21st Century Energy System Planning

Australia's bright future starts now

Webinar 1 – Planning with Purpose

27 September 2023

with
Lauren Shwisberg, Rocky Mountain Institute
Professor Pierluigi Mancarella, University of Melbourne

facilitated by

ENERGY CONSUMERS AUSTRALIA

ENERGY CONSUMERS AUSTRALIA

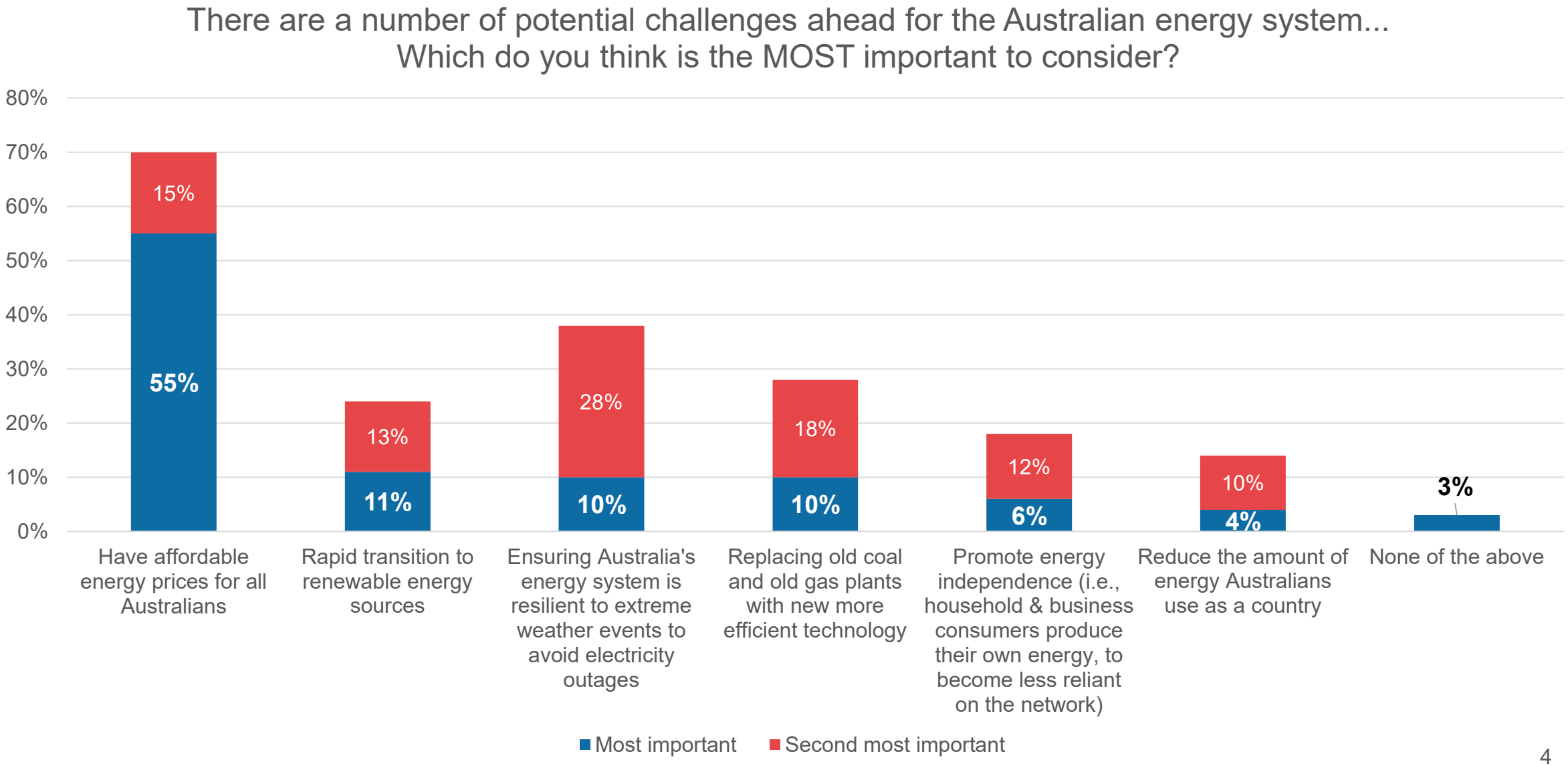
Acknowledgement of Country

We acknowledge the Traditional Owners of the lands on which we meet, live and work today, and we pay our deepest respects to Elders past, present and emerging.

Agenda

Time	Topic
10 min	Overview and Framing: Why is ECA hosting a series of webinars on energy planning? *Brian Spak, Energy Consumers Australia*
20 min	Reimagining Resource Planning *Lauren Shwisberg, Rocky Mountain Institute*
20 min	Different approaches to planning, the importance of incorporating uncertainty and risk, and the role of emerging technologies *Pierluigi Mancarella, University of Melbourne*
15 min	Panel discussion with *Pierluigi Mancarella, University of Melbourne* *Lauren Shwisberg, Rocky Mountain Institute* *Eli Pack, Group Manager System Planning at Australian Energy Market Operator (AEMO)* *Nicholas Horan, Manager, ISP Review Section – National Energy Transformation Division, DCCEEW*
15 min	Audience Q&A - *Please submit your questions via the Q&A feature in Zoom.*
5 min	Close

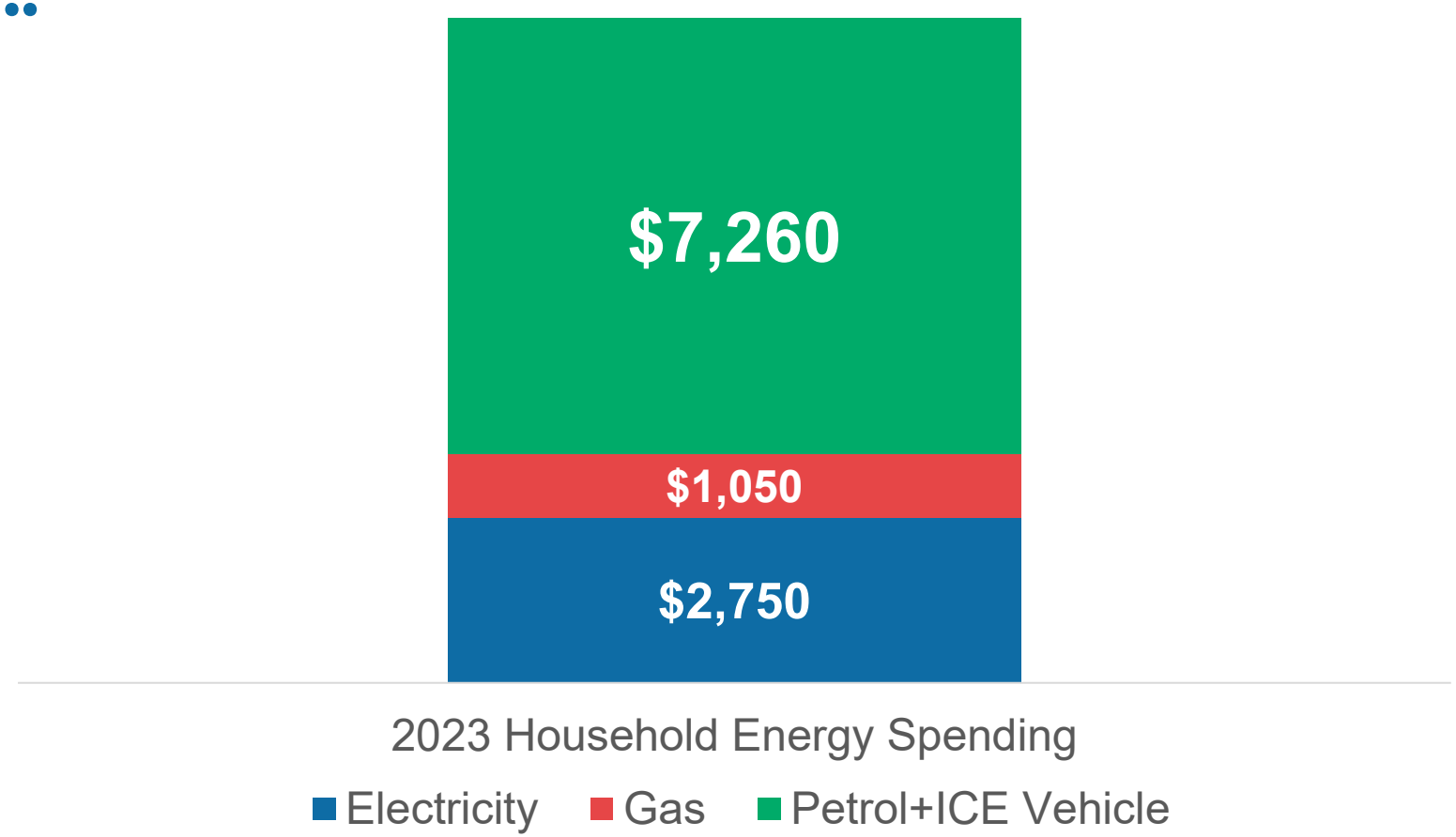
Affordability is consumers' top priority in the energy transition



Source: Energy Consumer Sentiment Survey June 2023; All households (n=2,120)

The average household's energy spending is mostly focused on transportation, which is outside of energy system planning...

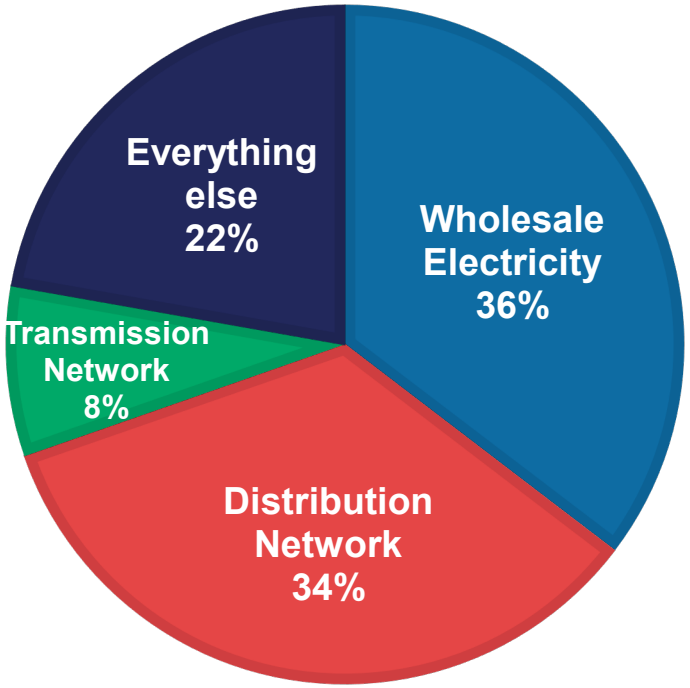
...for now...



Source: Energy Consumers Australia, 2023. "*Stepping Up: A smoother pathway for decarbonising households*", August 2023.

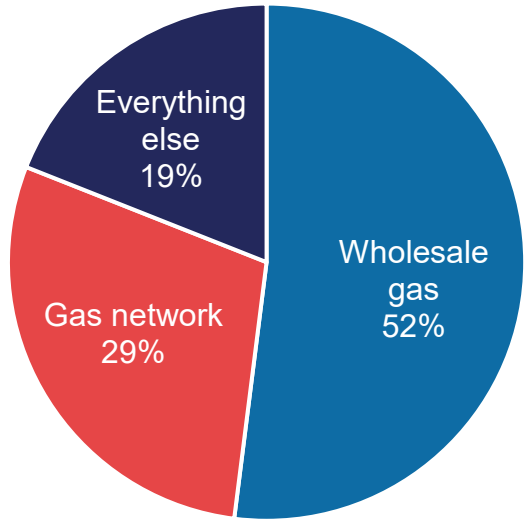
Planning informs network infrastructure and wholesale energy, which account for ~80% of the average household electricity and gas bills.

PROPORTION OF HOUSEHOLD ELECTRICITY BILLS (2020-21)



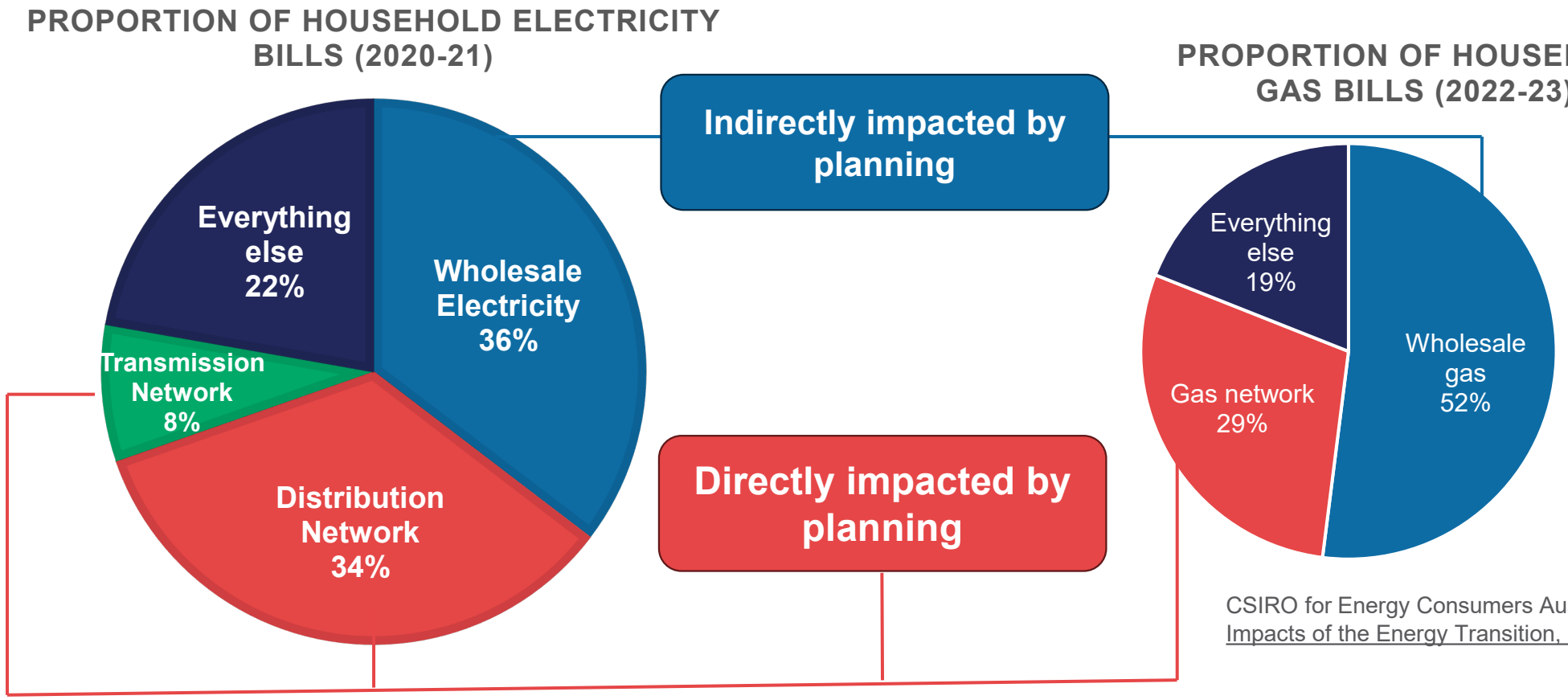
Analysis of AEMC, Residential Electricity Price Trends 2021, Final report, 25 November 2021

PROPORTION OF HOUSEHOLD GAS BILLS (2022-23)



CSIRO for Energy Consumers Australia, Consumer Impacts of the Energy Transition, Modelling Report, 2023

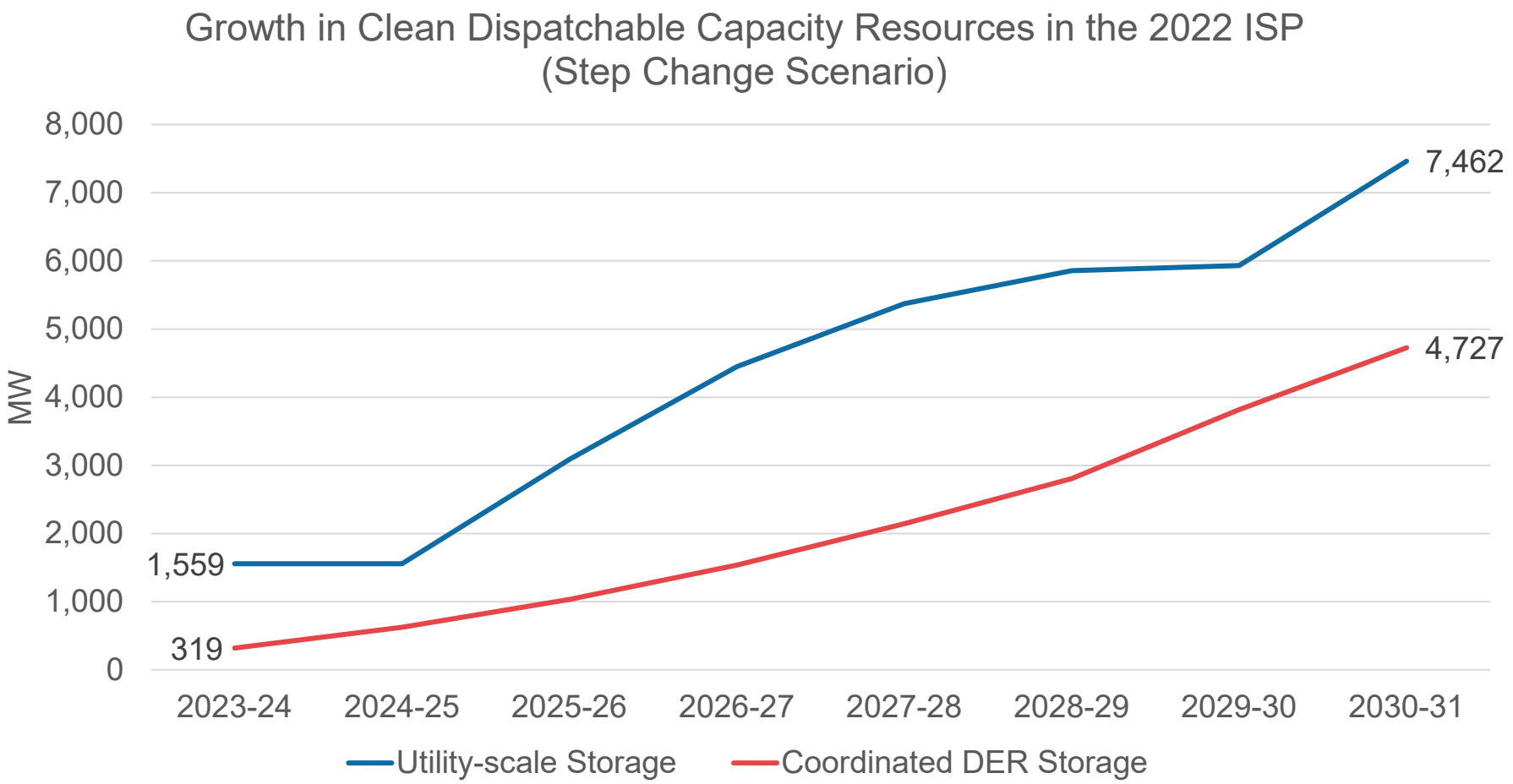
Planning informs network infrastructure and wholesale energy, which account for ~80% of the average household electricity and gas bills.



