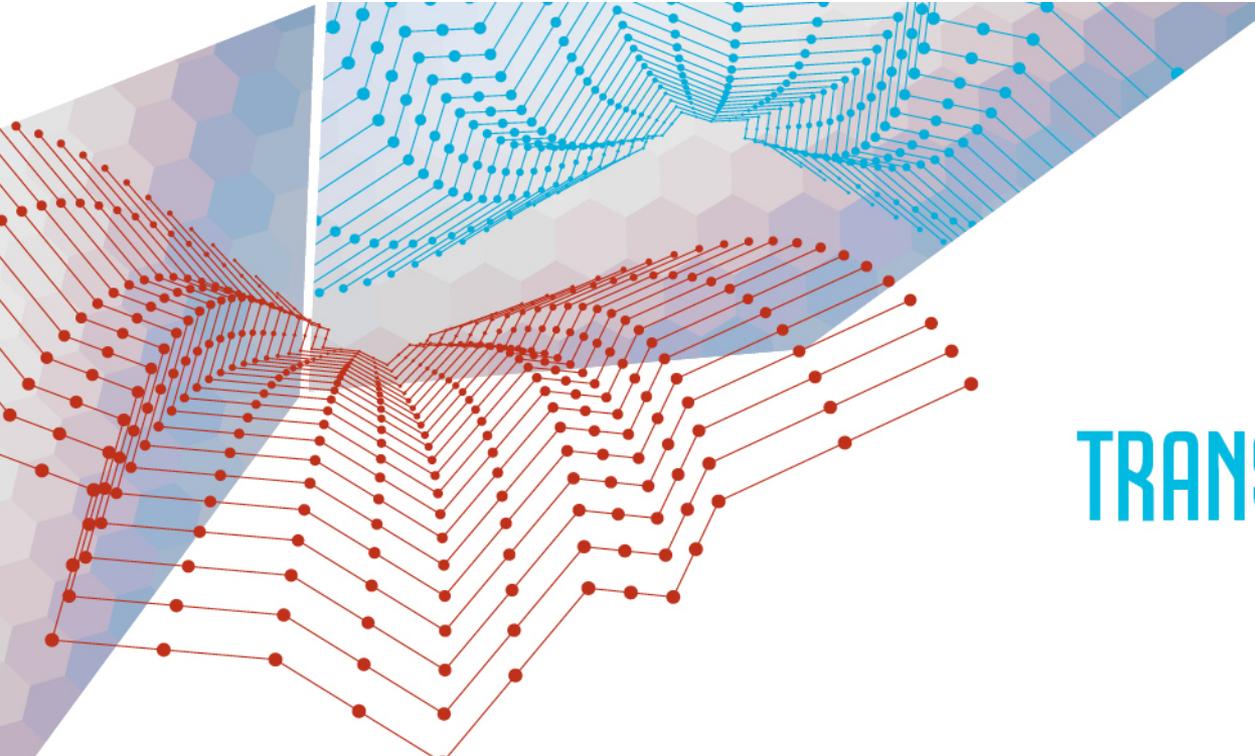
**To register your interest in this Work Package, please contact:**

**[Garth.Crawford@ena.asn.au](mailto:Garth.Crawford@ena.asn.au)**

Scope

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# ELECTRICITY NETWORK TRANSFORMATION ROADMAP

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## Work Package 5 – Pricing & Behavioural Enablers

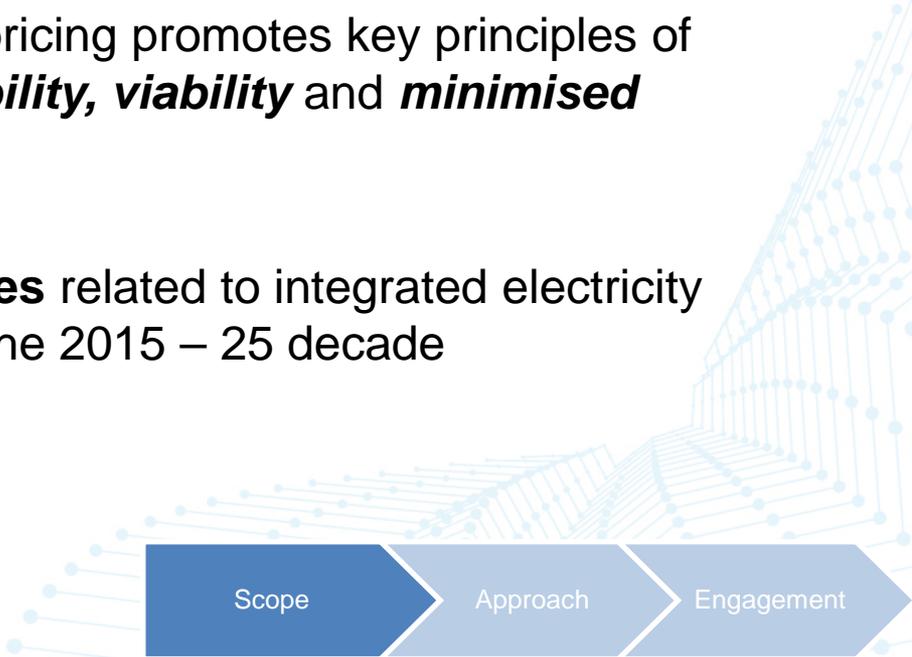
John Bradley, CEO Energy Networks Association



# WP 5 – Pricing and Behavioural Enablers

## Objectives

1. Understand how network pricing and incentives can evolve to enable **service innovation**, encourage **value creation** and **exchange**.
2. Understand the **enablers** affecting the rate of transformation
  - Metering
  - Customer choice and preferences
  - Enablers of Social Licence and Behavioural Change
3. Identify options to ensure network pricing promotes key principles of **efficiency, equity, simplicity, stability, viability** and **minimised cross subsidies**
4. Inform potential **Roadmap measures** related to integrated electricity pricing and incentive reforms over the 2015 – 25 decade



Scope

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# Key Areas of Analysis

- 1. Medium to longer term priorities for network pricing and incentives reform**
  - Valuing the potential of ‘second wave’ incentives for DER through tariffs, new markets and services; dependencies;
  - Implementation and sequencing options, dependencies.
- 2. Role and incentives of micro-grids and stand alone power systems**
  - plausible penetration scenarios,
  - service relationships between NSPs and micro-grids/SAPS,
  - role of regulatory frameworks and tariff products in enabling efficient and timely substitution in cases of both individual customers and embedded networks
- 3. Potential transmission pricing and incentive reform**
  - assessment of potential benefits in aligning transmission pricing signals with distribution pricing signals;
  - implementation options and barriers;
- 4. Enablers of social licence and behavioural change**
  - an integrated synopsis of interventions likely to effect social licence and residential behavioural change over 2017-27
  - summary research plan for field research/trials to quantify likely adoption rates and provide valid outputs to guide reform
- 5. Enablers of first wave tariff reform and meter migration**
  - leveraging current work program on *Electricity Network Tariff Reform Handbook*
  - analysis of long term outcomes (volumes, customer bills, cross-subsidies, economic costs, carbon) and technology deployment under meter and tariffs migration scenarios

Scope

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# Work Package 5 Engagement

- **Webinar /Workshop on Network Pricing and Incentives Reform**

To be scheduled late July / early August 2016

- **Consultation on key outputs & inputs to the Roadmap**

- *Medium to Longer Term Priorities for Network Pricing and Incentives Reform*
- *Role and Incentives of Microgrids and Stand Alone Power Systems*
- *Enablers of First Wave Tariff and Meter Migration*

Expected to commence: Late July – early August 2016

- **CSIRO/Energeia Technical Modelling Report**

Reports will be made available after internal reviews completed.

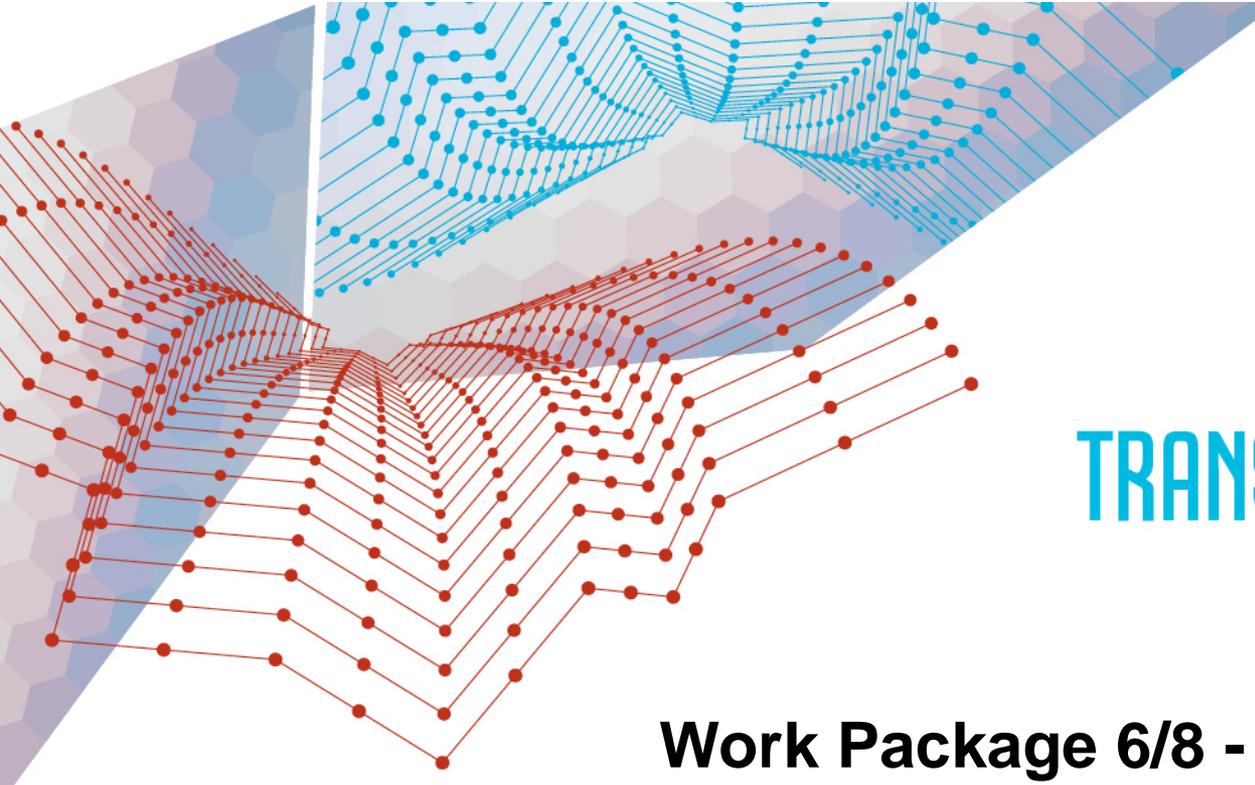
**To register your interest in this Work Package, please contact:**