CSIRO for Energy Consumers Australia, Consumer Impacts of the Energy Transition, Modelling Report, 2023.

Analysis of AEMC, Residential Electricity Price Trends 2021, Final report, 25 November 2021

What is the best relationship between energy planning and energy policy? What if “the market” doesn’t deliver?

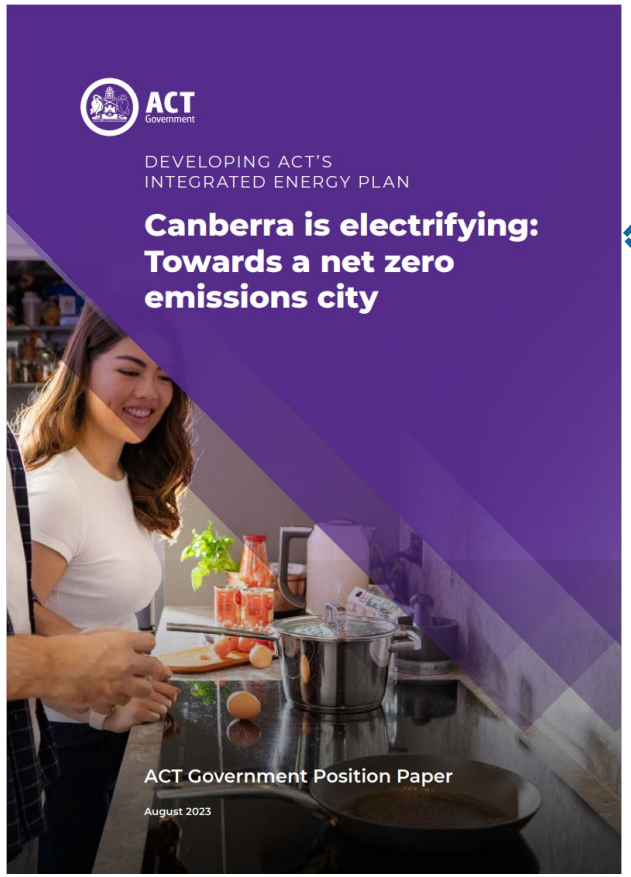


The Capacity Investment Scheme & Increasing Market Price Cap

Increasing Market Price Cap

Source: ECA Analysis of the 2022 ISP Chart Data

What is the proper scope for planning?
How integrated should our planning be?



Developing our future energy network and sharing the costs

Electrifying our community

Electrifying complex buildings

Electrifying business

Electrifying Industry and Heavy transport

Skills and workforce for the transition

The ACT Government is seeking community and stakeholder feedback on the proposed policy directions under each focus area to inform development of a final IEP, expected in early 2024.

Source: ACT Government, 2023. "*Canberra is electrifying: Towards a net zero emissions city*", Developing ACT's Integrated Energy Plan - Position Paper, August 2023.

ENERGY CONSUMERS AUSTRALIA

21st Century Energy System Planning

Webinar 1: Planning with purpose
Why do we plan and how might we do it better?
TODAY

Webinar 2: Demand-side solutions for a least-cost transition
How can we best integrate CER and efficiency into planning?
13 October: 9am-10.30am AEDT

Webinar 3: Transmission and distribution planning
How might we better plan the distribution system?
20 October: 9am-10.30am AEDT

Webinar 4: The future of gas network planning
How might we best plan the gas network and align gas and electricity plans?
27 October: 9am-10.30am AEDT

Reimagining Resource Planning

How long-term planning's purpose is evolving in the United States

LAUREN SHWISBERG
RMI
SEPTEMBER 2023

RMI
ENERGY. TRANSFORMED.

Agenda

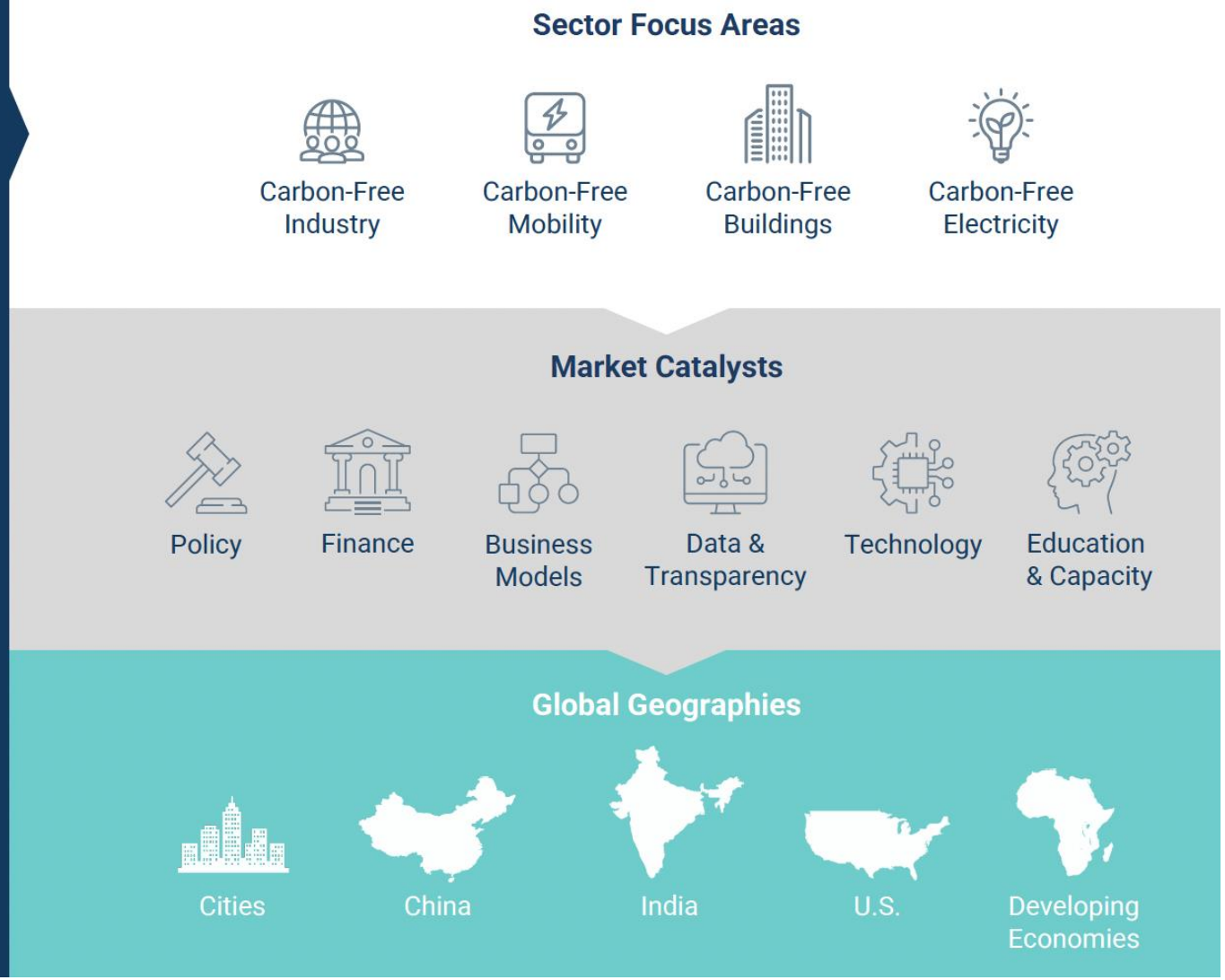
- Introduction to RMI and context for integrated resource planning in the US
- Key findings on the evolving ‘purpose’ of integrated resource planning in the US
- Examples of leading practices in US states in integrating new objectives or topics into planning

Introduction to RMI and context for long-term planning in the US

About RMI

RMI's mission is to transform the global energy system to secure a clean, prosperous, zero-carbon future for all

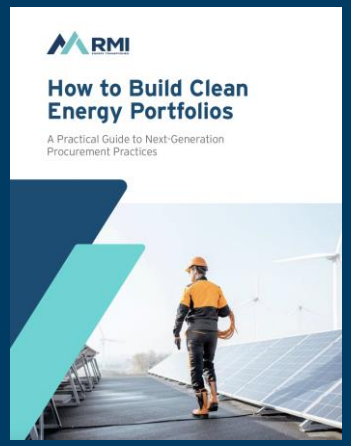
RMI – Energy. Transformed.



How we work on long-term planning

Thought leadership & convening

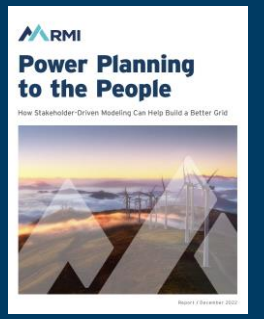
- Resource planning & procurement best practices
- Reliability



Direct support for Public Utilities Commissions (state regulators) and Utilities

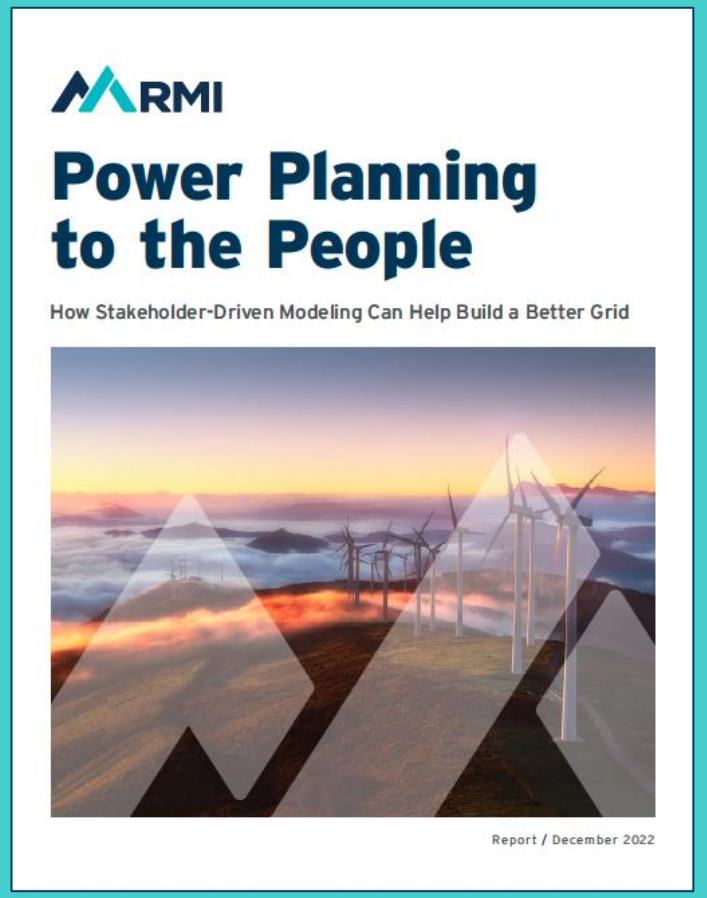
- Direct support for the **Oregon Public Utilities Commission** in updating planning to incorporate their landmark climate law (HB 2021)
- Support for the **Hawaii Public Utilities Commission** in their Integrated Grid Planning Process

Accelerate advocacy and decision-making with analysis

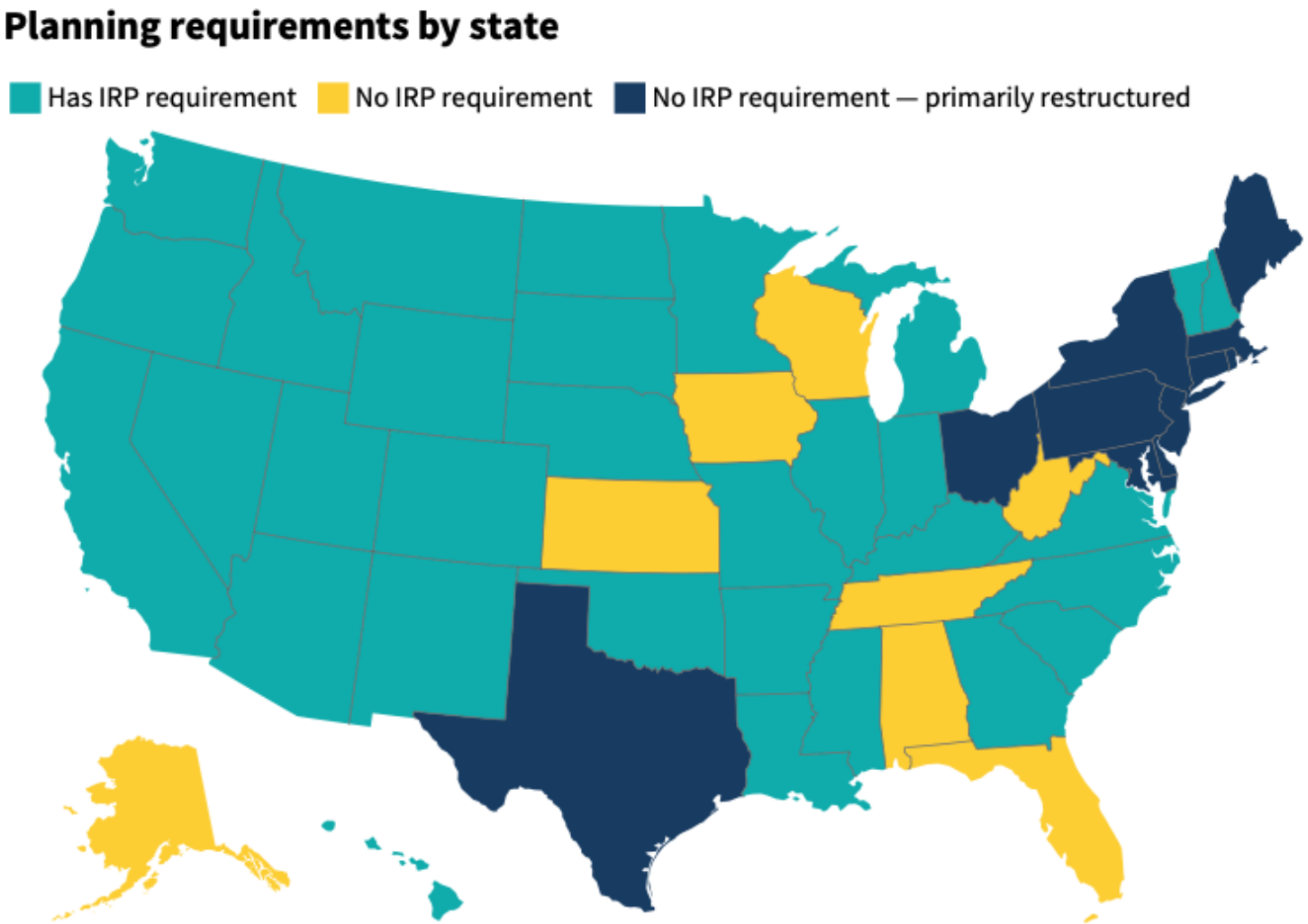


- Direct support for advocates modeling health and economic impacts of proposed gas
- Case for more transparent modeling through a case study in KY

Key Resources: Reimagining Resource Planning & Power Planning to the People



Utilities in most US states do integrated resource planning



Source: US Environmental Protection Agency, *State Energy and Environment Guide to Action: Resource Planning and Procurement*, Figure 2; RMI analysis of EIA-860M to add distinction for primarily restructured states

Key findings on the evolving purpose of planning in the US

Resource planning is a crucial opportunity for utilities, regulators, and stakeholders to shape the future electricity system

Understand the energy needs of the households, communities, and businesses a utility serves, as well as how they will change over time, and translate them into system needs

Establish a common set of assumptions and evidence that can be used to assess which near- and long-term options can meet system needs and achieve desired utility performance across multiple objectives

Identify longer-term risks and opportunities and strategies to navigate them

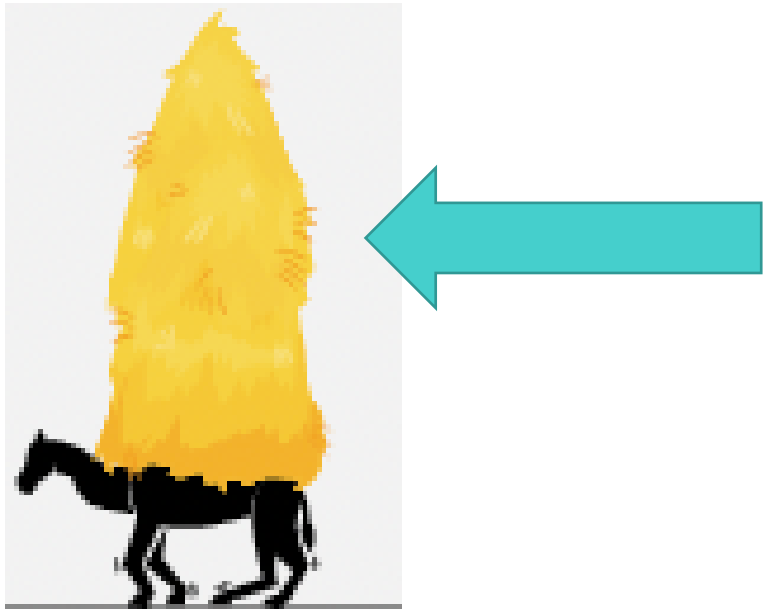
IRPs must maintain three core qualities to be effective tools for utilities and regulators to evaluate resource decisions

IRP quality	*Definition*
Trusted	The IRP is **transparent and well vetted**, with stakeholder input.
Comprehensive	The IRP can **accurately represent the costs, capabilities, system impacts, and values of resources** that might be available within the planning time horizon; the IRP can **consider actions across the transmission and distribution systems** as portfolio options.
Aligned	It is clear how the plan evaluates options to meet traditional planning requirements such as **reliability, affordability, and safety,** as well as **state and federal policies and customer or company priorities**, such as reducing emissions and advancing environmental justice.