**[jbradley@ena.asn.au](mailto:jbradley@ena.asn.au)**

Scope

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# ELECTRICITY NETWORK TRANSFORMATION ROADMAP

2015-25

## Work Package 6/8 - Technical Enablers

Dr. Stuart Johnston, ENA  
Executive Director, Assets and Network Transformation

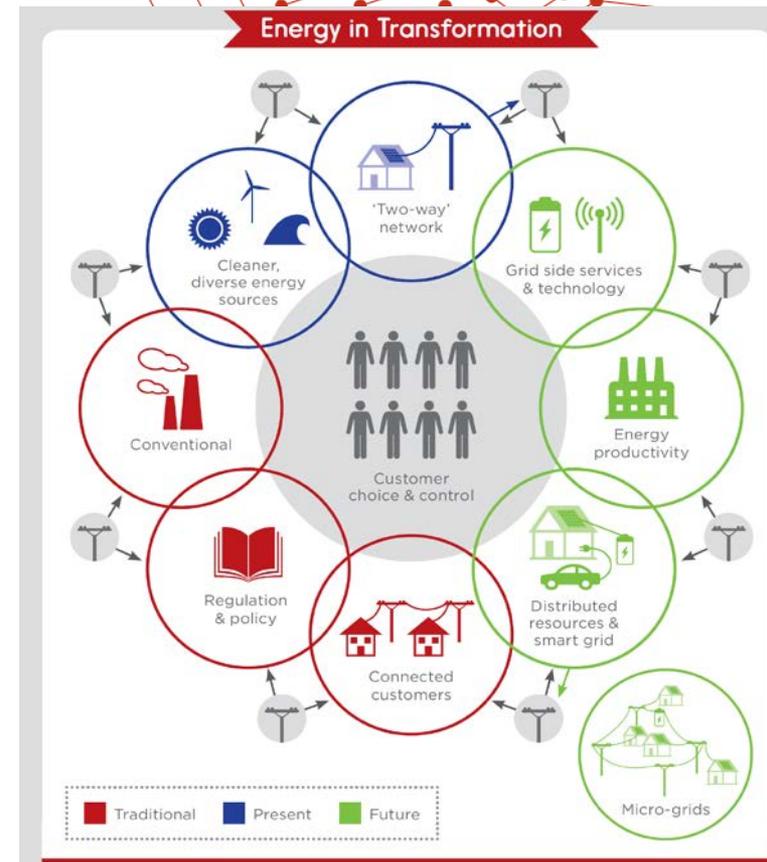


# Work Package 6/8

## Objectives

Identify the actions and measures that highlight the incremental and transformational options enabling connection of distributed generation and demand side services for customers whilst maximising system benefits and improving network operations.

This knowledge will be used to identify a sound common vision of a preferred 'end-state' and the appropriate long-term pathways and mechanisms for the evolution of the physical grid required to get there by 2027.

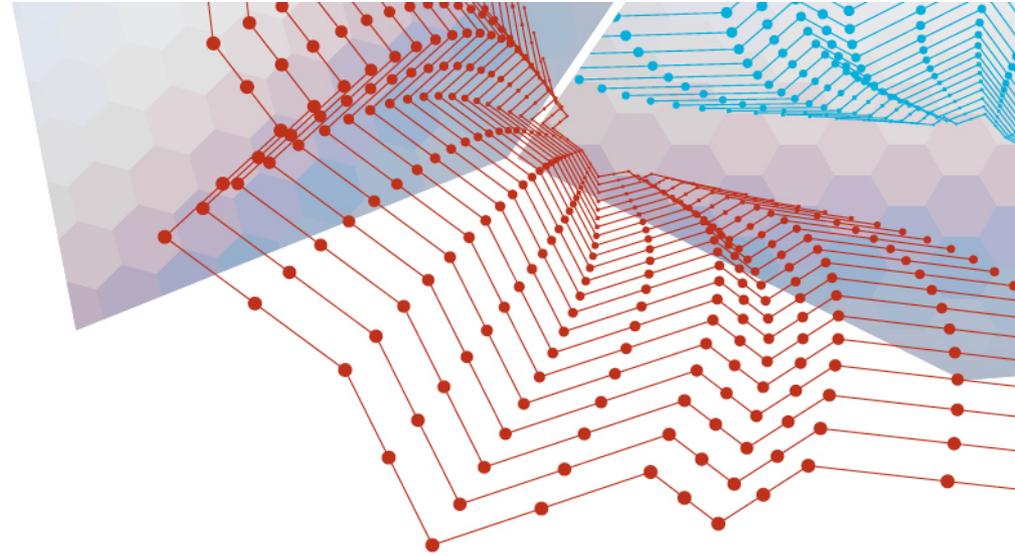


Scope

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# Technical Focus of Stage 2



## 1. Grid Design & Operation

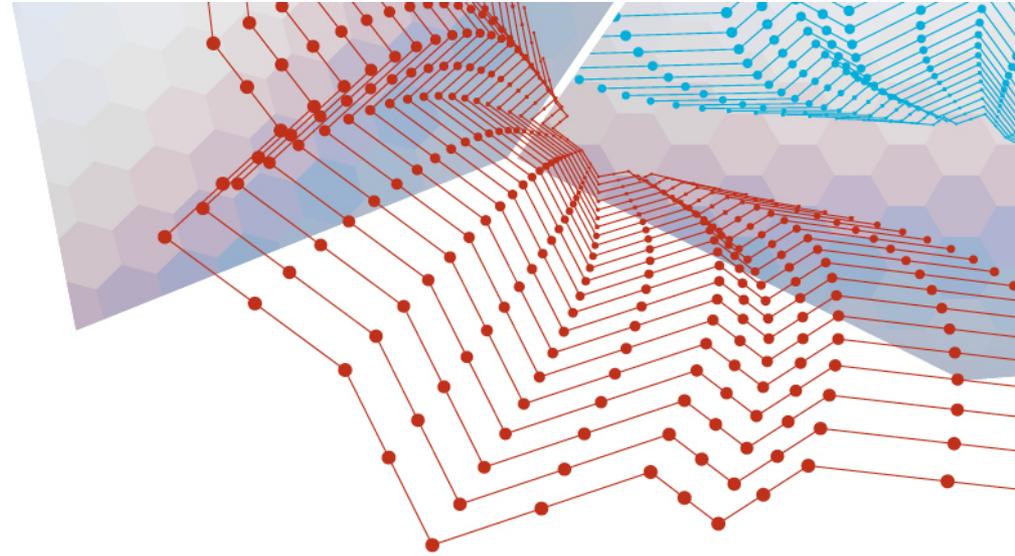
- Develop a functional description/specification of DSO functionality that are likely to be inherent in future network services
  - Establish what is the optimum design and operating parameters of an inverter dominated power system of the future to allow for the likely reduction in the level of synchronous generation.
  - Identify the solutions to efficiently design, control, and operate grid connected and islanded/non-connected microgrids/minigrids.
  - Balancing demand side response.

Scope

Approach

Engagement

# Technical Focus of Stage 2



## 2. Identify the operating platform that allows full optimisation and coordination of the diverse range of new products and services.

**This includes:**

- network operation and control that alleviates the technical impacts and maximises the benefits of new demand side technologies
- Establish the optimal controls required to maximise overall system performance and maintain system stability and optimisation.
- How energy storage can be optimised to mitigate system operability issues such as frequency and voltage stability, inertia and constraint management issues

Scope

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# Technical Focus of Stage 2

## 3. Technical enablers

- Establish a strategy with prioritised actions to deal with gaps in industry standards and guidelines
- Establish what communication requirements needed to enable the full range of intended smart grid activities

## 4. Innovation

- Identify the key gaps in research and development required to enable the required operating platform to deliver the integrated grid of the future

## 5. Future Industry Workforce Requirements

- Establish a strategy to identify and facilitate the changes required to service the future skills and training requirements for the Electricity Supply Industry for 2027 and beyond.

Scope

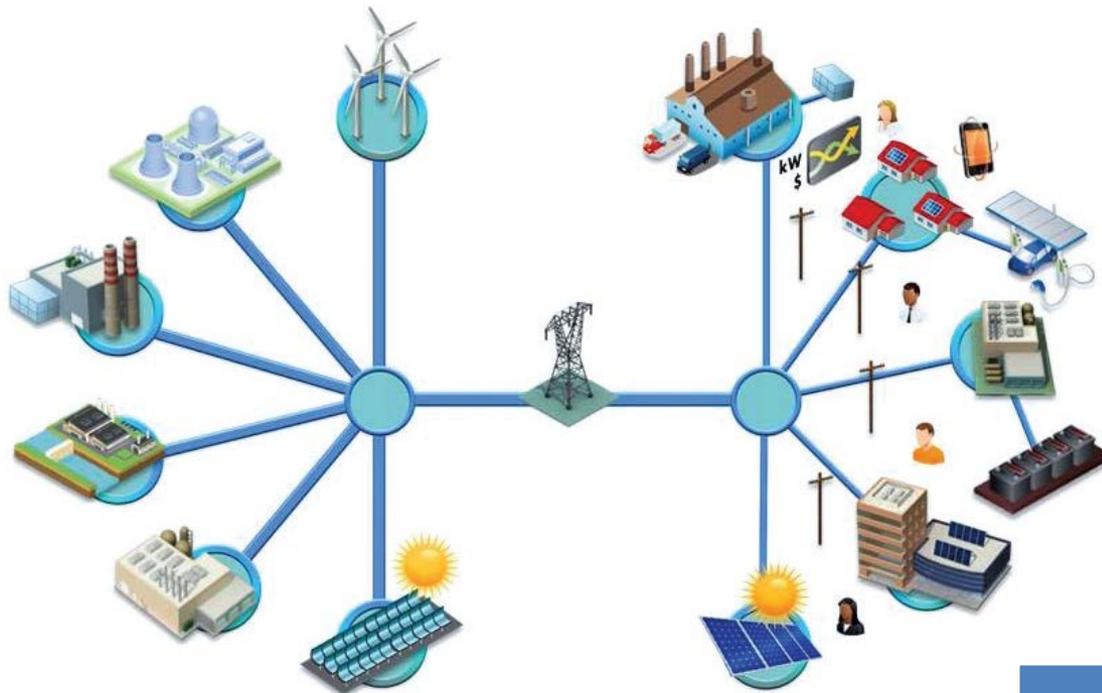
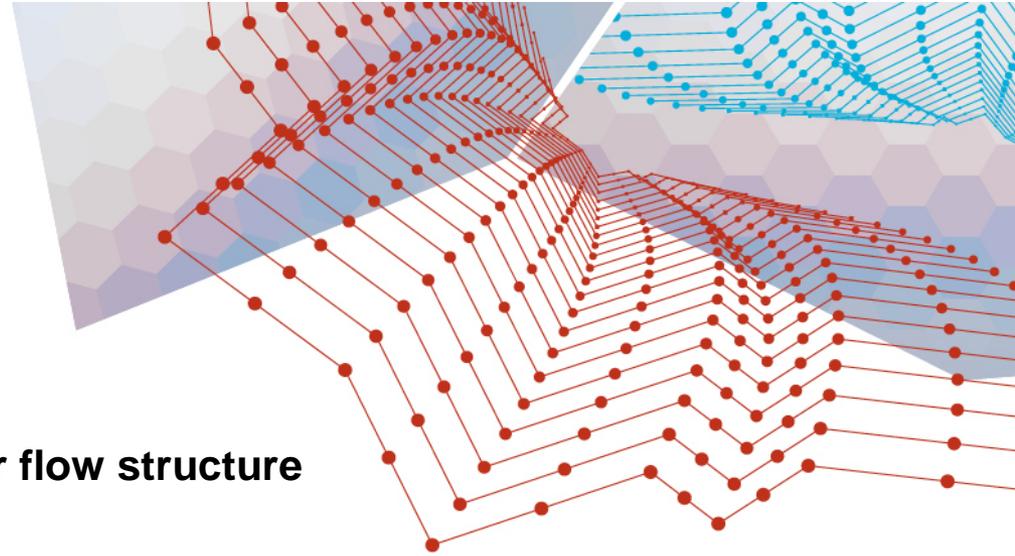
Approach

Engagement

# One potential system concept

## A highly integrated network and power flow structure of the future

Source: EPRI product ID 3002004103

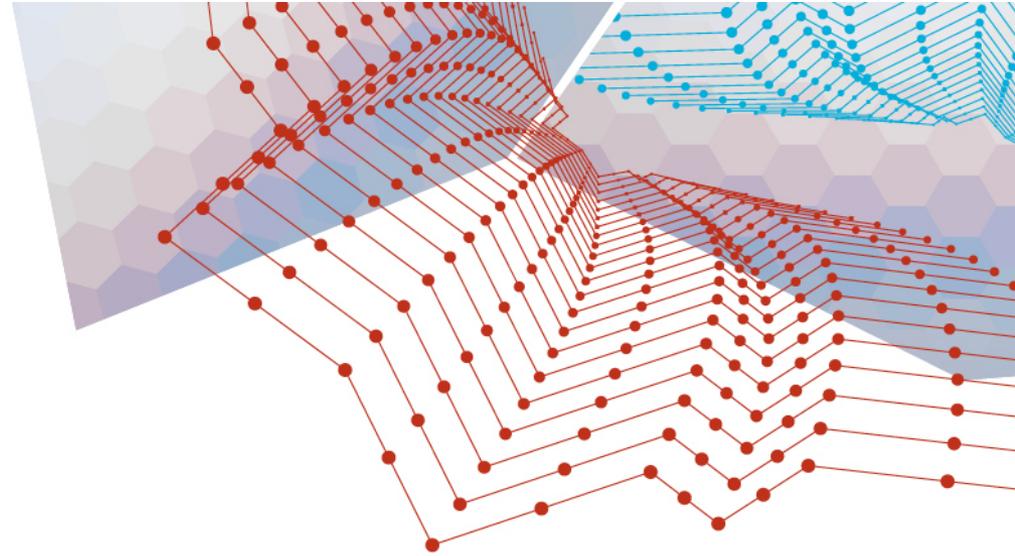


Scope

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# Engagement: Work package 6/8 - Technical Enablers



- **Technical working papers: mid June - August 2016**
- **Workshops:**
  1. Future Workforce Requirements - Week of 6 June 2016
  2. Grid Design & Operating Platform – Week of 13 June 2016

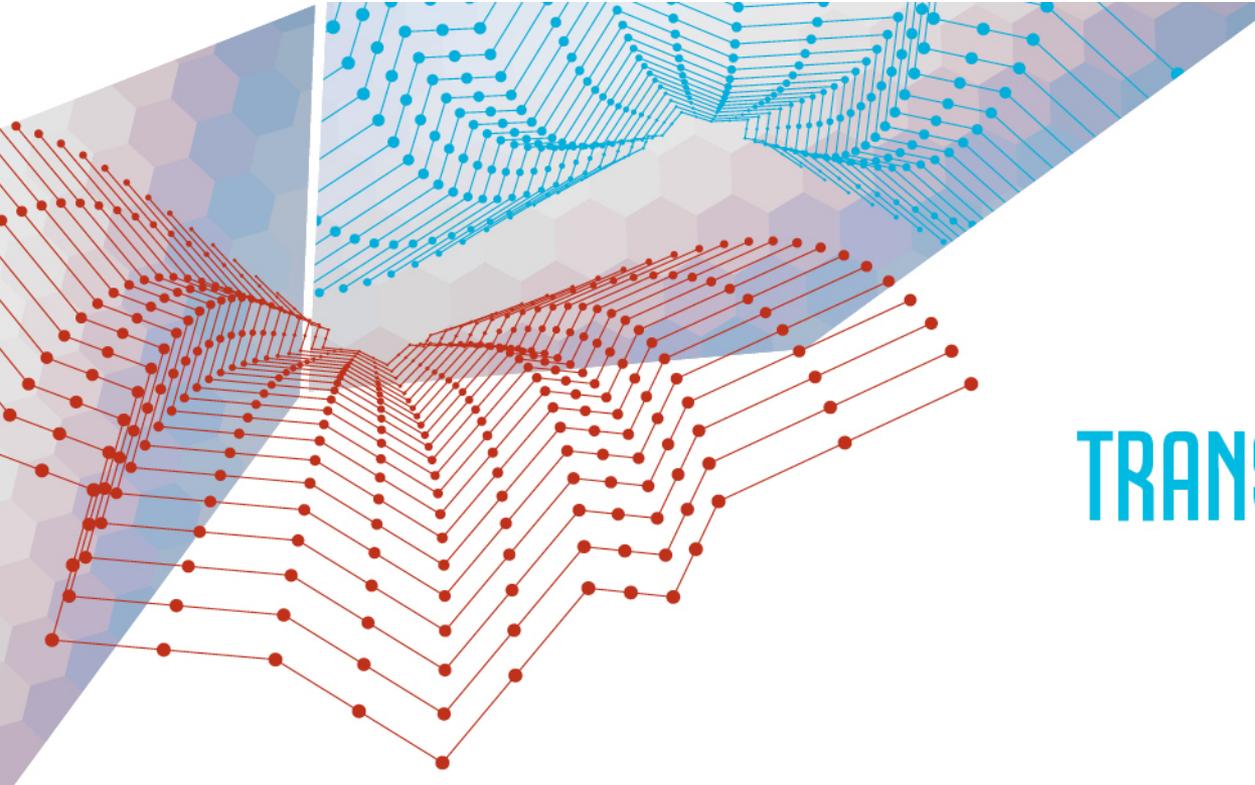
**To register your interest in this Work Package, please contact:**

**Dr Stuart Johnston at ENA at [ntr@ena.asn.au](mailto:ntr@ena.asn.au) or 02 6272 1555**

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# ELECTRICITY NETWORK TRANSFORMATION ROADMAP

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## Work Package 9 – Next Generation Platforms

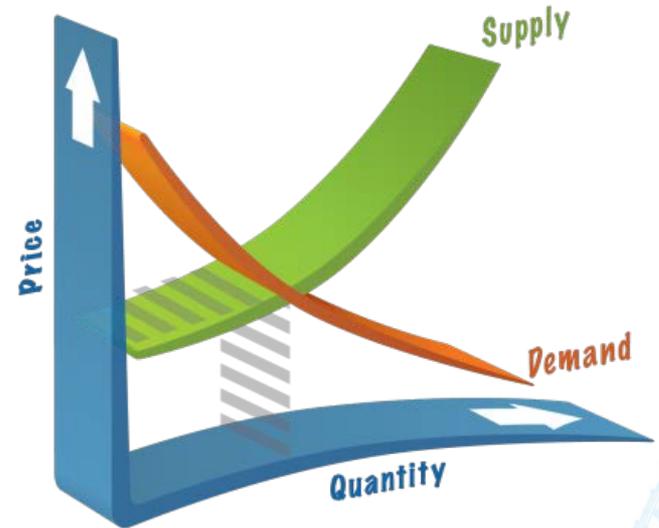
Mark Paterson, CSIRO  
Program Director NTR



# Overview of WP9

This Work Package is a 'Capstone' activity that integrates mature content from WP1 – WP8 to inform the types of market operation and automation needed in a highly distributed electricity future. For example, options that enable the:

- **Instantaneously balancing** dynamic demand requirements with supply from millions of distributed generation, energy storage and 'virtual storage' sources;
- **Optimising the utilisation** of multi-billion-\$ system assets and minimise the need for expensive augmentation; and,
- **Incentivisation of millions** of consumer / producers to participate and receive a compelling quid pro quo from the value created by whole-of-system optimisation.