Several key trends are challenging utilities and regulators to maintain these qualities in planning processes

- **Rapid technology change and shifting resource costs**
- **New policies that expand planning objectives in US states beyond affordability, reliability, and safety to include:**
  - Emissions reductions
  - Advancement of environmental justice
  - Economic development
  - Support of electrification of transportation, buildings, and industry
- **Recognition that distribution and transmission impact resource planning (and vice versa)**
- **Links between planning and local air quality, health, jobs, energy bills, and climate change**

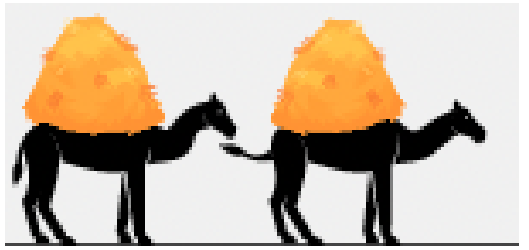
To ensure these new expectations don't "break the camel's back"…



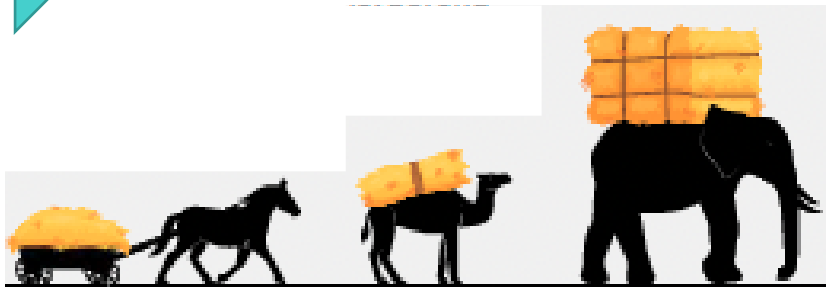
New IRP expectations risk being like the straw that breaks the camel's back

…leading US utilities and regulators are proactively and repeatedly refining IRP purpose, scope, roles, and tools

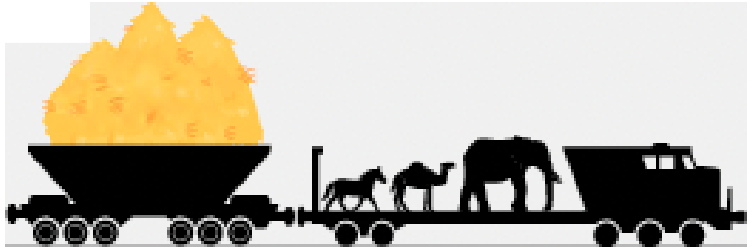
Purpose



Scope

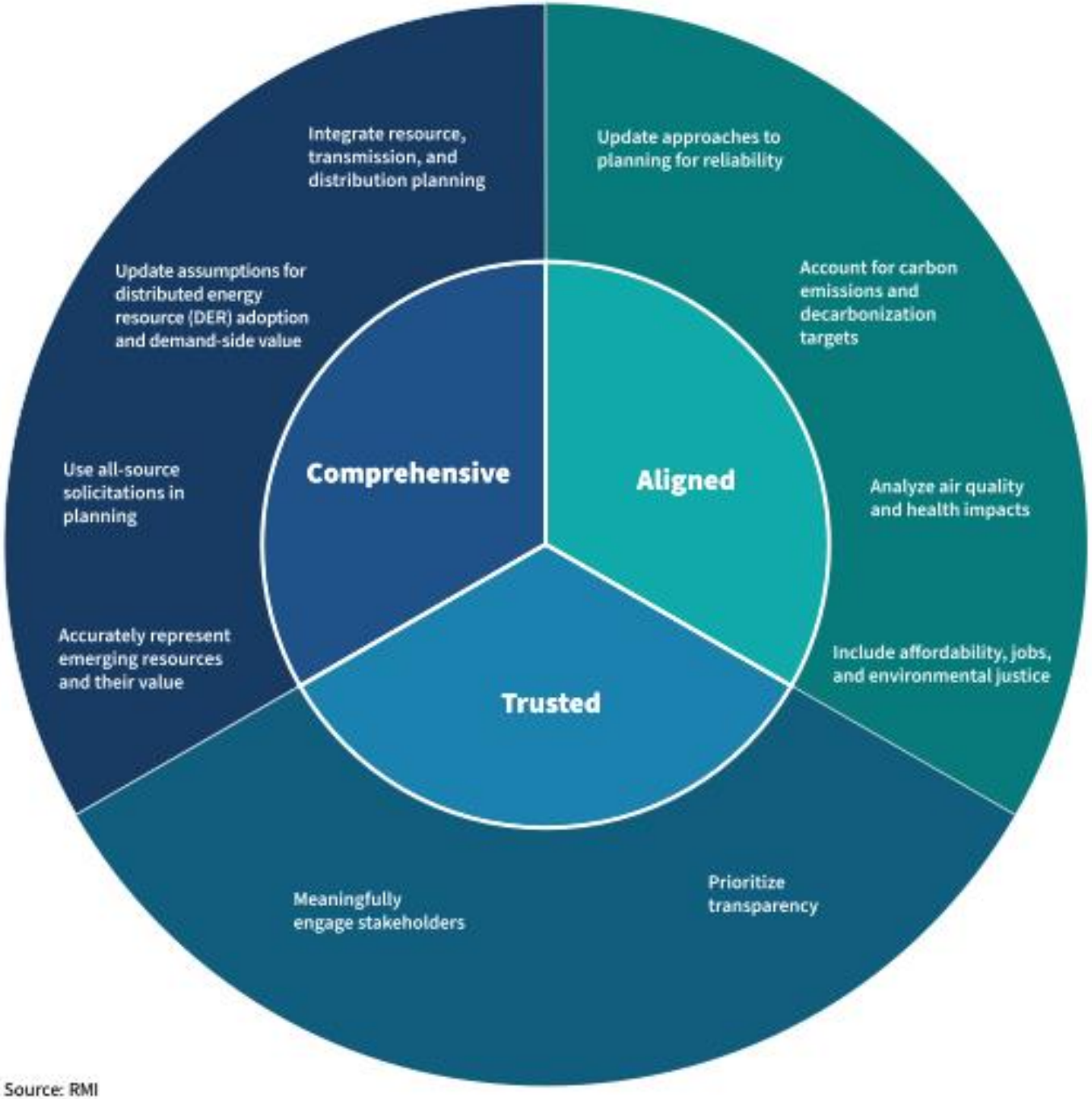


Roles



Tools

We identified several options, being used by leading utilities across the US to enhance resource planning practices to make them more comprehensive, trusted, and aligned



Source: RMI

Examples of leading practices in US states in integrating new objectives or topics into resource planning

IRP quality	*Description of planning enhancement*
Trusted	1. Prioritizing transparency 2. Meaningful engaging stakeholders
Comprehensive	3. Integrating resource, transmission, and distribution planning 4. Using all-source solicitations in planning **5. Updating assumptions for DER adoption and demand-side value** **6. Accurately representing emerging resources and their value**
Aligned	**7. Updating approaches to planning for reliability** 8. Accounting for carbon emission and decarbonization targets 9. Analyzing air quality and health impacts **10. Including affordability, jobs, and environmental justice**

Each of these options affects one or more "building blocks" of integrated resource planning process

Source: "Standard Building Blocks" from the National Association of Regulatory Utility Commissioners-National Association of State Energy Officials (NARUC-NASEO) Task Force on Comprehensive Electricity Planning, 2019

Options for accurately representing emerging resources and their value

Select models and use features that enable more spatial and temporal granularity*

Include resource options that are expected to be available in the market within the planning horizon

Entergy Louisiana's pre-IRP filing included a comprehensive assessment of the technological maturity levels of all options it might consider in its IRP, and included several "demonstration" options in its modeling

Integrating distribution planning can occur before or throughout the resource planning process

1 **Implement a distribution system planning process to complement resource planning***

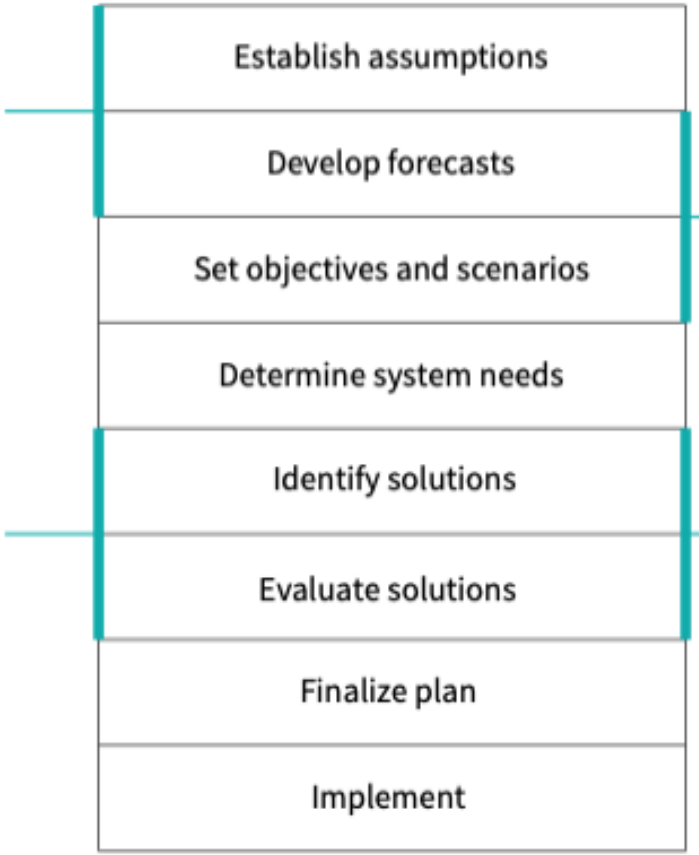
1. In Minnesota, current integrated distribution planning (IDP) requirements ask utilities to describe how IDP and IRP are coordinated

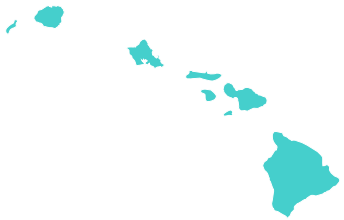
Options for improving DER adoption and value in the IRP process

Model DER adoption and electrification forecasts more granularly

Treat DERs, including energy efficiency, as a resource in planning

AES Indiana has created demand-side management supply curves that are selectable resources





Model interactions among DERs and integrate those into planning scenarios

Value the reliability contribution of DERs in planning

Hawaiian Electric uses "bookend" scenarios by combining DER adoption trajectories

Options for updating reliability modeling throughout the IRP process

PacifiCorp in Washington assesses climate impacts on load and resource availability

Redefine the goals and metrics for assessing reliability in an IRP*

Integrate resilience into planning*

Oregon planning guidelines require utilities to assess expected and worst-case unserved energy in addition to loss of load probability and planning reserve margin

Analyze the impacts of reliability-threatening scenarios, including those exacerbated by climate change

Understand regional reliability needs

Improve alignment between portfolio optimization models and reliability analysis

*Applied before and throughout the process

Options for including affordability, jobs, and environmental. justice in resource planning

1. In Minnesota, utilities are required to consider the "human impacts" of asset retirements in their planning, including collaborating with workers and worker representatives.

2. CPUC requires utilities to identify which disadvantaged communities they serve.

- Establish assumptions
- Develop forecasts
- Set objectives and scenarios
- Determine system needs
- Identify solutions
- Evaluate solutions
- Finalize plan
- Implement

Estimate comparative rate impacts of portfolios

Factor community acceptance into resource availability and feasibility of plans

Plan for community transition associated with asset retirements

1

2

Define and map disadvantaged communities to assess impacts*

*Applied before and throughout the process

Risk-aware flexible whole-system planning

Prof Pierluigi Mancarella, FIEEE

Chair of Electrical Power Systems, The University of Melbourne

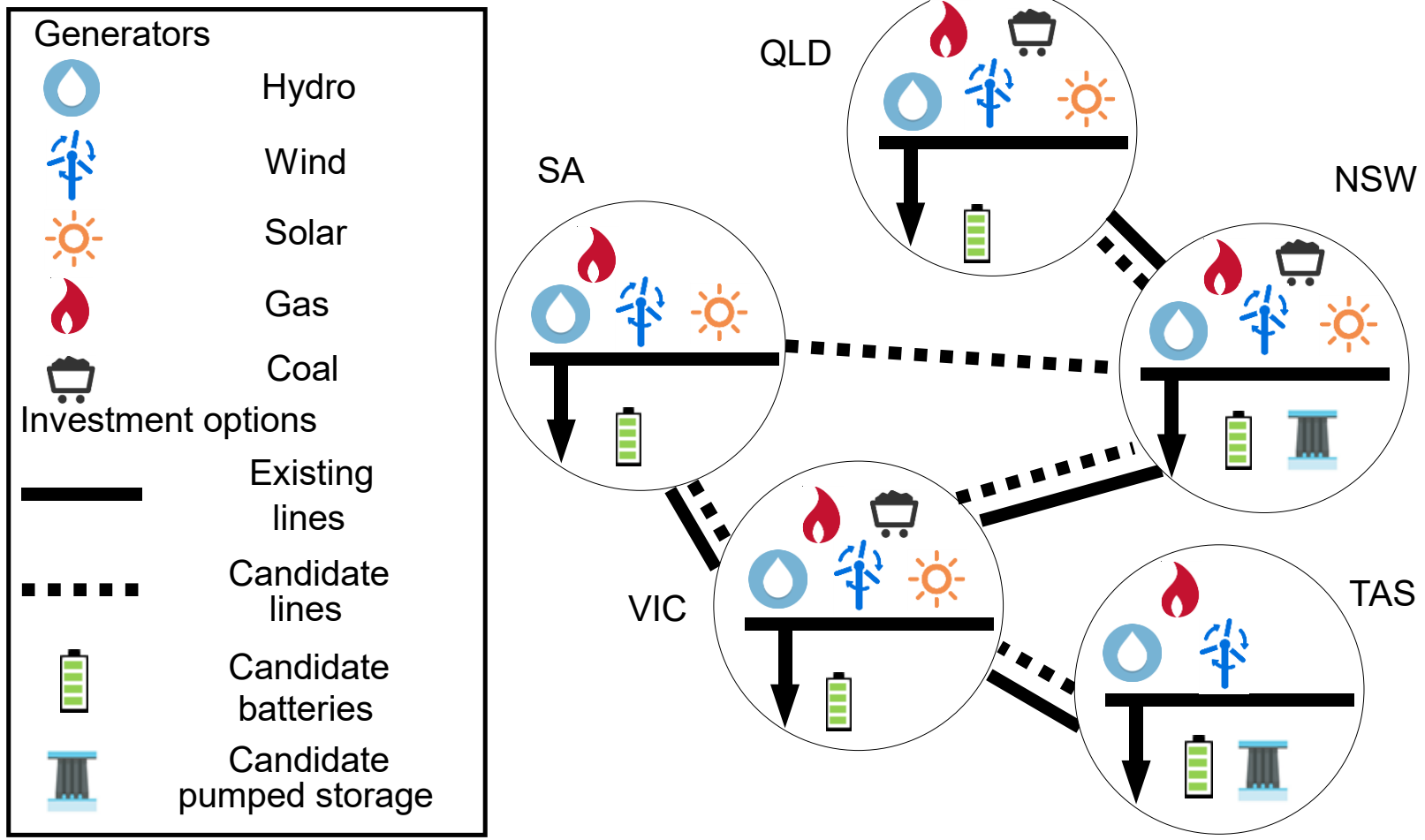
Professor of Smart Energy Systems, The University of Manchester, UK