Scope

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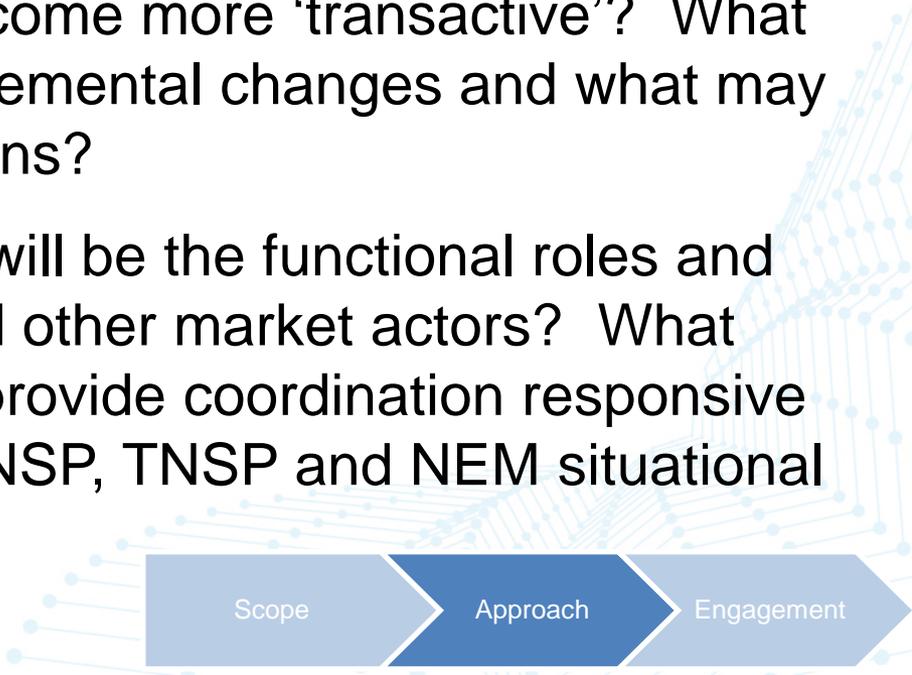
# Approach

This Work Package is designed to collaboratively explore the following seven key areas:

- **Services & Value.** The range of energy and grid-support services provided in a highly distributed electricity future, and by whom? How will these services be valued?
- **Markets & Institutions.** Future market designs and institutional roles and forms. How might they compare when subjected to an indicative cost-benefit review? Which options are best for attracting and driving customer-oriented innovation?
- **Enabling Infrastructure.** What system architecture, forecasting and planning alternatives may be needed to maximise system efficiency in a highly distributed future? What does distribution system planning look like in this environment?



- **Monetisation & Transaction.** What standards and mechanisms may be required to monetise and dynamically transact value where the network functions as a platform for exchange?
- **Regulation & Standards.** What is the role of regulation and standards with the various market designs and institutional forms?
- **Transitional Processes.** How might existing market and institutional forms evolve to become more 'transactive'? What might be achieved through incremental changes and what may require step-change interventions?
- **System Coordination.** What will be the functional roles and responsibilities of networks and other market actors? What capabilities will be required to provide coordination responsive to both customer needs and DNSP, TNSP and NEM situational information?



Scope

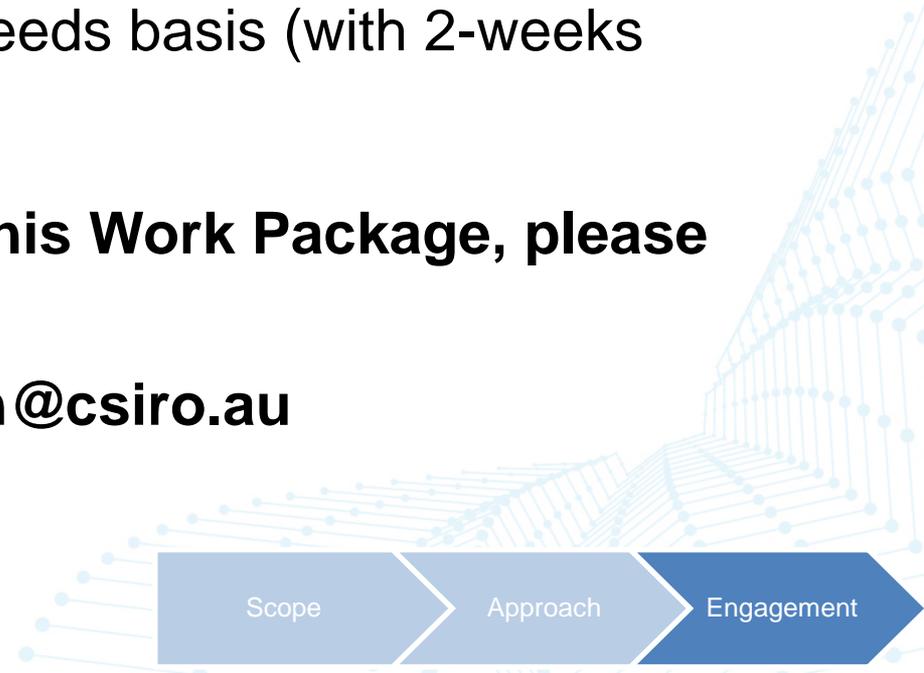
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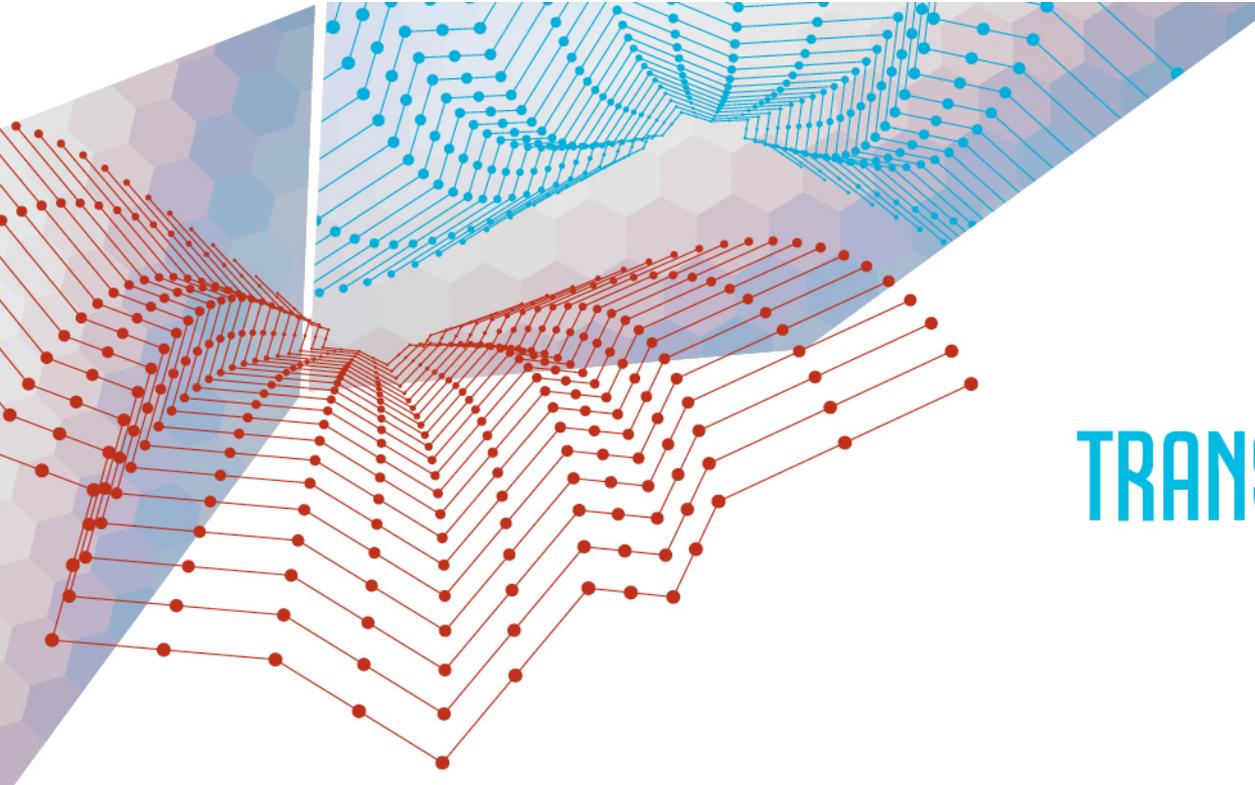
Engagement

# WP9 Engagement Opportunities

- Draft content for this capstone activity will be explored and matured at sequential workshops in:
  - Early July 2016; and,
  - Early August 2016.
- Additional webinars may also be scheduled through August – September 2016 on an as needs basis (with 2-weeks notice).
- **To register your interest in this Work Package, please contact:**

**Mark.Paterson@csiro.au**





# ELECTRICITY NETWORK TRANSFORMATION ROADMAP

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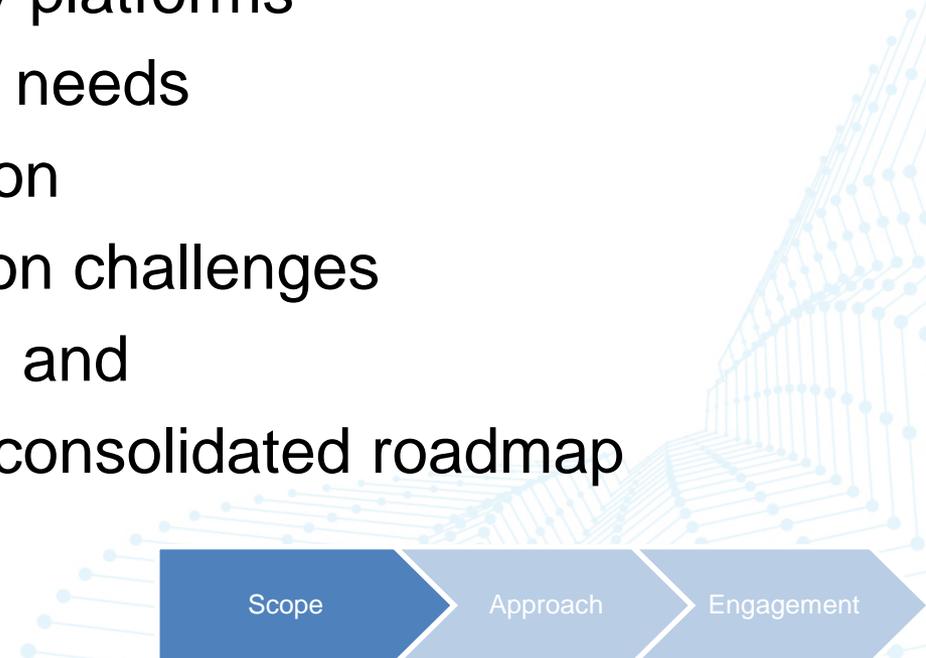
**NTR 2016 modelling**  
Paul Graham  
Senior Economist CSIRO Energy



# NTR 2016 modelling

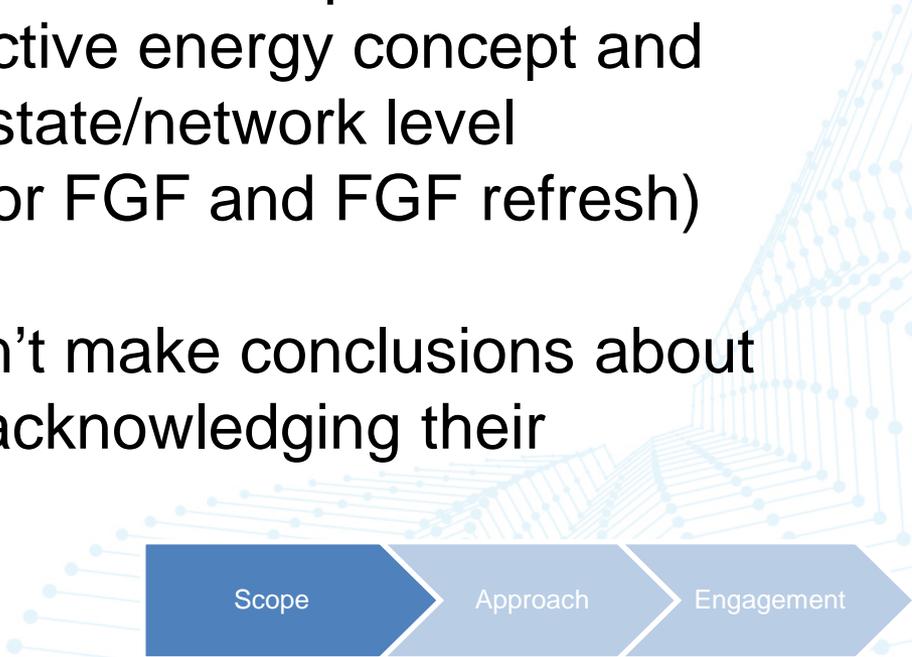
Broadly speaking the modelling needs to be able to support, with quantitative data, any identified *net* benefits of implementing the NTR roadmap, which could include net benefits from:

- Price reform
- Access to transactive energy platforms
- Services matching customer needs
- Efficient and flexible regulation
- Responses to DER integration challenges
- Volume growth through EVs, and
- Combining the above into a consolidated roadmap outcome.