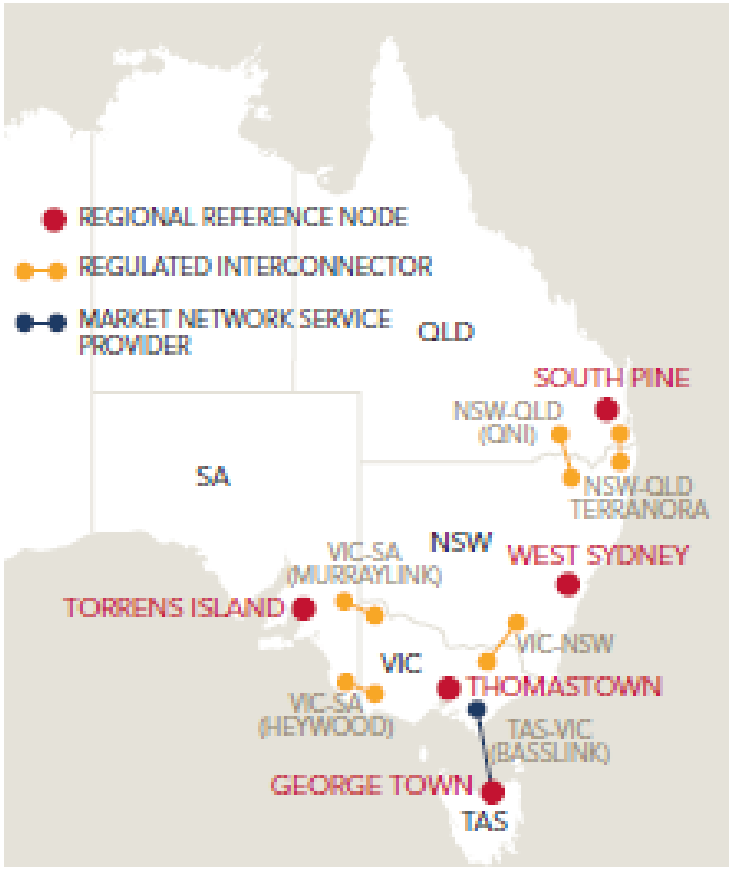
pierluigi.mancarella@unimelb.edu.au

Energy Consumers Australia's 21st Century Energy System Planning Series

27th September 2023

Network planning and technology solutions: Spoilt for choice!

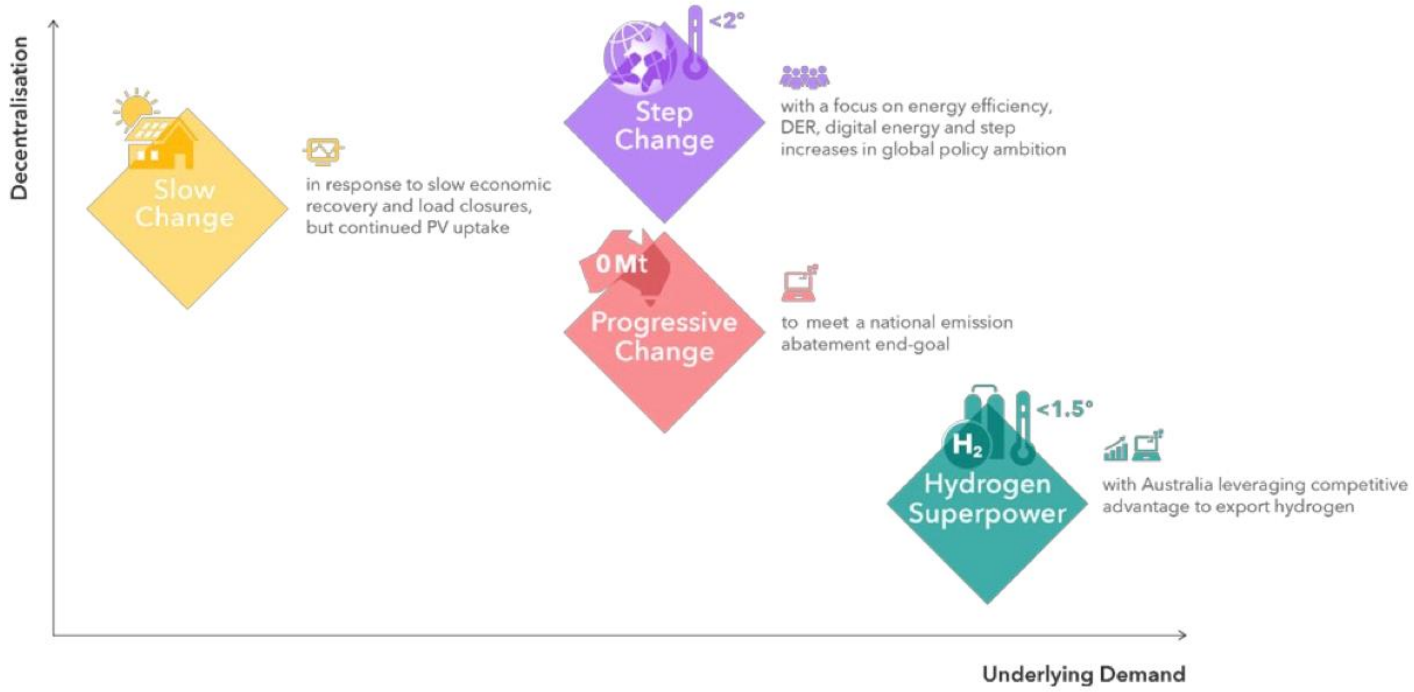




B. Moya, *et al.*, "Co-optimized Energy Storage and Transmission Expansions with Various Representations of Long-Term Uncertainty and Decision Dynamics", *EPSR 2022*

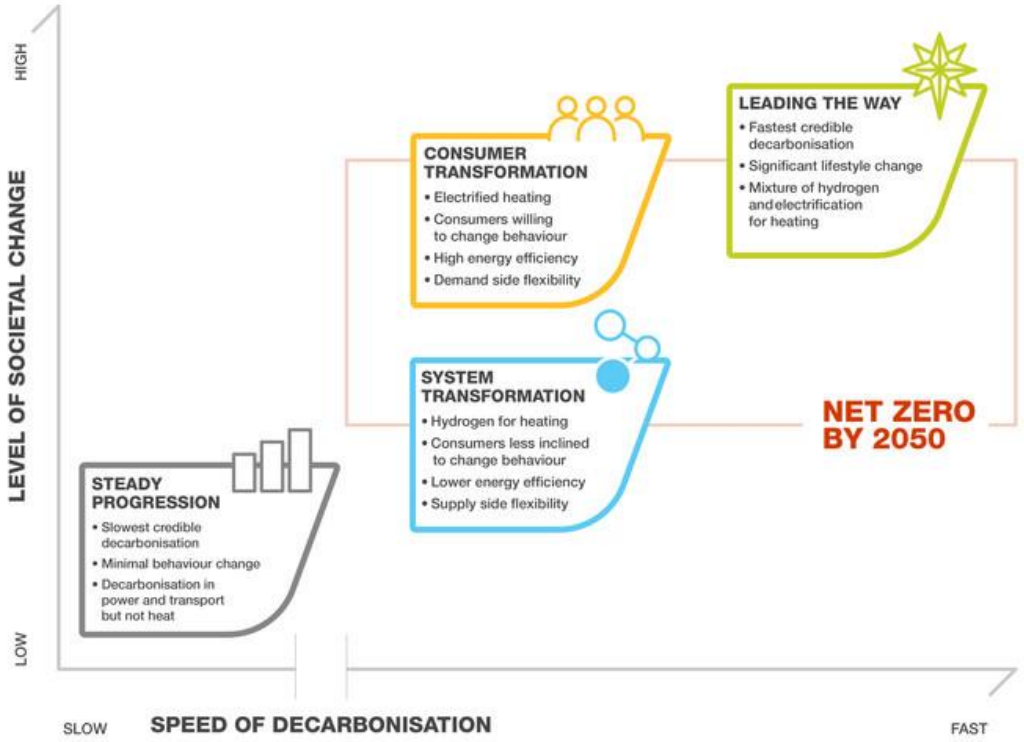
Net zero can be reached in many ways…

Australia



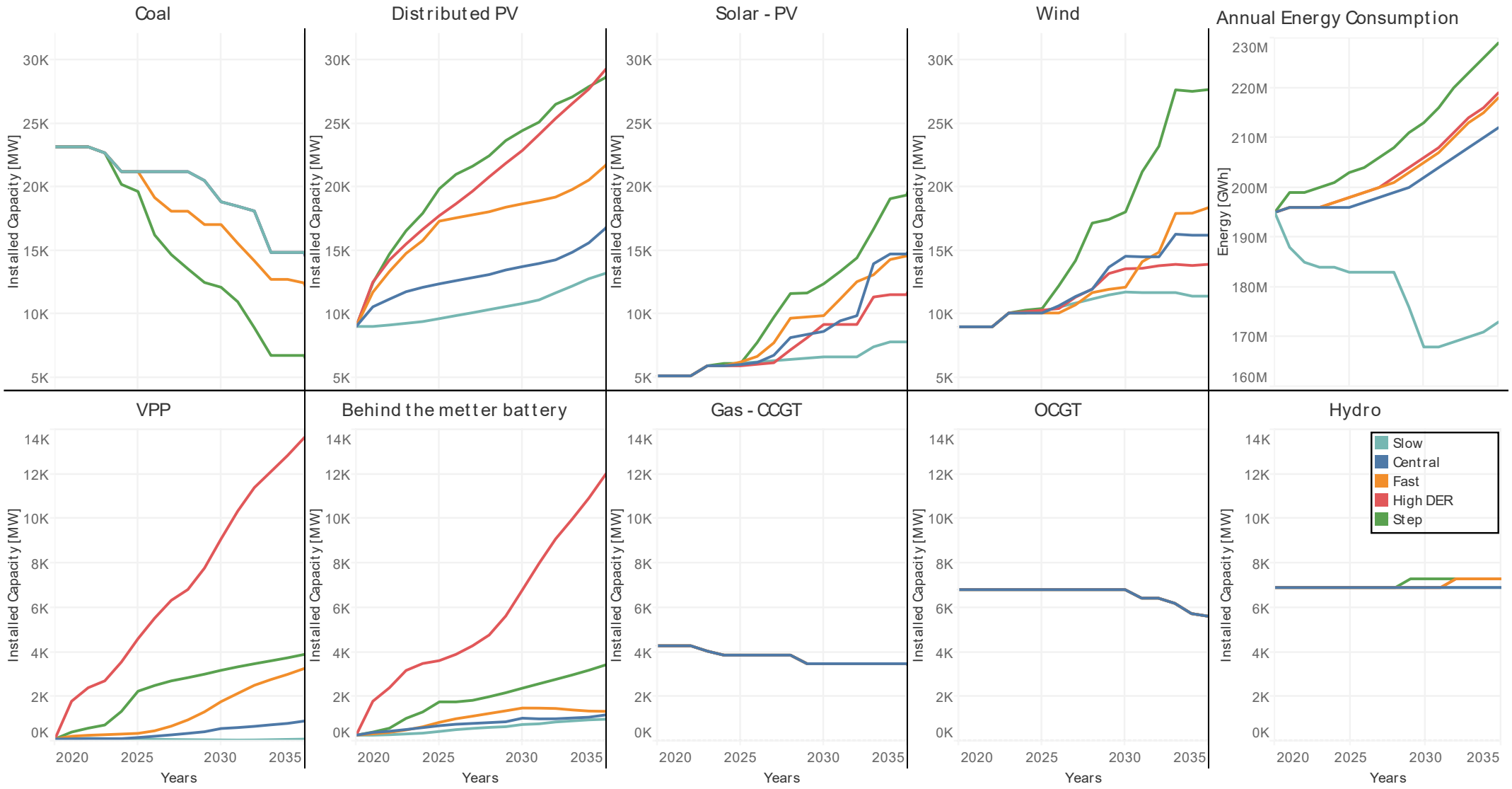
Source: AEMO, ISP 2022

UK



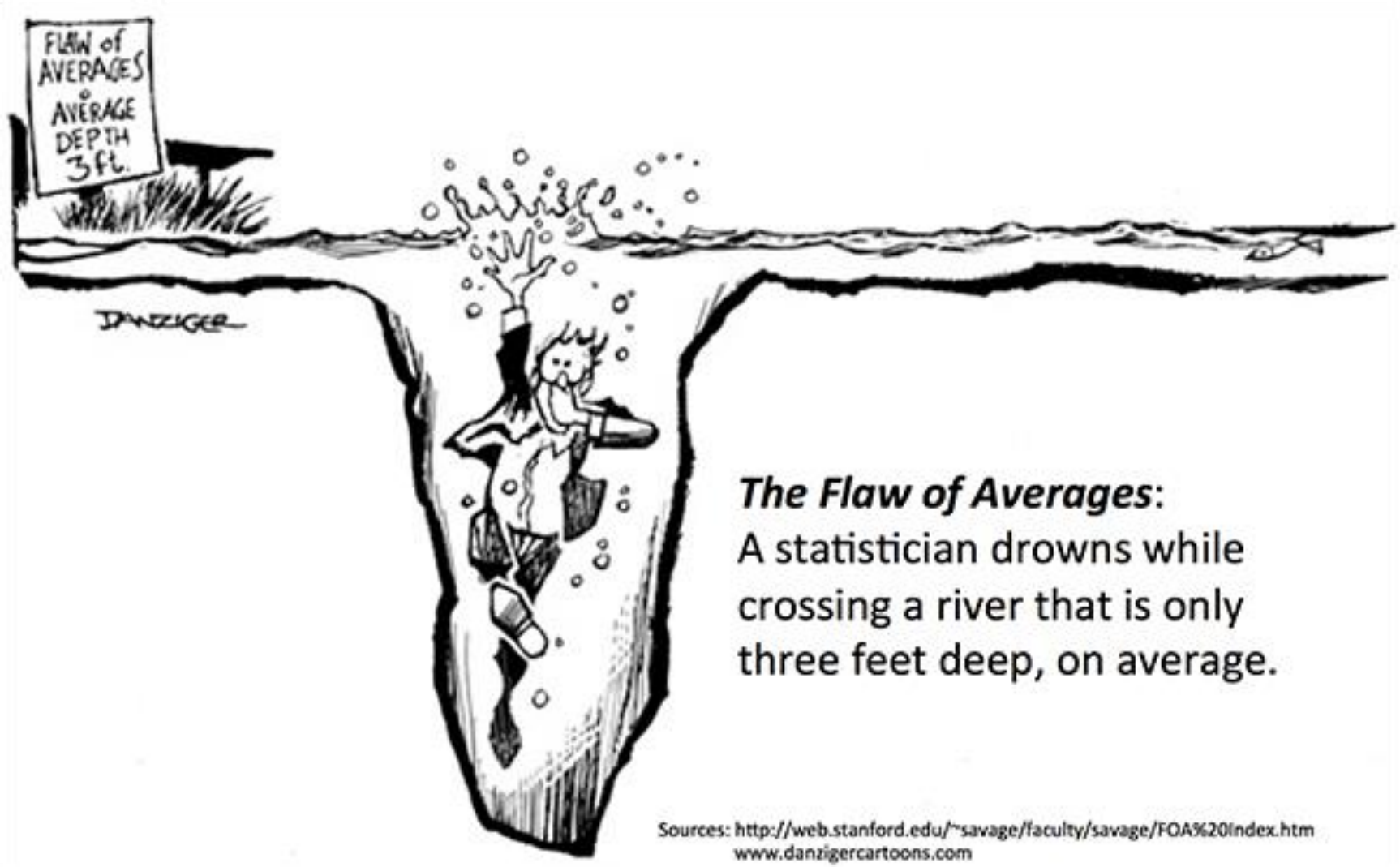
Source: National Grid ESO, UK, FES 2021

What future do we plan for?

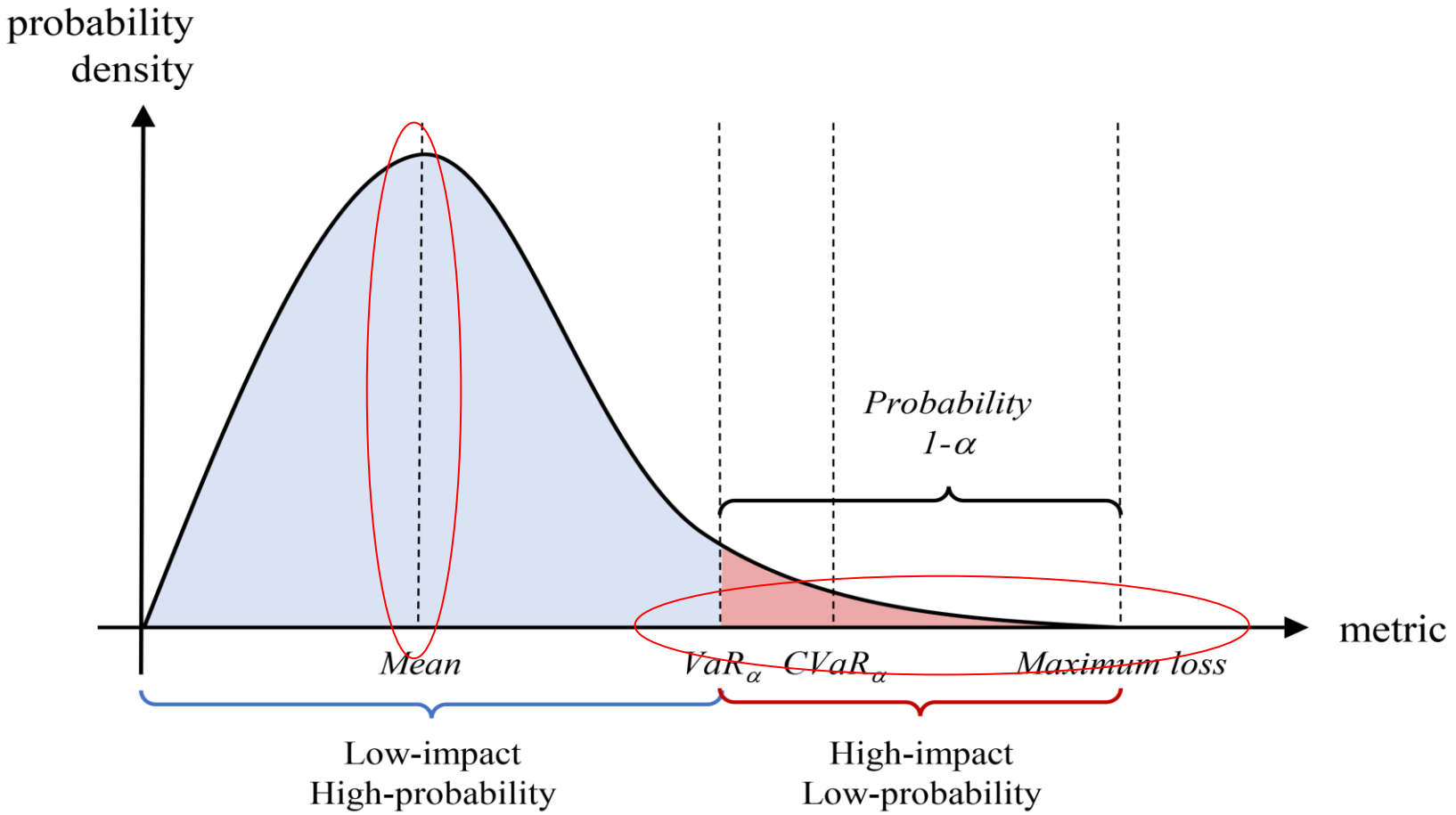


Source: AEMO, ISP 2020

A vignette is worth more than one thousands words…



We plan for the average but fear the extreme…



THE UNIVERSITY OF MELBOURNE

Considerations in support of the 2022 Reliability Standards and Settings Review

Briefing Note prepared for the Australian Energy Market Commission

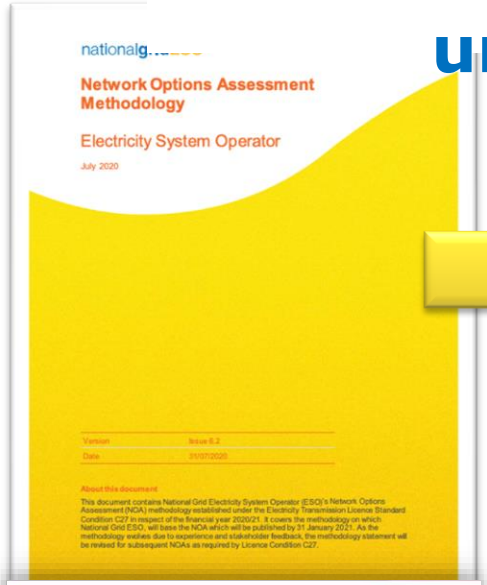
Pierluigi Mancarella

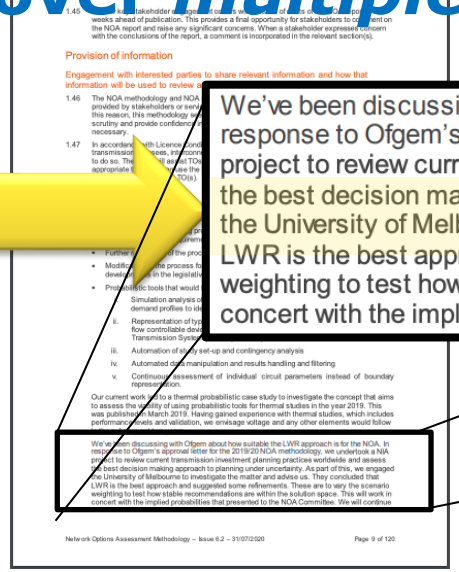
The University of Melbourne

August 2022

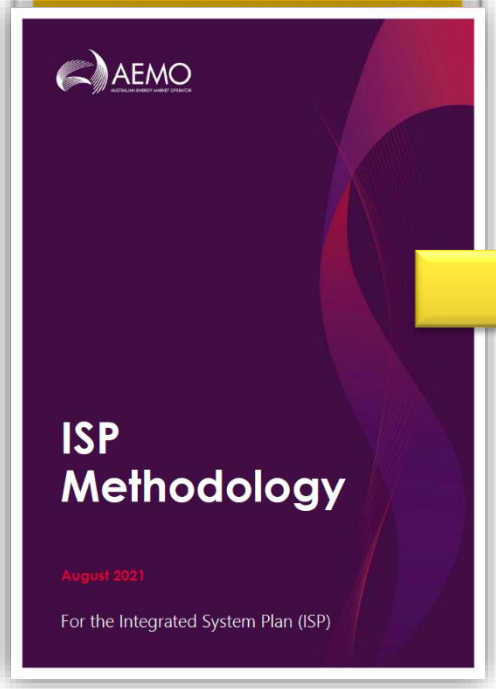
https://www.aemc.gov.au/sites/default/files/2022-08/Pierlugi%20Mancarella%20-%20Briefing%20note%20-%20form%20of%20the%20reliability%20standard.pdf

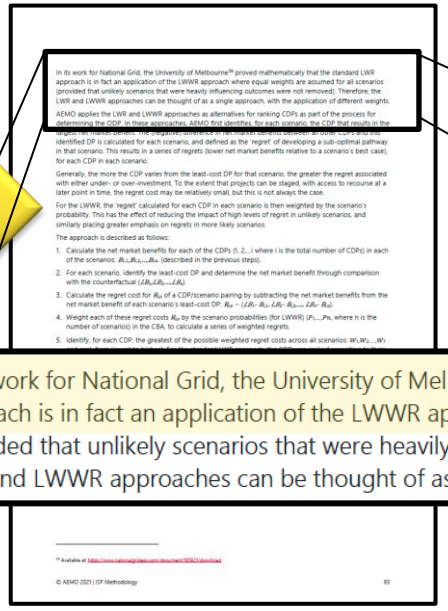
How can I make a *risk-aware* decision under uncertainty over *multiple* scenarios?





We've been discussing with Ofgem about how suitable the LWR approach is for the NOA. In response to Ofgem's approval letter for the 2019/20 NOA methodology, we undertook a NIA project to review current transmission investment planning practices worldwide and assess the best decision making approach to planning under uncertainty. As part of this, we engaged the University of Melbourne to investigate the matter and advise us. They concluded that LWR is the best approach and suggested some refinements. These are to vary the scenario weighting to test how stable recommendations are within the solution space. This will work in concert with the implied probabilities that presented to the NOA Committee. We will continue



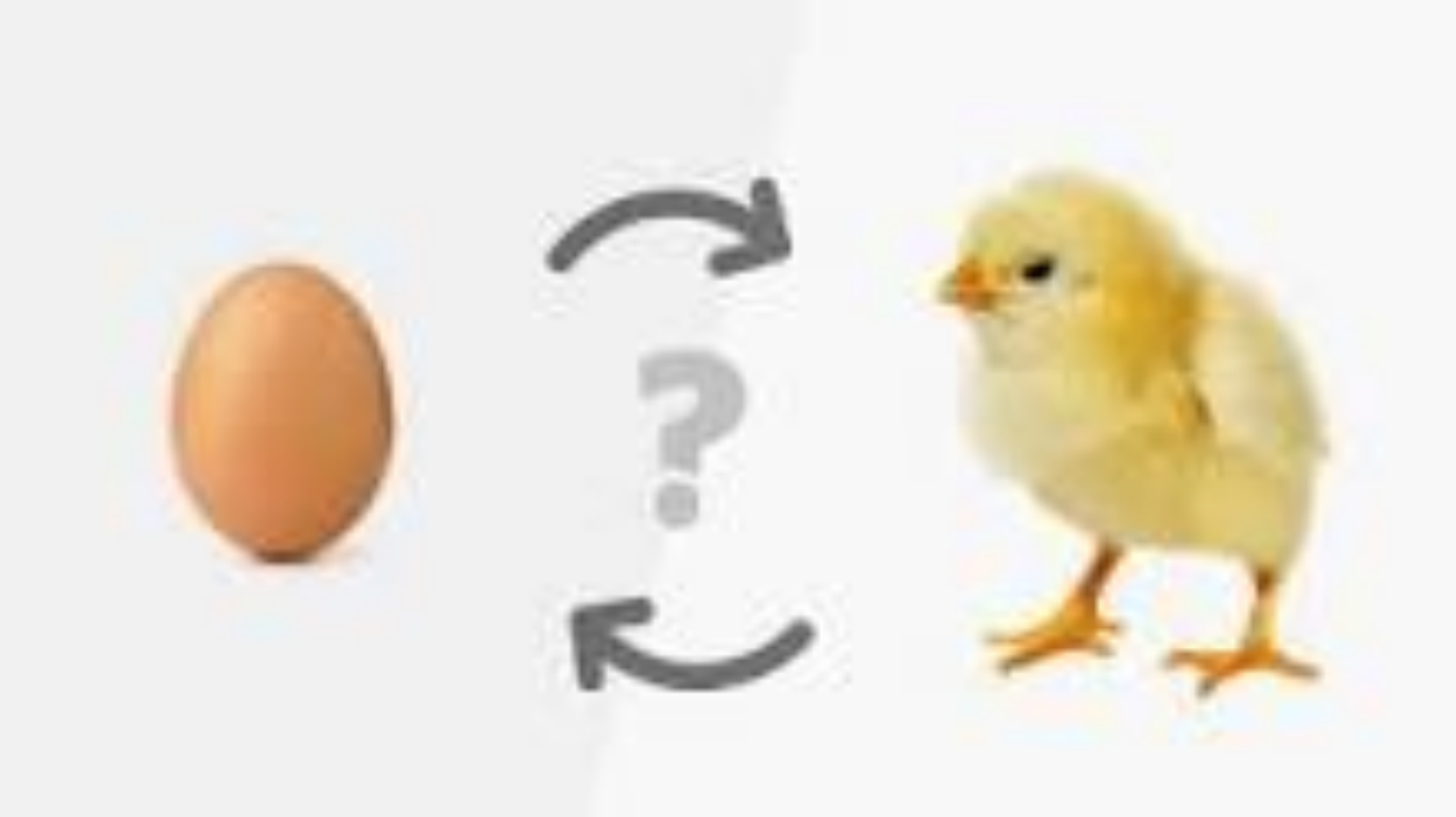


Least-Worst Weighted Regret (LWWR) analysis

In its work for National Grid, the University of Melbourne[59] proved mathematically that the standard LWR approach is in fact an application of the LWWR approach where equal weights are assumed for all scenarios (provided that unlikely scenarios that were heavily influencing outcomes were not removed). Therefore, the LWR and LWWR approaches can be thought of as a single approach, with the application of different weights.

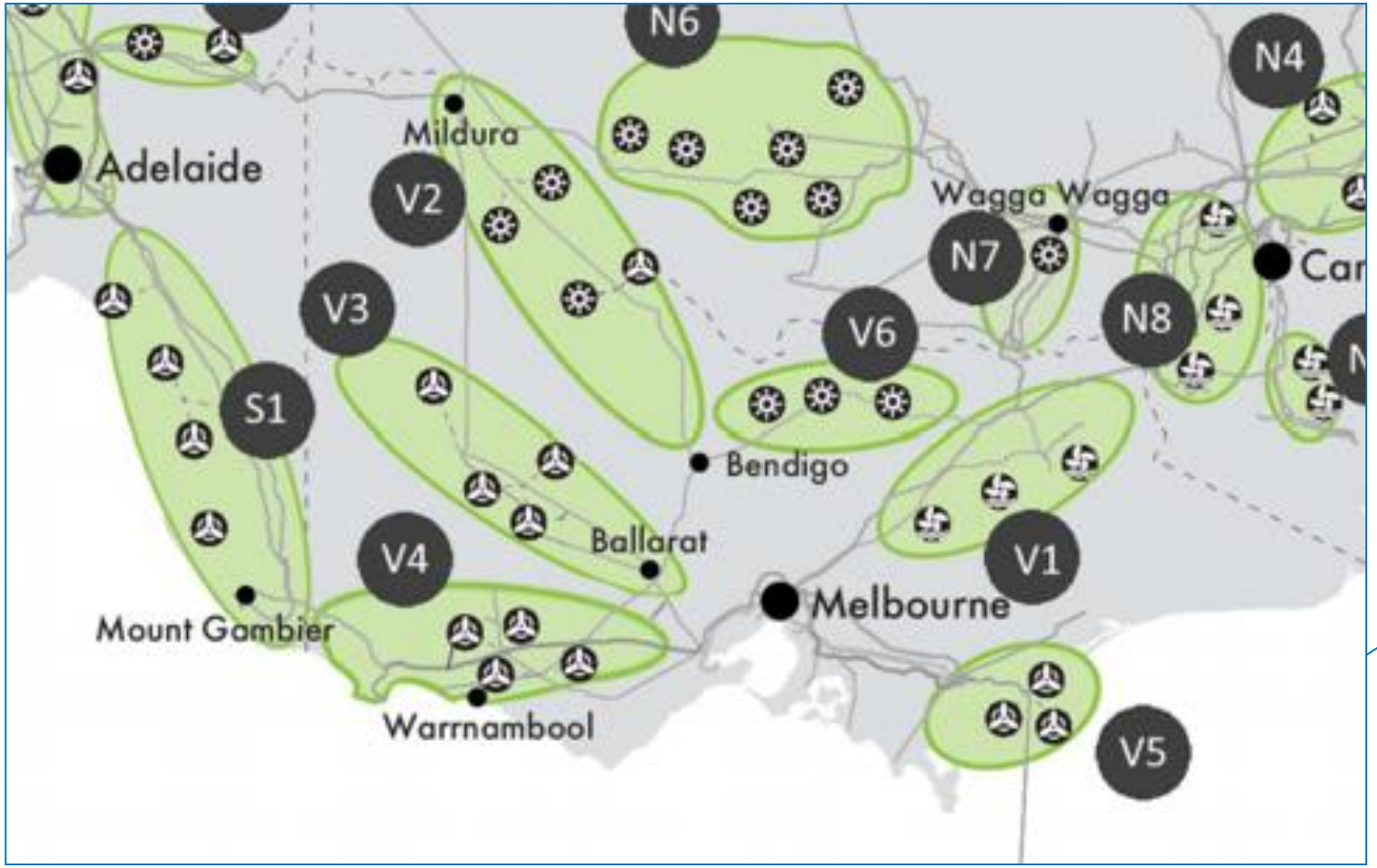
See : P. Mancarella, *et al.*, "Study of advanced modelling for network planning under uncertainty - Part 1", Report for National Grid ESO, 2020: https://www.nationalgrideso.com/document/185821/download

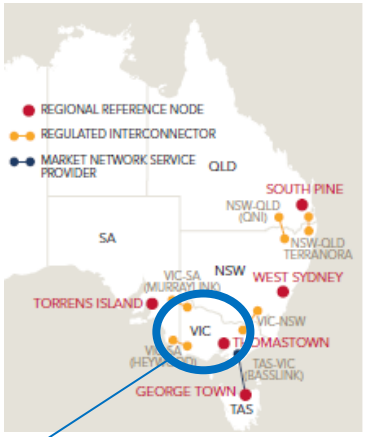
But the modern investment problem is even more complicated….