# What's different in 2016?

- **Modelling a baseline with actions/alternative policy:** All the FGF scenarios are plausible. What we're trying to discover for the roadmap is what actions, which address FGF scenario challenges, lead to better outcomes for the system and customers.
- **Zone substation level focus:** We can't produce required price reform, transactive energy concept and micro-grid insights with only state/network level modelling (i.e. as was used for FGF and FGF refresh)
- **Customer diversity:** We can't make conclusions about customer outcomes without acknowledging their diversity

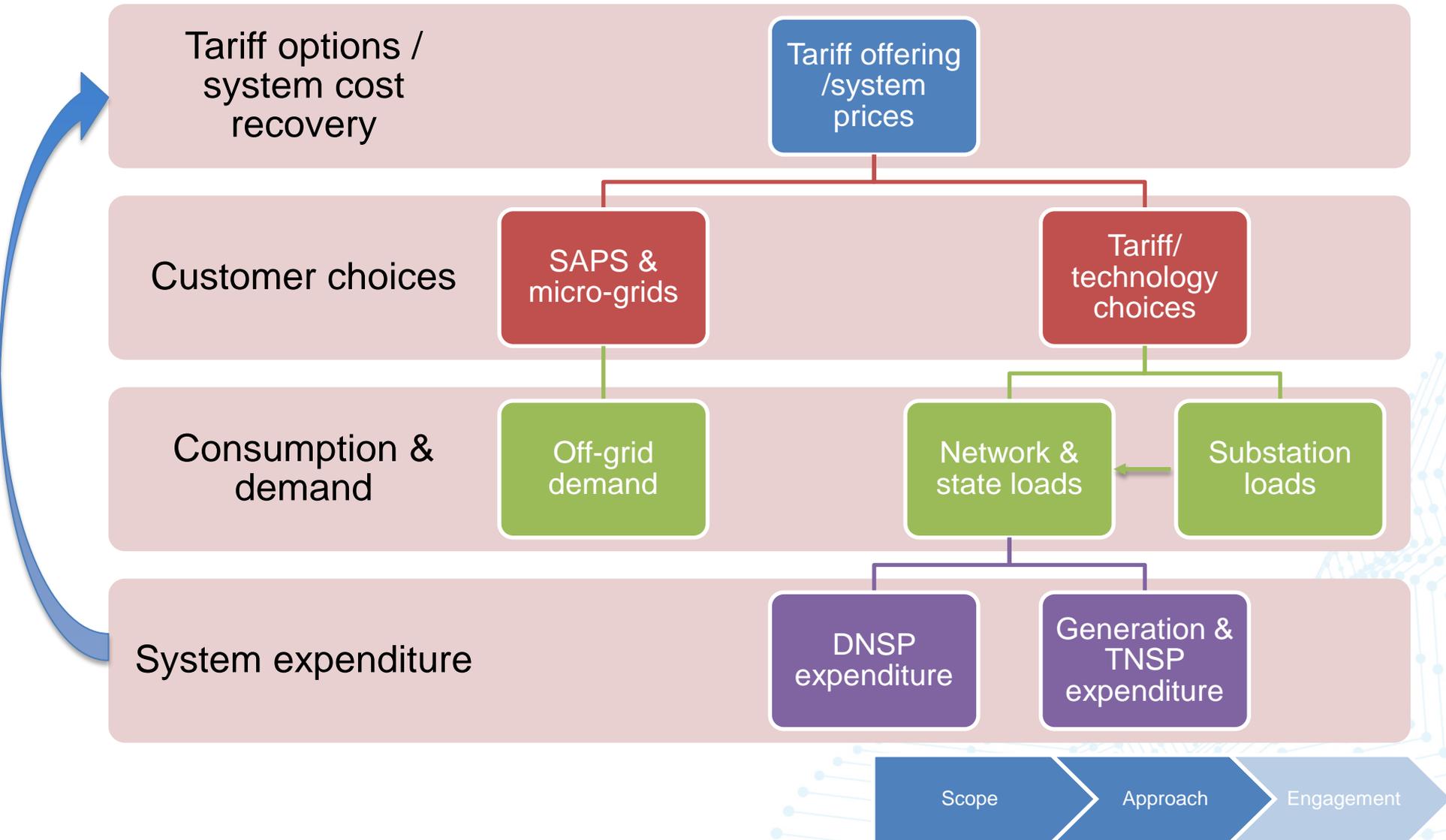


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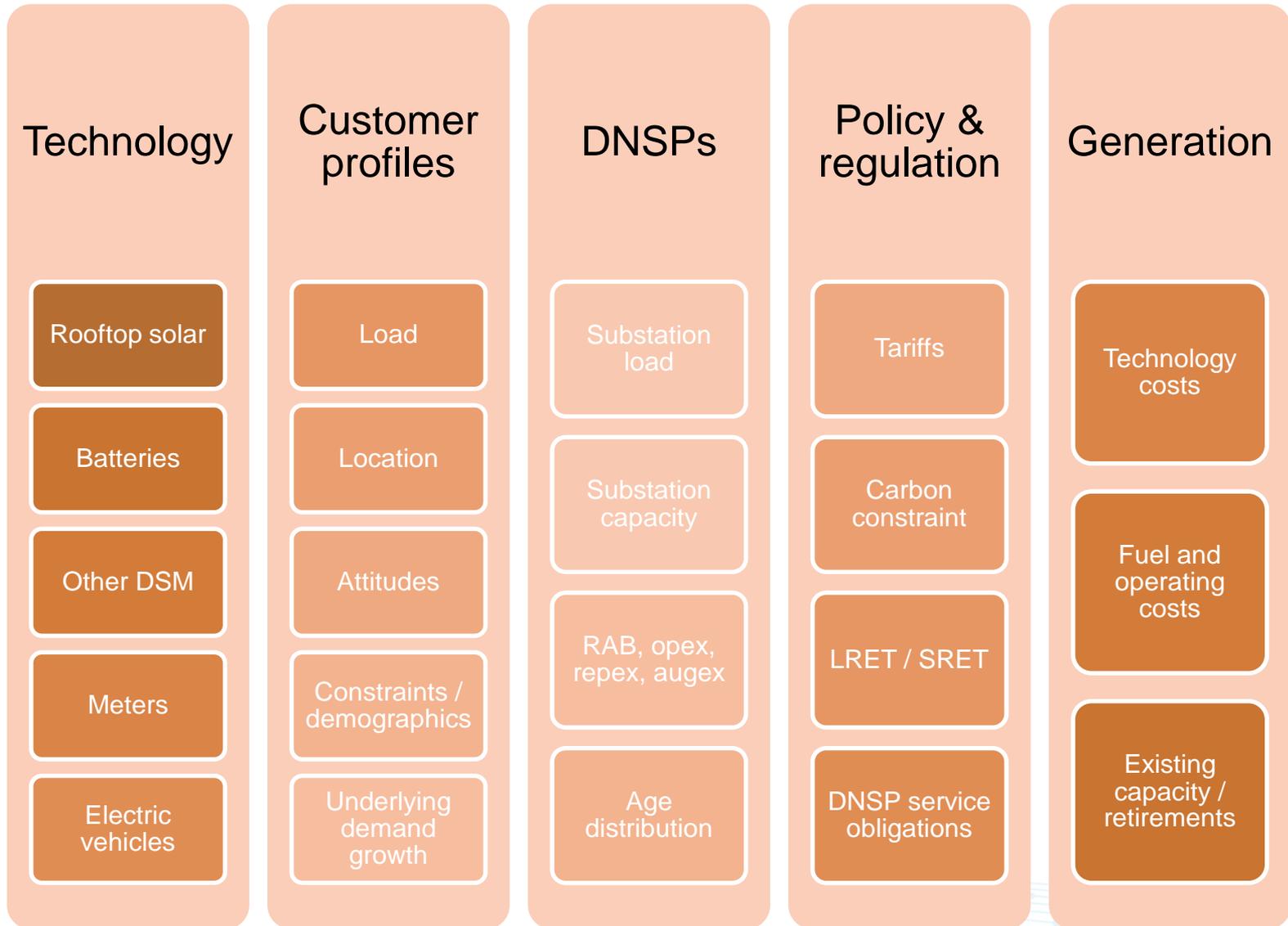
Approach

Engagement

# CSIRO and Energeia joint modelling framework



# Major inputs required

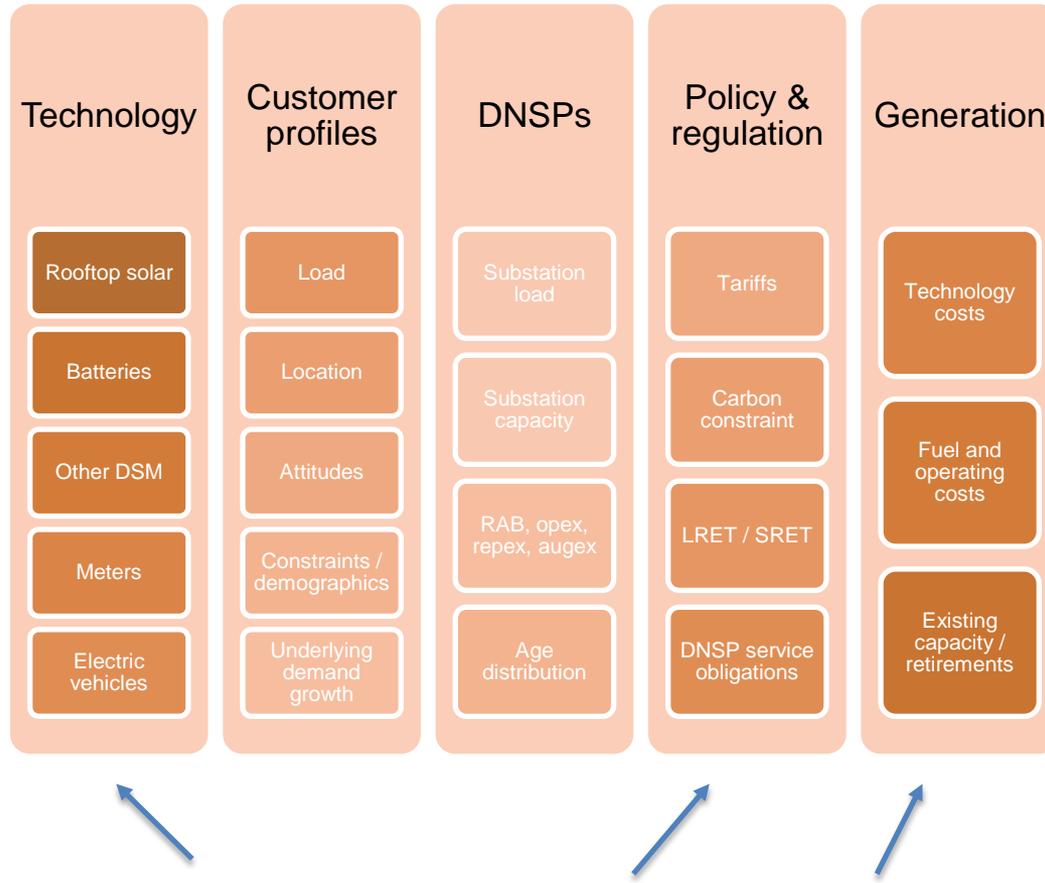


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Engagement

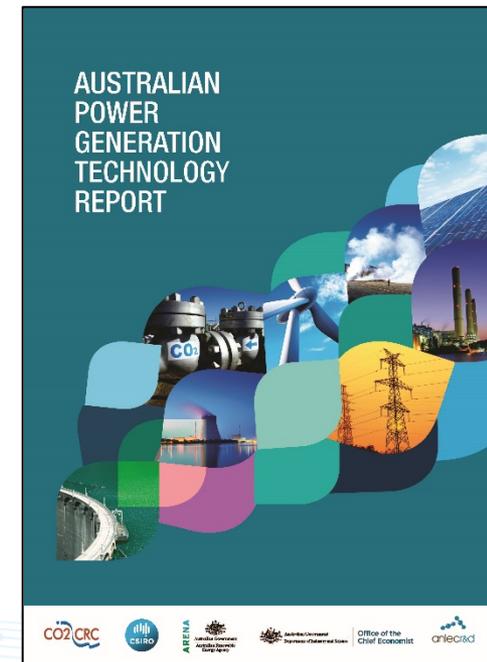
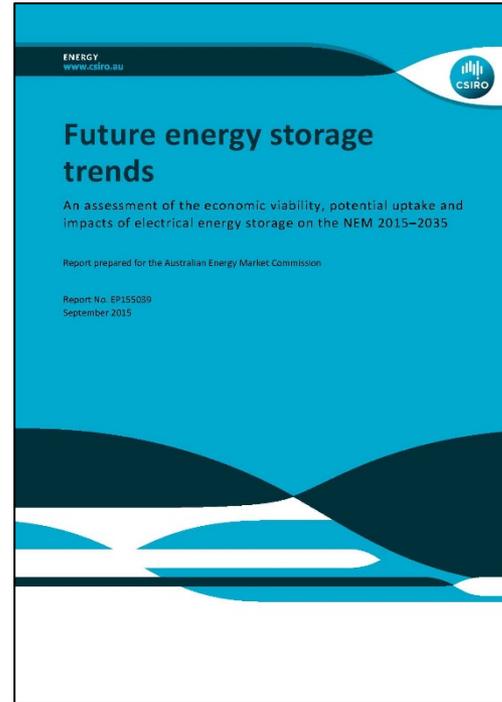
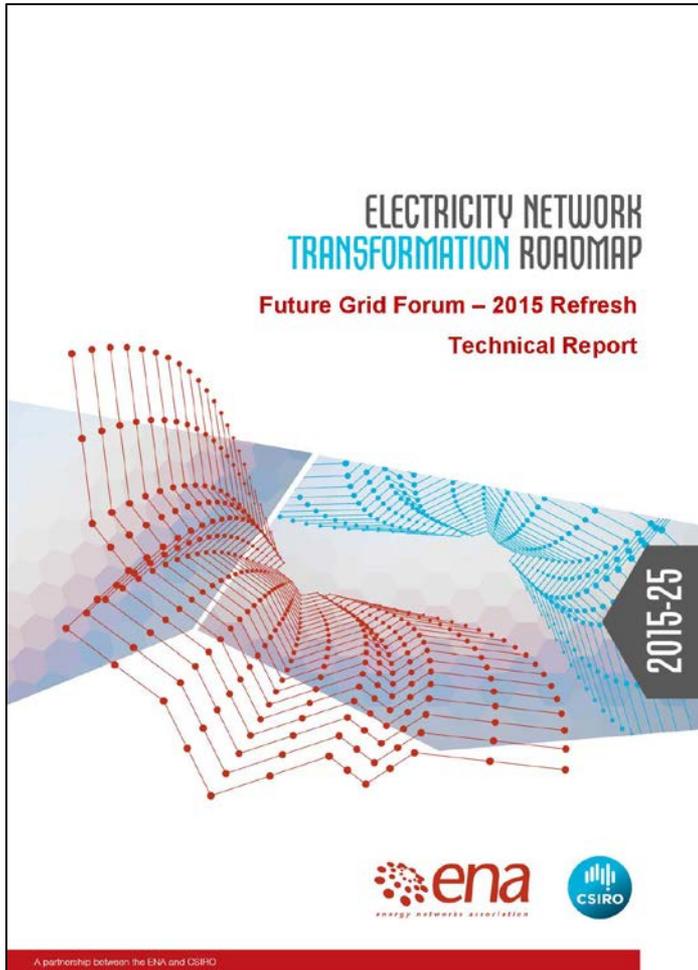
# Major inputs required



Data for these categories was established in the Stage 1 Refresh



# Useful references



Scope

Approach

Engagement

# Sources

First three new, generally wasn't required for FGF refresh

## Customer profiles

Load shape

Location

Attitudes

Constraints /  
demographics

Underlying load growth

## Sources

Clustering SGSC, RBT,  
RBEES, some inferred

Literature + ABS

Matching various sources  
to NTR stage 1 segments

ABS, HIA

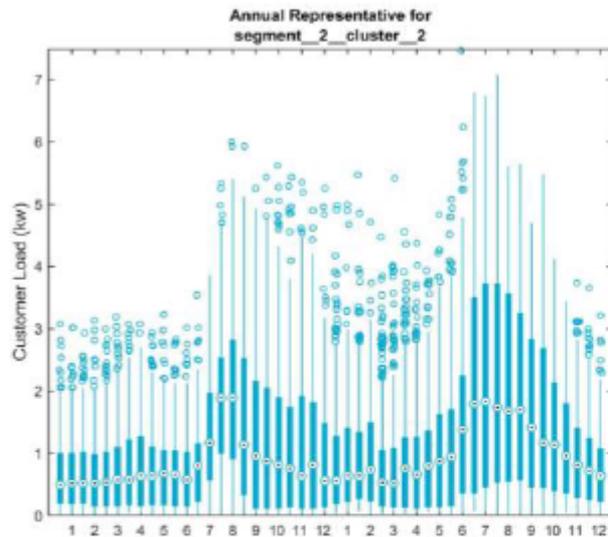
AEMO / IMO

Scope

Approach

Engagement

# Clustering to create representative customer profiles



*Detached upper-middle-income*

*(Representative 2)*

High consumption.

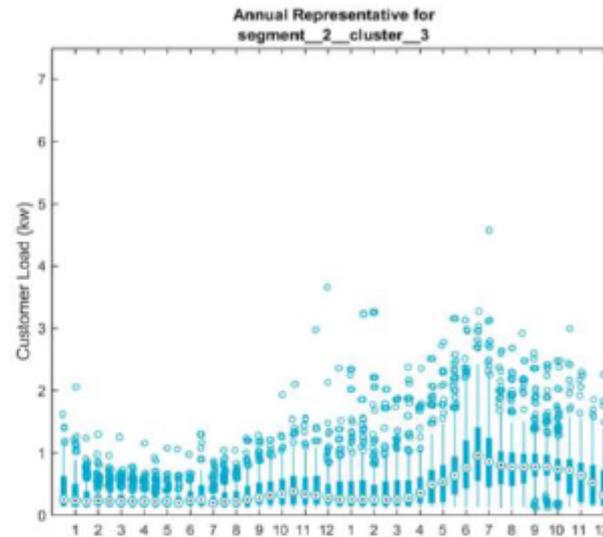
Lower daytime load.

Peak later in the evening.

Lower summer load.

High likelihood of solar in the cluster.

27 cluster members.



*Detached upper-middle-income*

*(Representative 3)*

Low consumption.

Small evening peak.

98 cluster members.