Source: https://clockwise.software/blog/solve-the-chicken-and-egg-problem/

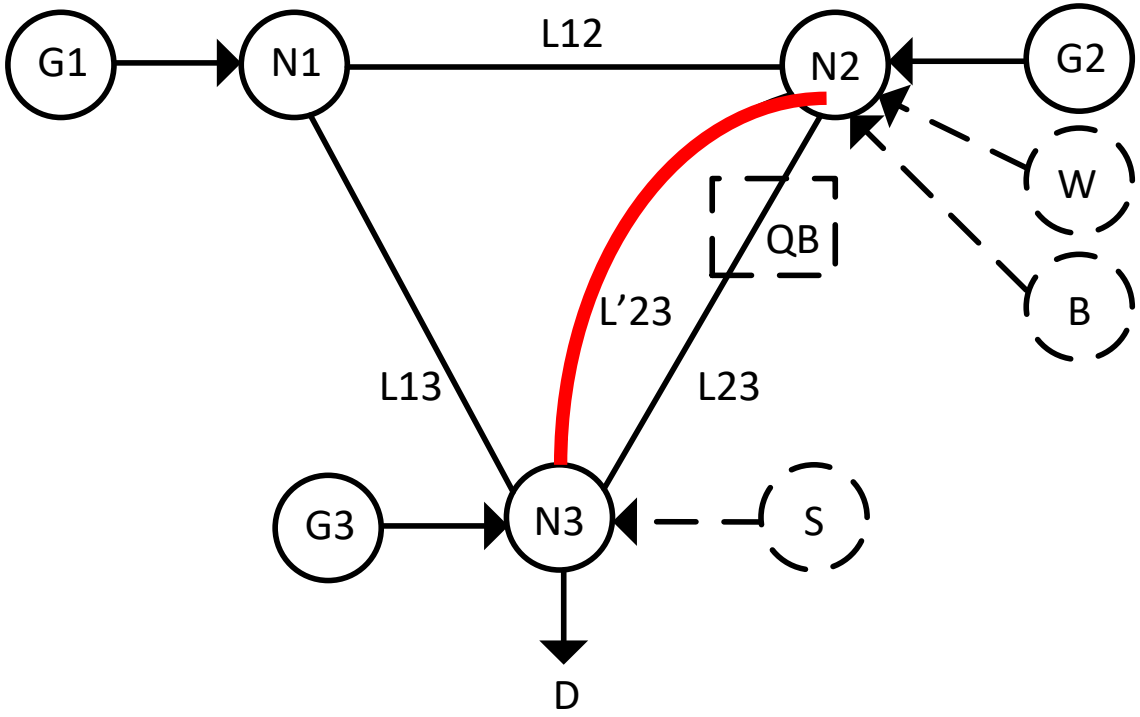
How can we facilitate *risk-aware proactive, anticipatory* investment?





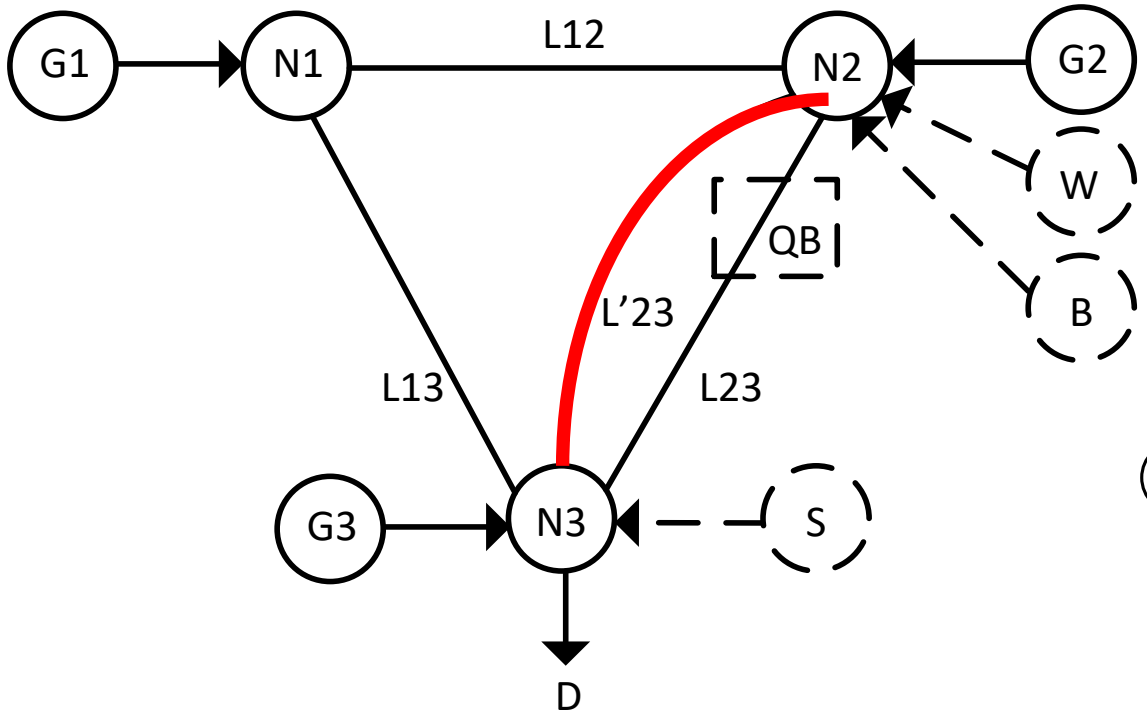
Source: AEMO ISP 2020 and Environment Victoria

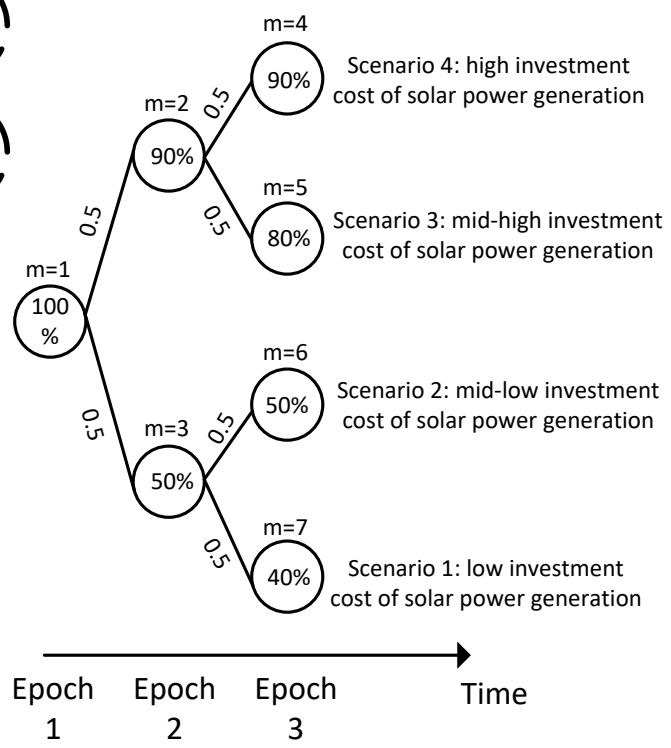
Deterministic planning



R. Moreno, *et al.*, "Planning Low-Carbon Electricity Systems under Uncertainty Considering Operational Flexibility and Smart Grid Technologies", *Philosophical Trans. Royal Society A*, June 2017

But under uncertainty…

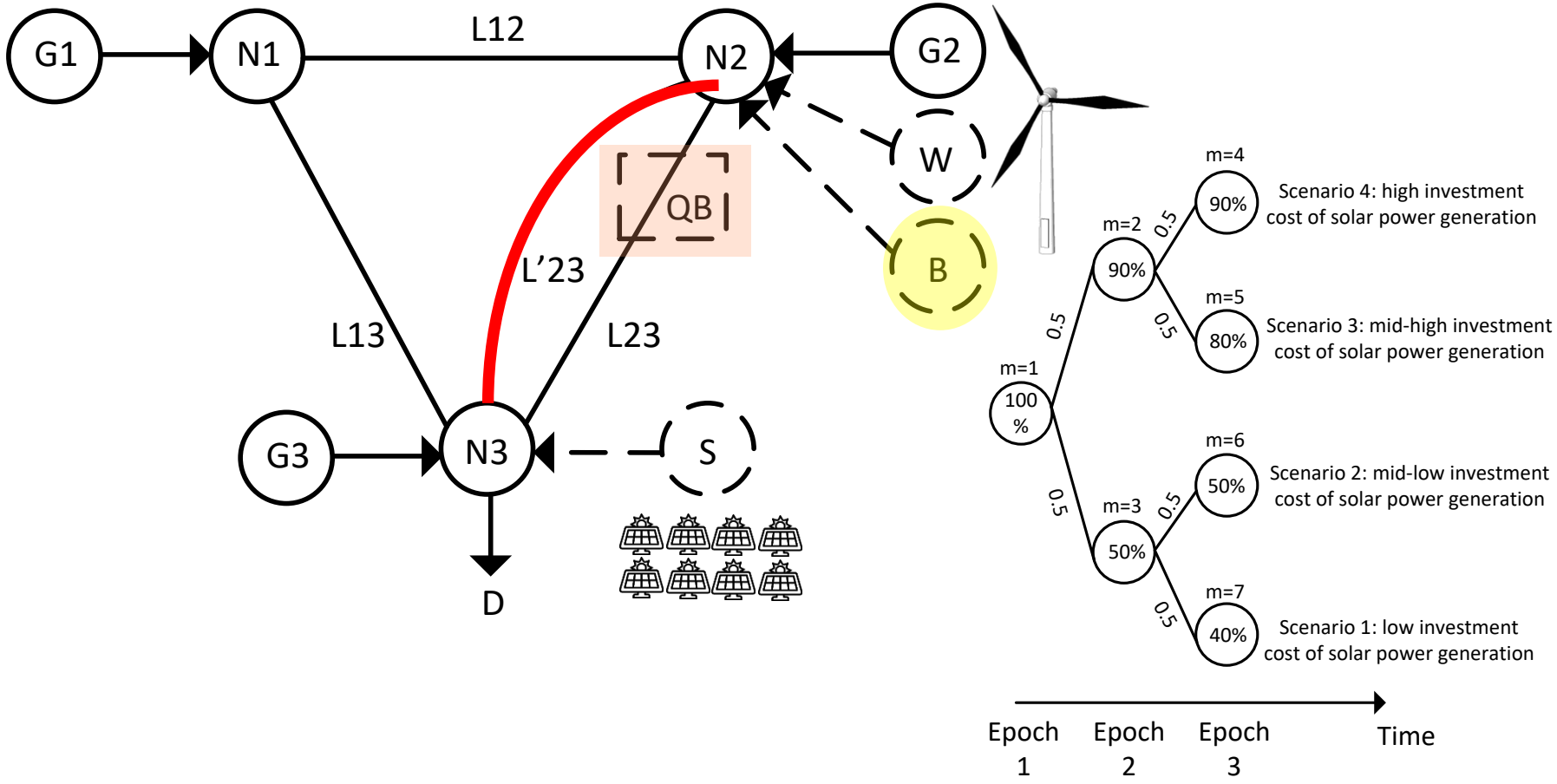




R. Moreno, *et al.*, "Planning Low-Carbon Electricity Systems under Uncertainty Considering Operational Flexibility and Smart Grid Technologies", *Philosophical Trans. Royal Society A*, June 2017

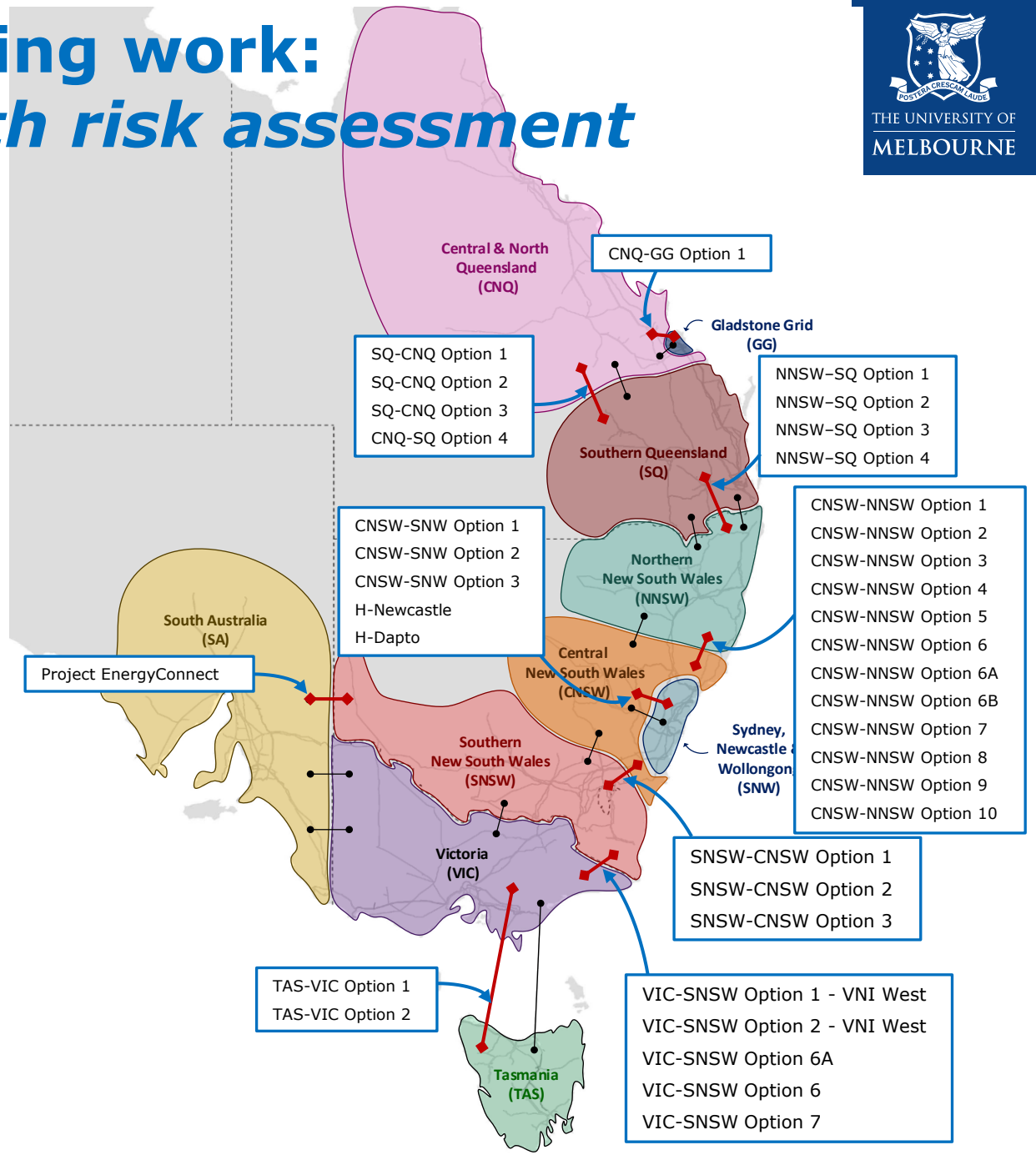
… a flexible, *stochastic* planning methodology unlocks the *option value of proactive* investments

Wire and *non-wire* solutions!



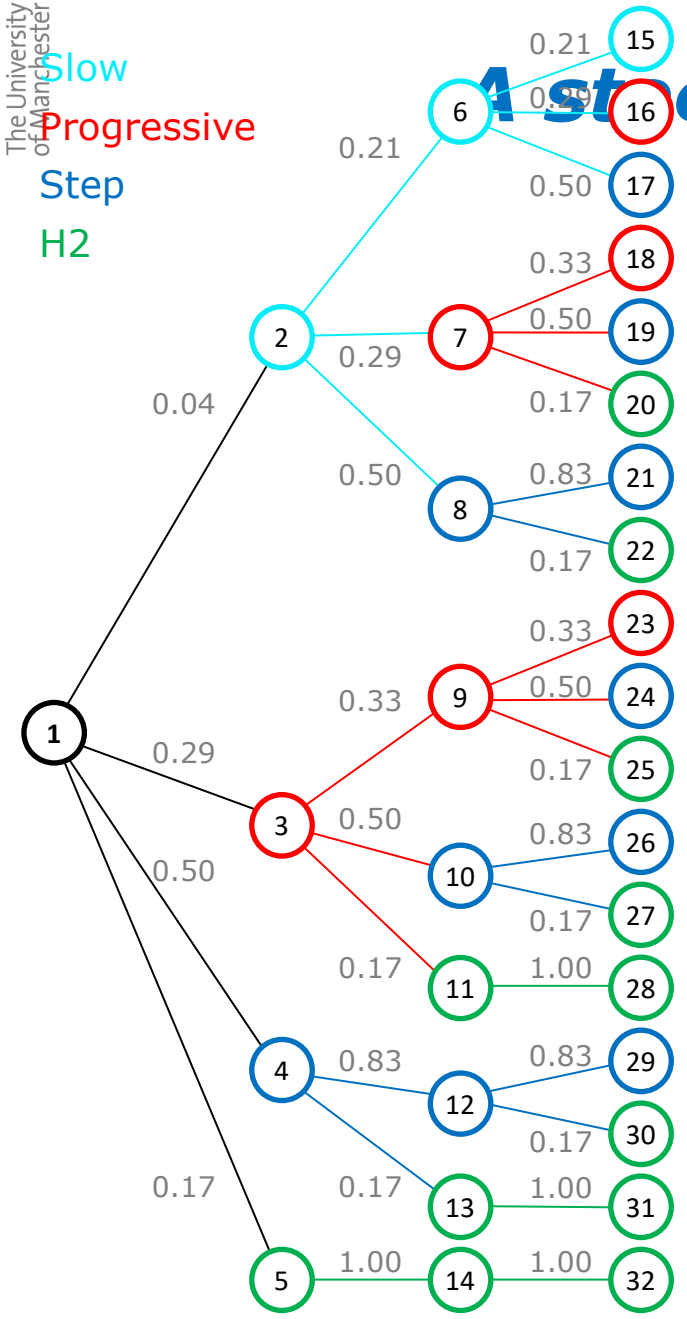
R. Moreno, *et al.*, "Planning Low-Carbon Electricity Systems under Uncertainty Considering Operational Flexibility and Smart Grid Technologies", *Philosophical Trans. Royal Society A*, June 2017