Example above from Berry, A., Motlagh, O., Grozev, G., Ren, Z., Perfumo, C., Lane, B., Anticev, J. June, 2015, *Energex customer load profile market segmentation and clustering*, CSIRO report to Energex, [https://www.energex.com.au/\\_data/assets/pdf\\_file/0011/280289/CSIRO-Energex-Report-24-June-2015.pdf](https://www.energex.com.au/_data/assets/pdf_file/0011/280289/CSIRO-Energex-Report-24-June-2015.pdf)

Scope

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# Engagement

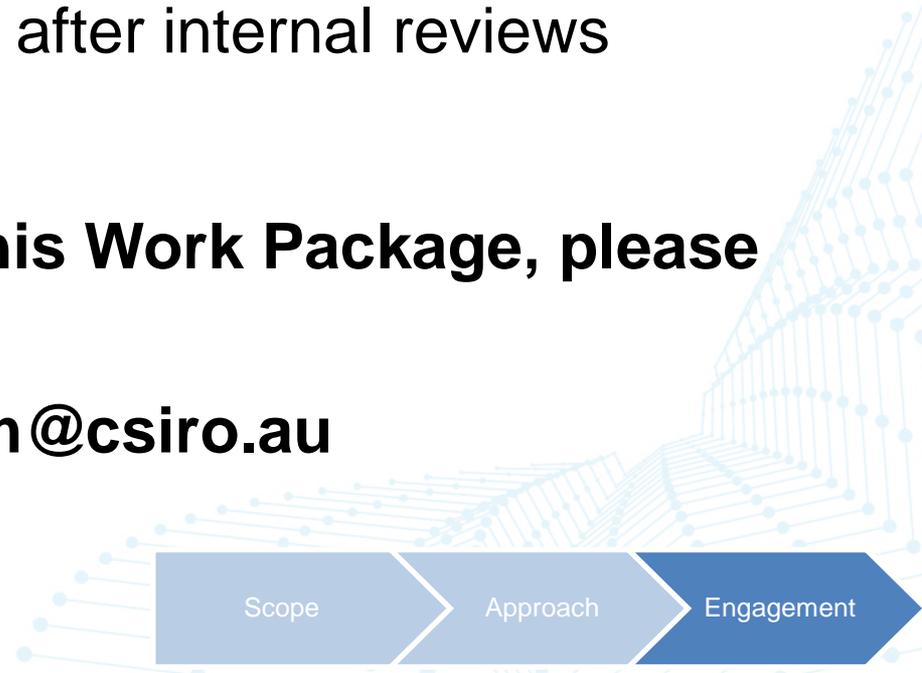
Mid July – Workshop to share modelling results addressing particular roadmap actions.

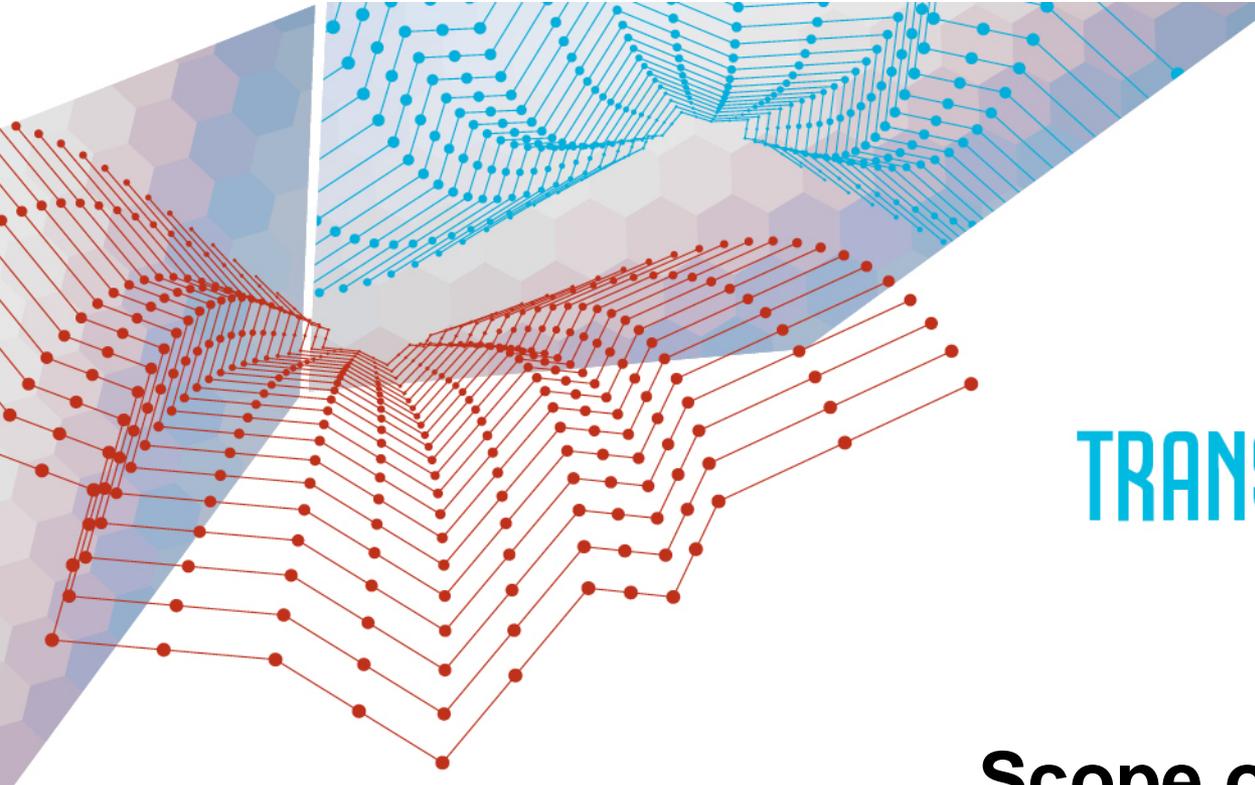
August-September - Share any further refinement of results and estimated whole of roadmap net-benefits.

Reports will be made available after internal reviews completed.

**To register your interest in this Work Package, please contact:**

**[Paul.Graham@csiro.au](mailto:Paul.Graham@csiro.au)**



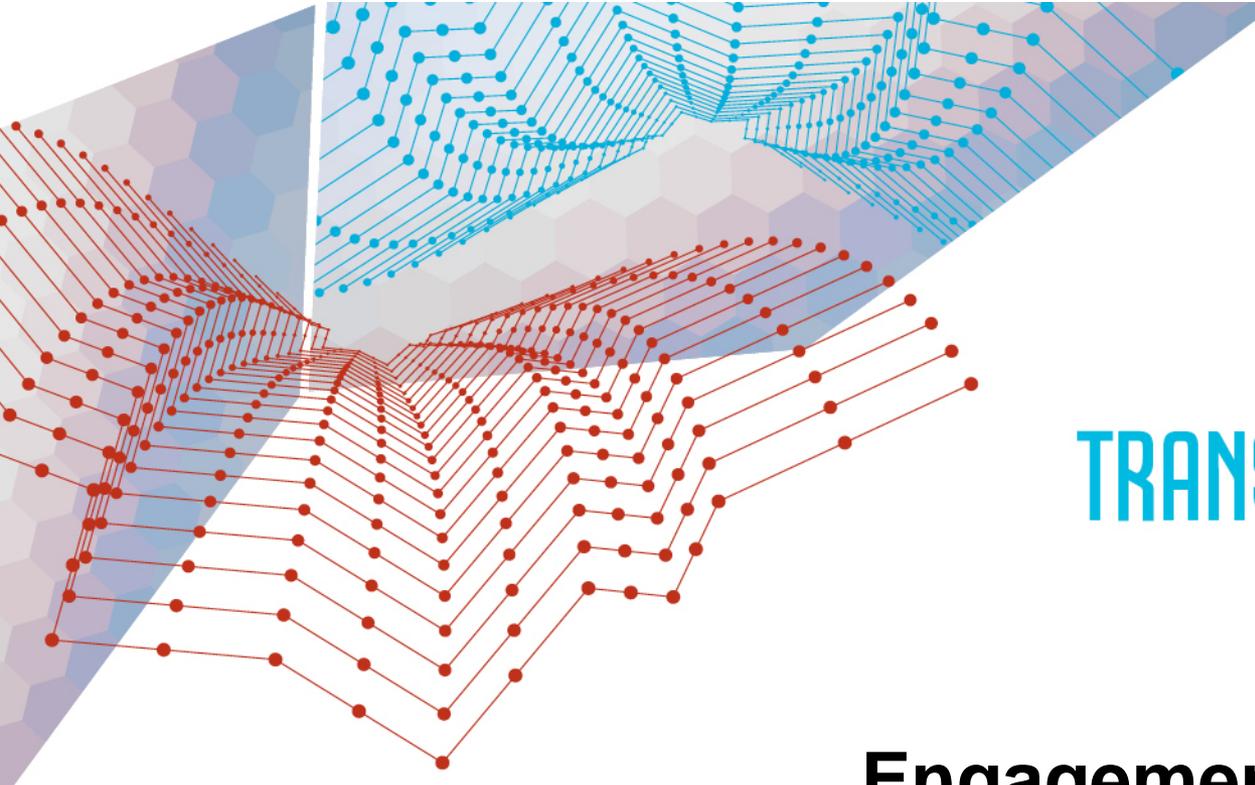


# ELECTRICITY NETWORK TRANSFORMATION ROADMAP

2015-25

## Scope or Approach Questions?





# ELECTRICITY NETWORK TRANSFORMATION ROADMAP

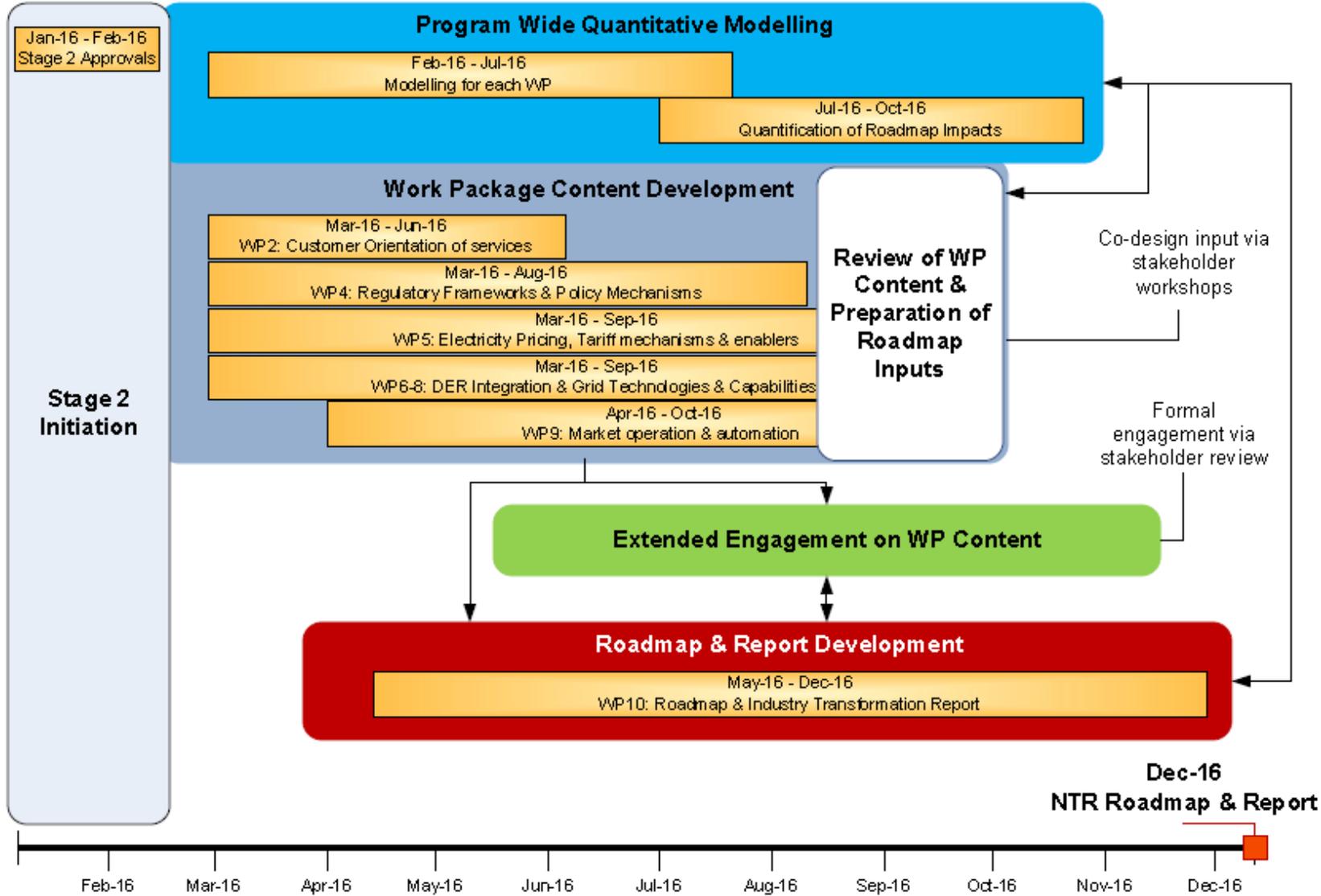
2015-25

## Engagement Overview

Mark Paterson



# Stage 2 Integrated Schedule



Jan-16



# Engagement Principles

The Roadmap project will help guide the transformation of Australia's electricity networks over the 2017-27 decade for a customer-oriented future.

Stakeholders can expect:

- Design time-efficient workshops, webinars and feedback processes that respect stakeholders' time, with adequate notice;
- Reasonable feedback periods following workshops which may include out-of-session discussions; and,
- A summary of stakeholder feedback, how it's been acted upon and where it may not have been acted upon.

In placing a high priority on engagement and collaboration, the ENA and CSIRO also recognize that not all stakeholders will agree with all decisions made or content developed.

Given the finite Roadmap development schedule, a process is outlined in the NTR Engagement Principles for respectfully working through points of difference and making transparent differences of perspective.

**<http://www.ena.asn.au/electricity-network-transformation-roadmap>**

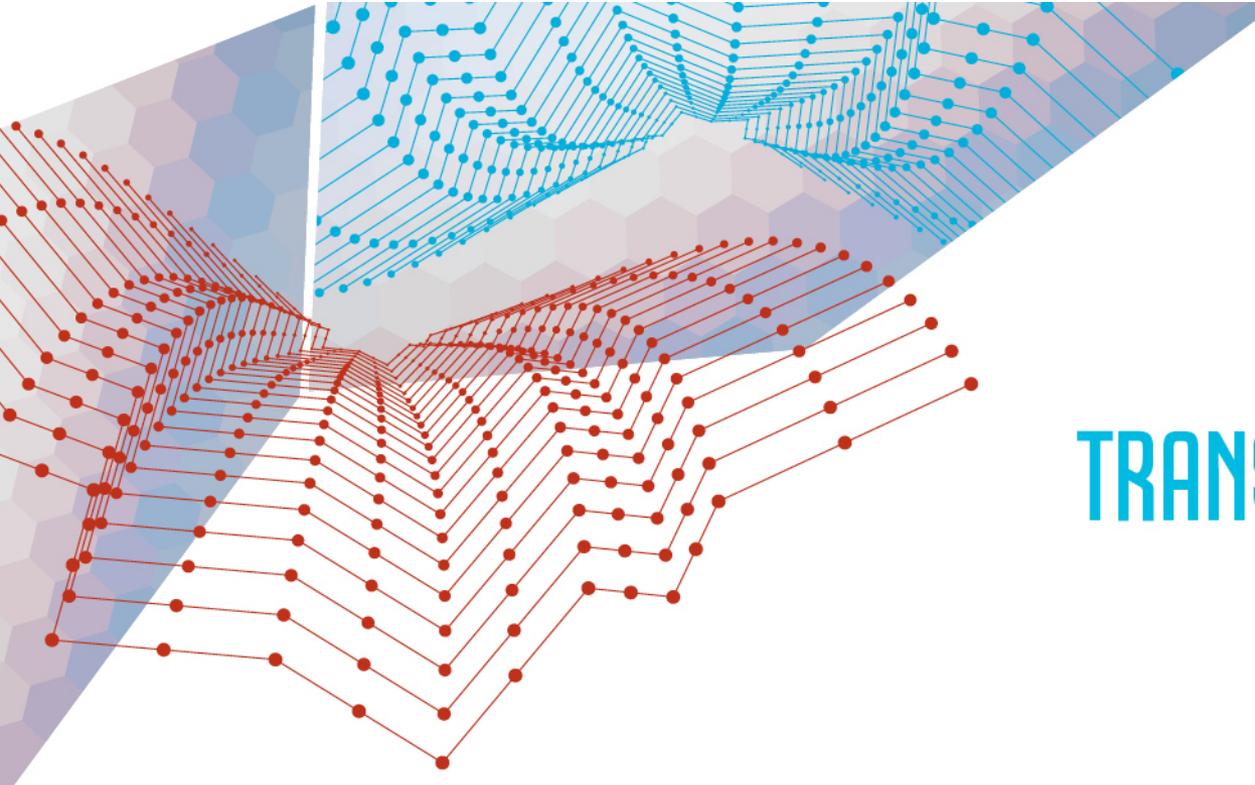
# Workshop / Webinar Schedule

NTR Engagement Activity	Event Type	Proposed Date
<b>Stage 2 NTR Program-wide Overview</b>	<b>Program-wide Webinar</b>	<b>5-May</b>
Customer Re-Orientation Roadmap Inputs & Future Regulatory Options and Pathways	Workshop	Mid-June
Beneficial System Integration of DER & Grid Capabilities	Workshops	Mid-June
Future Market Platforms Design & Implementation Options	Workshops	Early July
<b>Review of and feedback on quantitative modelling progressive outputs</b>	<b>Program-wide Workshop 1</b>	<b>mid-July</b>
Enablers of Network Tariff Reform and Incentives	Workshop/Webinar	Late July / Early Aug
Additional selected small workshops as required for individual Work Packages	Small workshops and webinars	Jul / Aug
<b>Roadmap overview and strawman content review</b>	<b>Program-wide Workshop 2</b>	<b>Early/mid-Aug</b>
Future Market Platforms – Transitional Roadmap inputs	Workshop	Mid-Aug
<b>Advanced roadmap content review</b>	<b>Program-wide Workshop 3</b>	<b>Early/mid-Sep</b>
Optional Supplementary Roadmap Draft Transitional Content	Optional Program-wide Workshop 4	Late Sep/Oct

Scope

Approach

Engagement

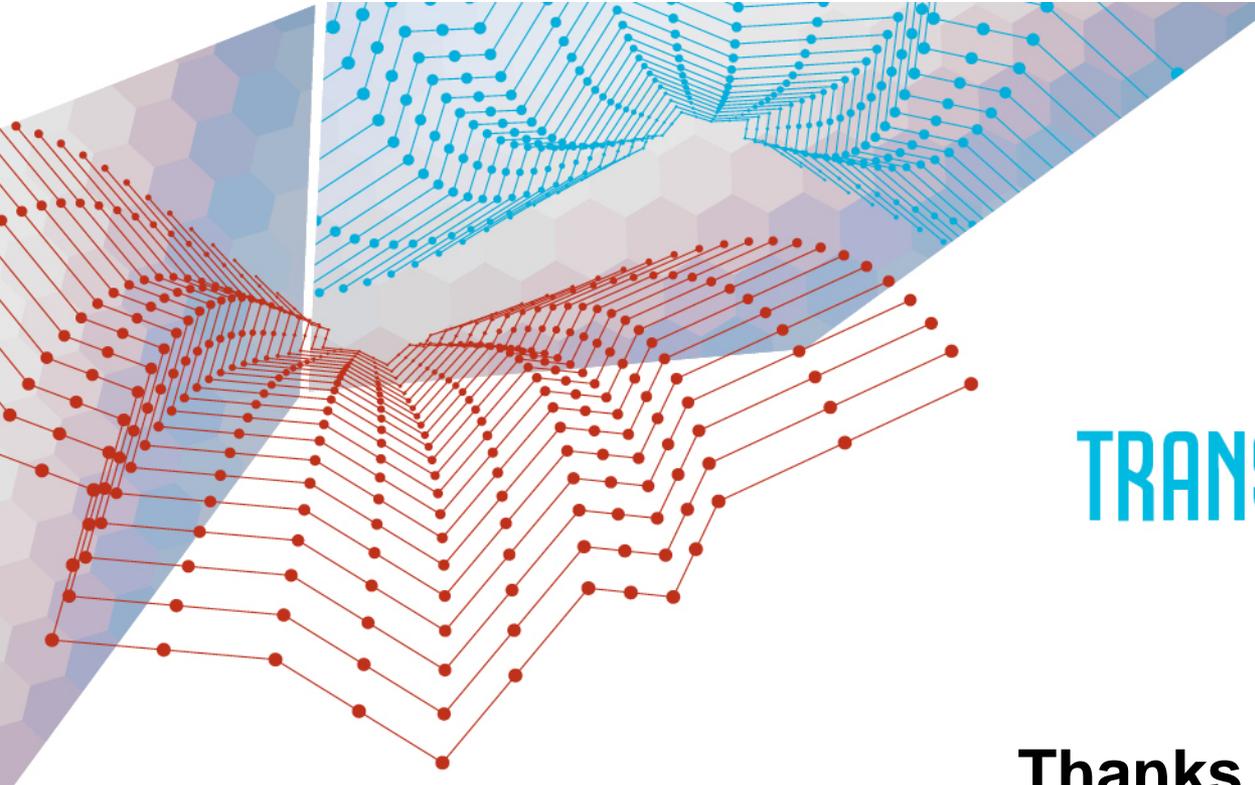


# ELECTRICITY NETWORK TRANSFORMATION ROADMAP

2015-25

## Questions?





# ELECTRICITY NETWORK TRANSFORMATION ROADMAP

2015-25

**Thanks for joining us**  
Questions or comments:  
let us know - [ntr@ena.asn.au](mailto:ntr@ena.asn.au)