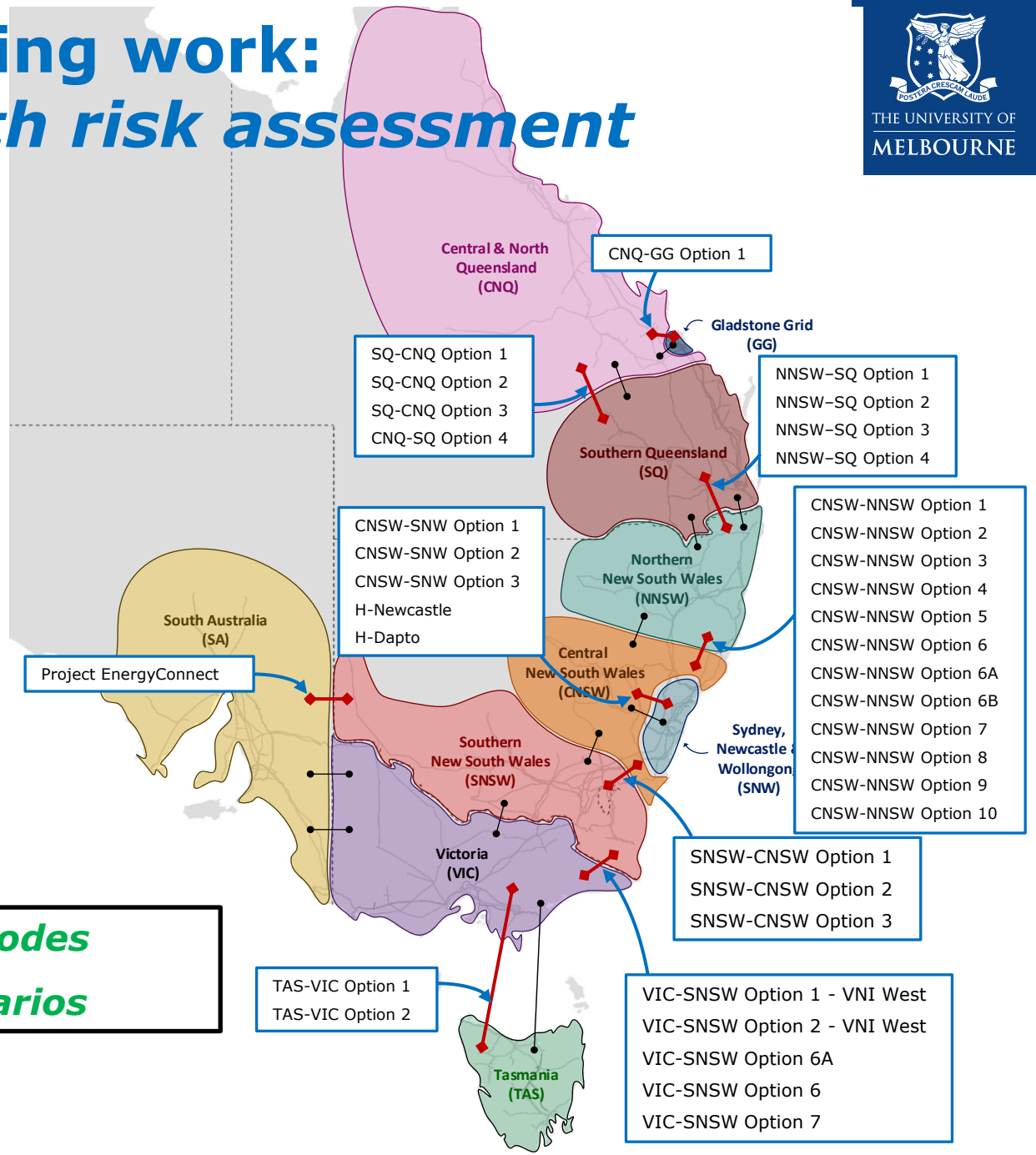
GPST ongoing work:
A stochastic ISP with risk assessment



GPST ongoing work:
A stochastic ISP with risk assessment

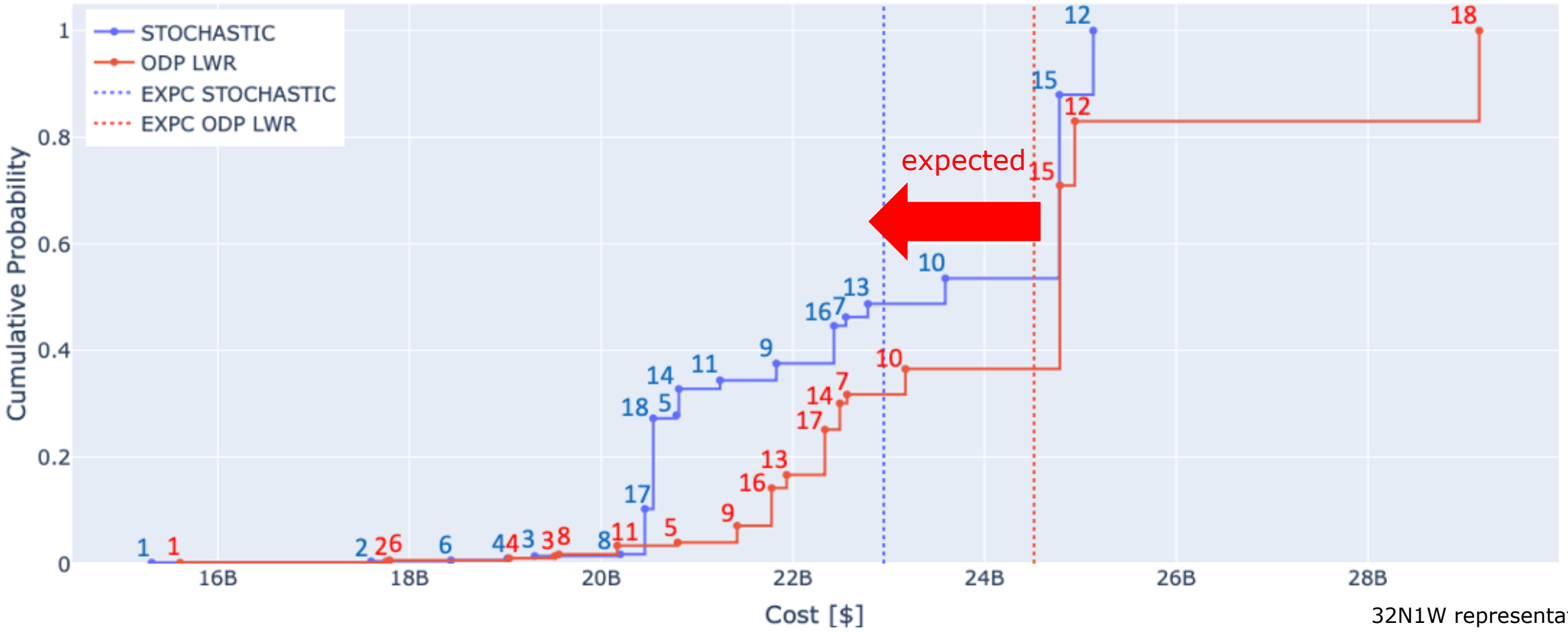
Slow
Progressive
Step
H2





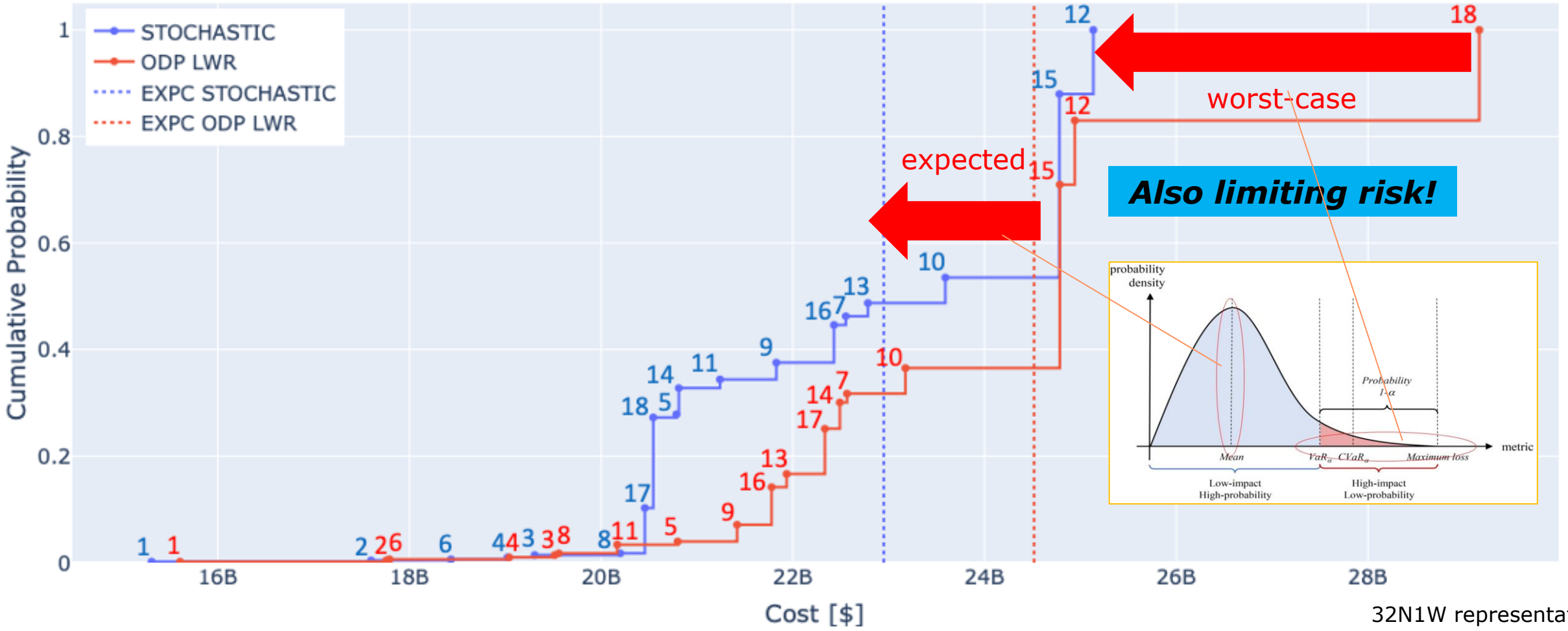
- ***4-stage tree – 32 nodes***
- ***18 equivalent scenarios***

Comparison between stochastic and LWWR optimal development paths



A stochastic plan enables identification of investment portfolios with better techno-economic performance against different future scenarios

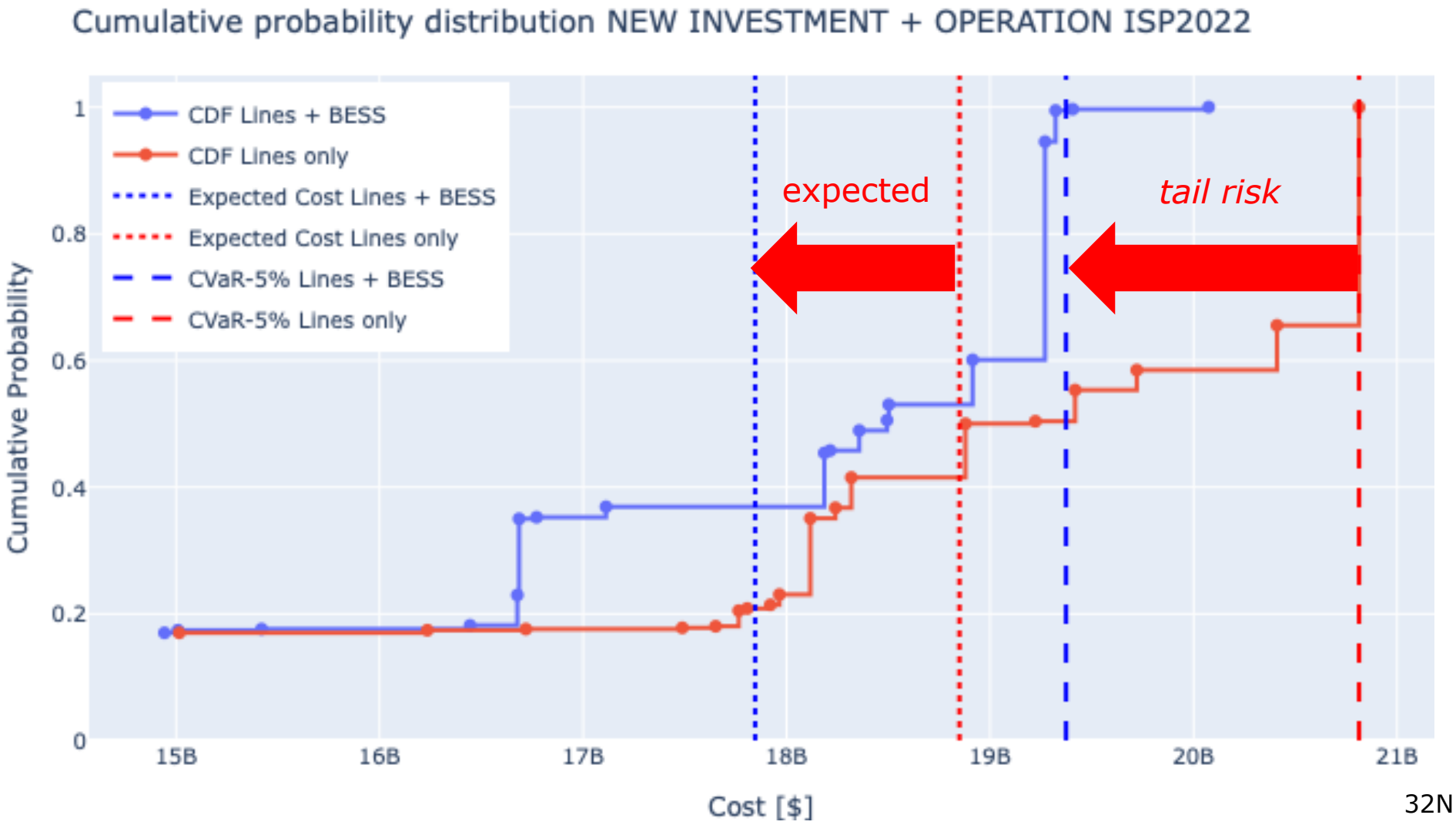
Comparison between stochastic and LWWR optimal development paths



32N1W representation

A stochastic plan enables identification of investment portfolios with better techno-economic performance against different future scenarios

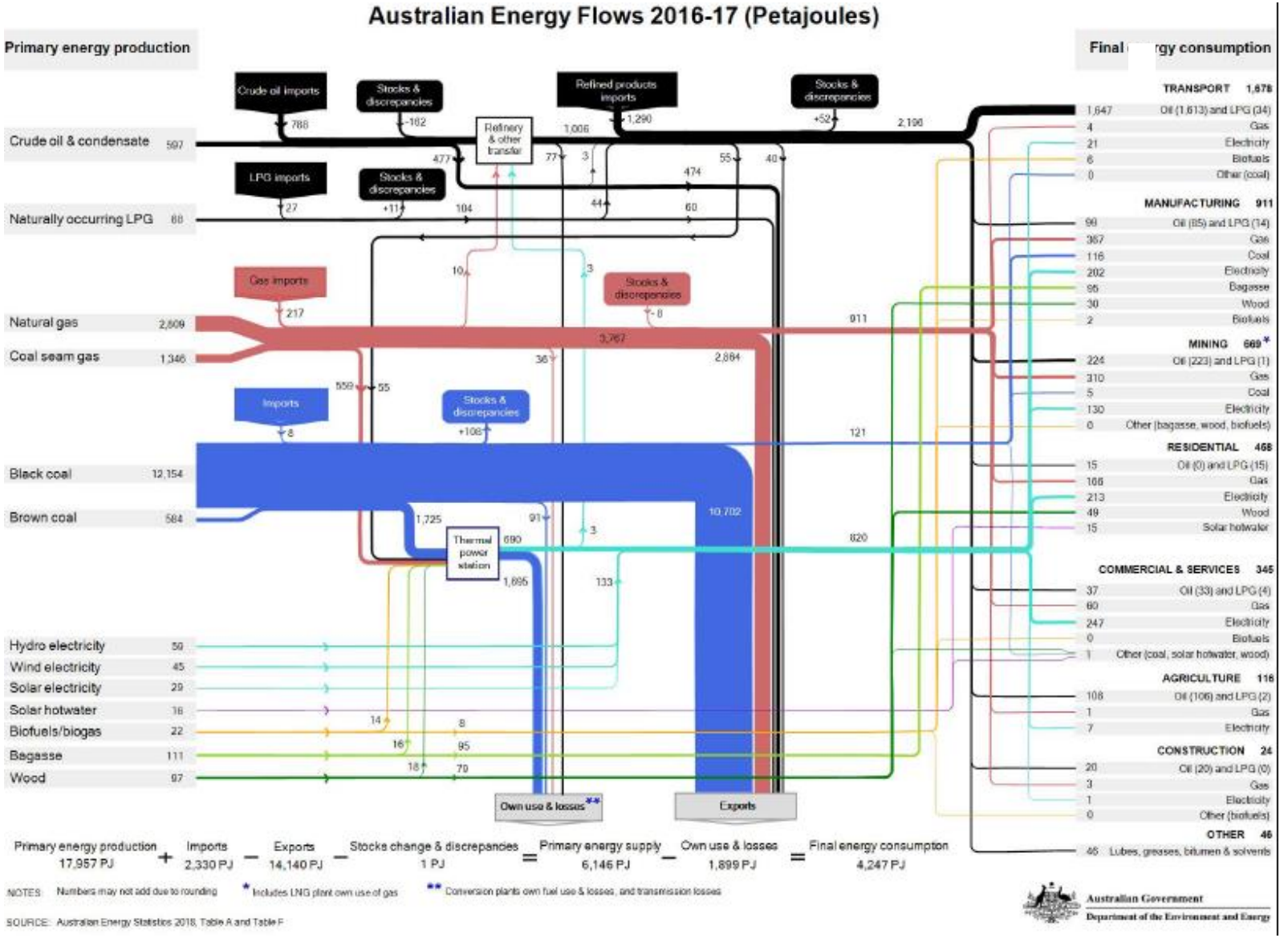
Storage complements transmission, *reducing expected cost and risk*



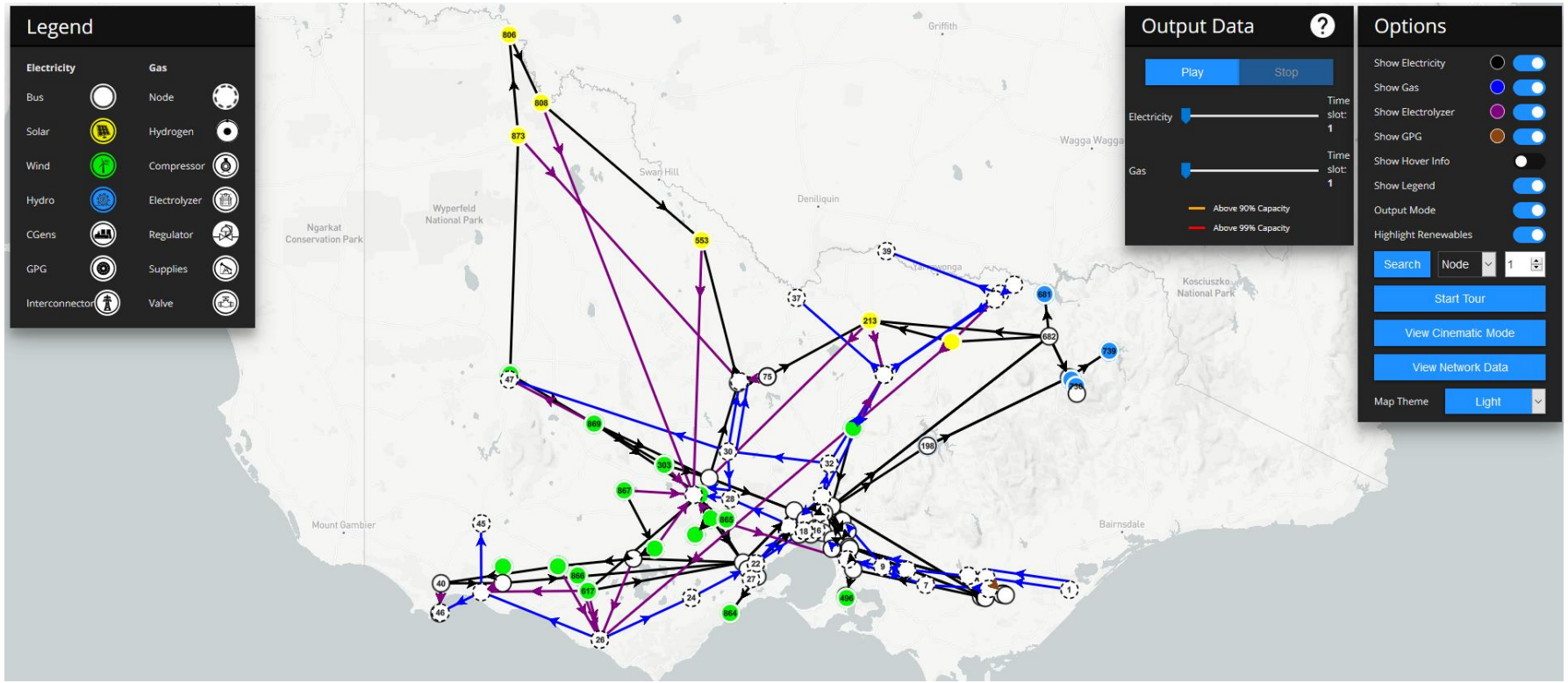
32N1W representation

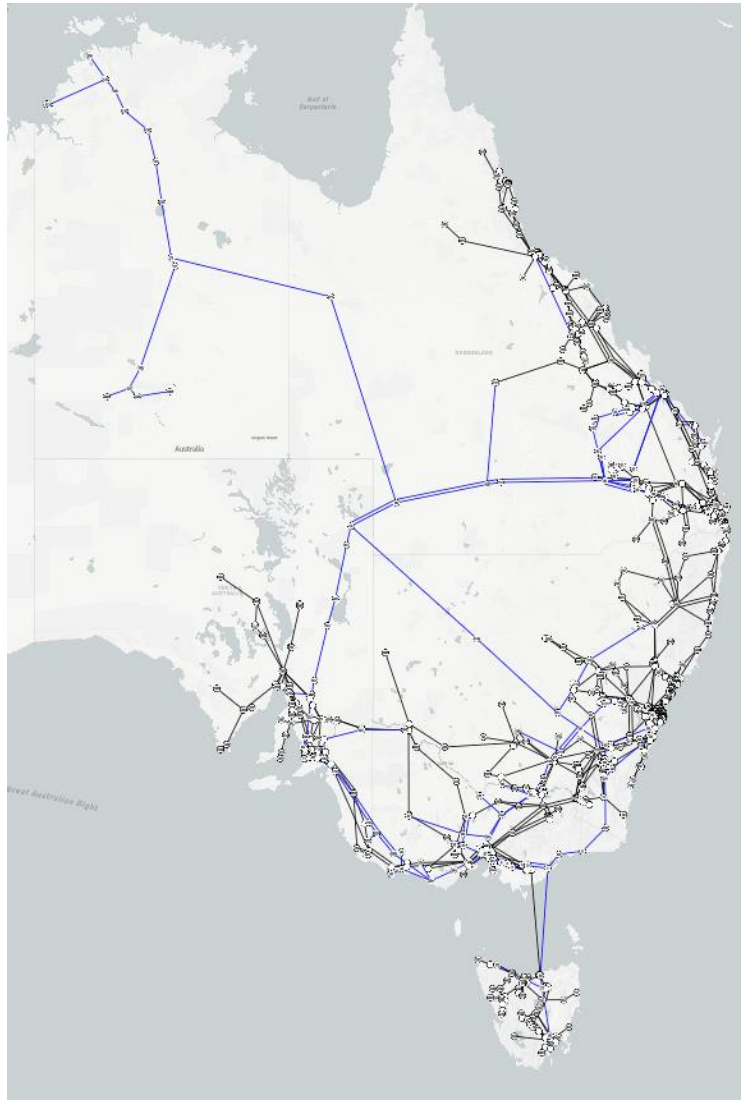
A stochastic plan helps manage risk and extract the risk-hedging value of new technologies

Eye on the superpower!



Integrated energy vector modelling





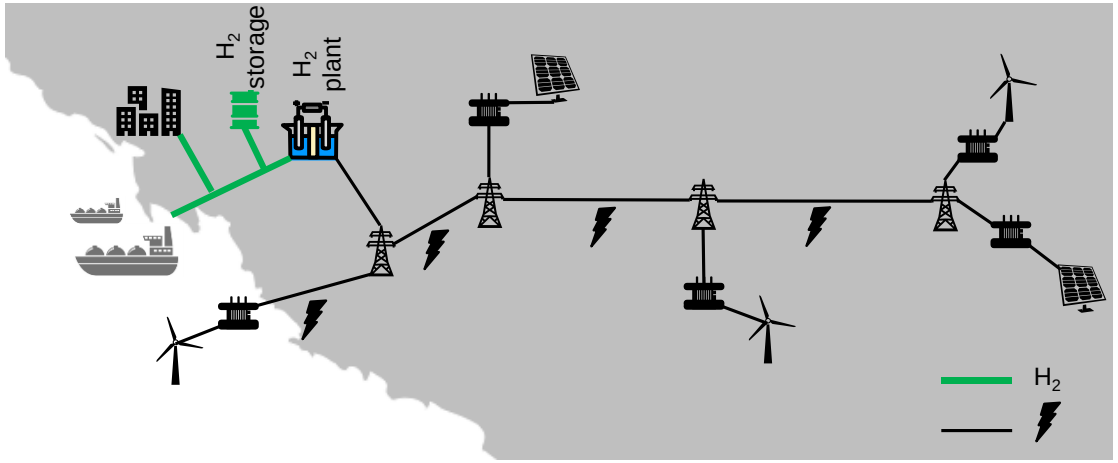
I. Saedi, *et al.*, "Integrated Electricity and Gas System Modelling with Hydrogen Injections and Gas Composition Tracking", *Applied Energy*, 2021

S. Mhanna, *et al.*, "Iterative LP-based Methods for the Multiperiod Optimal Electricity and Gas Flow Problem", *IEEE Trans. on Power Systems*, 2021

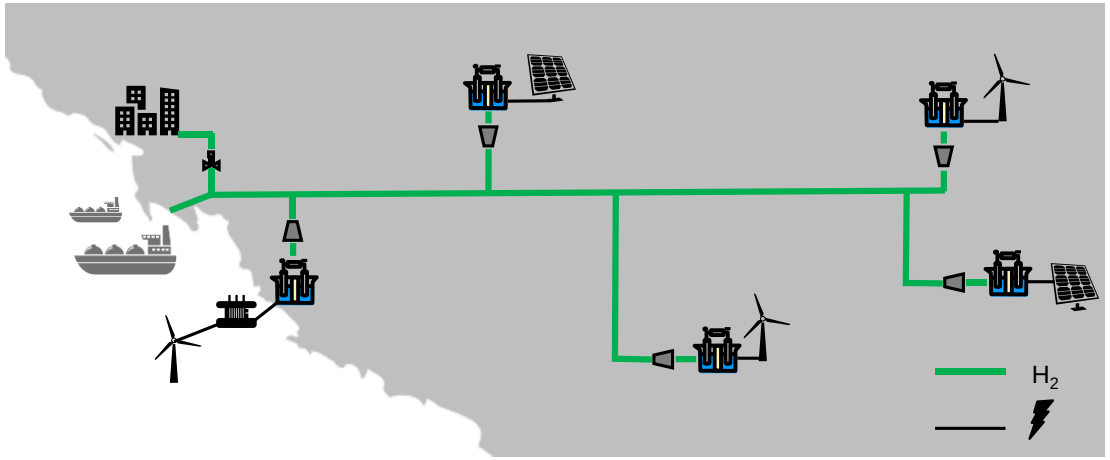
Courtesy of Future Fuels CRC

Do we move electrons or molecules?

Centralised H_2 production…



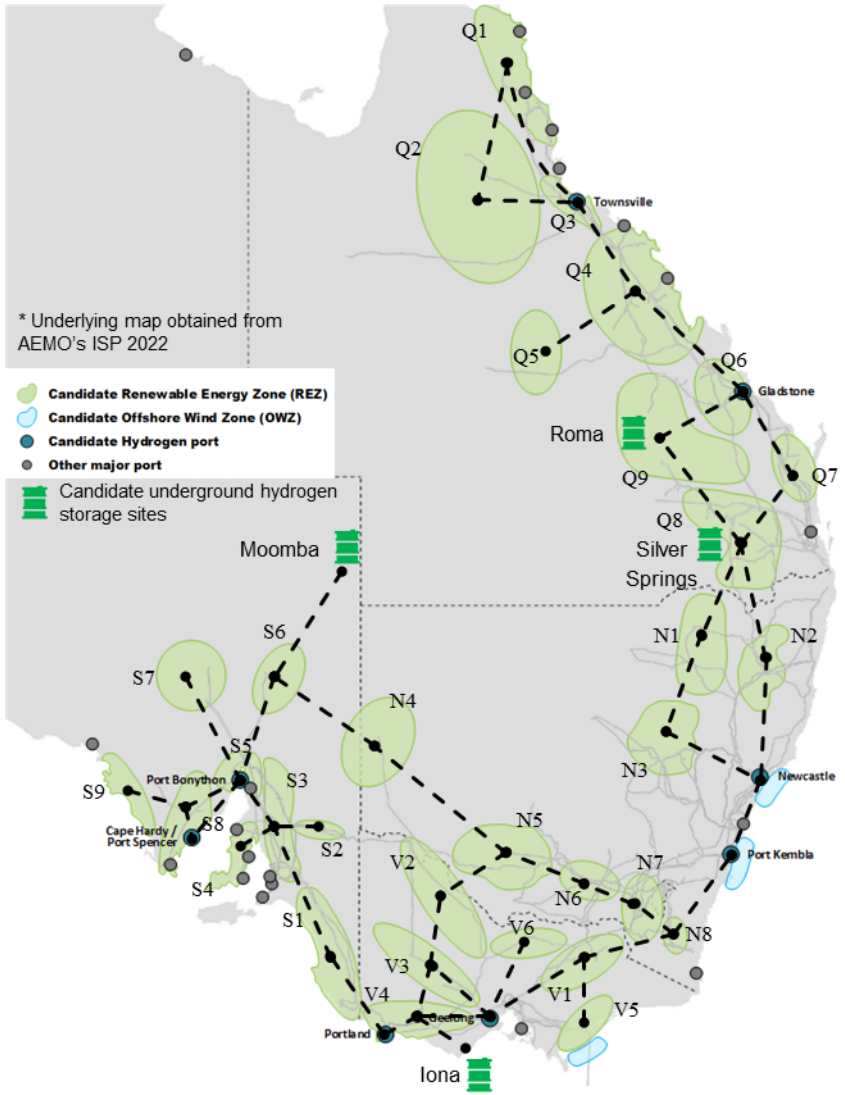
… or distributed?

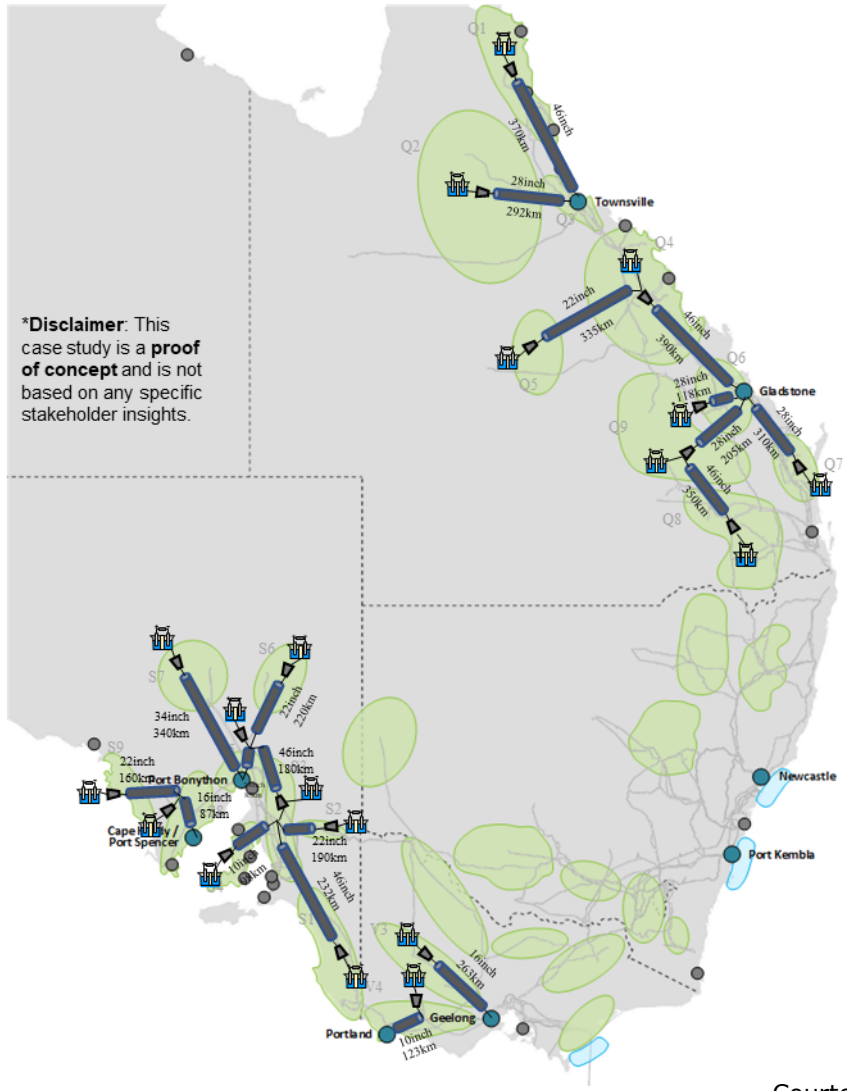


S. Mhanna, *et al.*, "Iterative LP-based Methods for the Multiperiod Optimal Electricity and Gas Flow Problem", *IEEE Trans. on Power Systems*, 2021

Courtesy of Future Fuels CRC

Whole-system planning:
Electricity, gas, hydrogen and other commodities

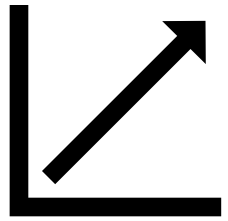




Courtesy of Future Fuels CRC

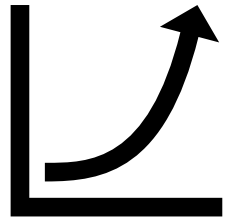
How much and what storage do we need?

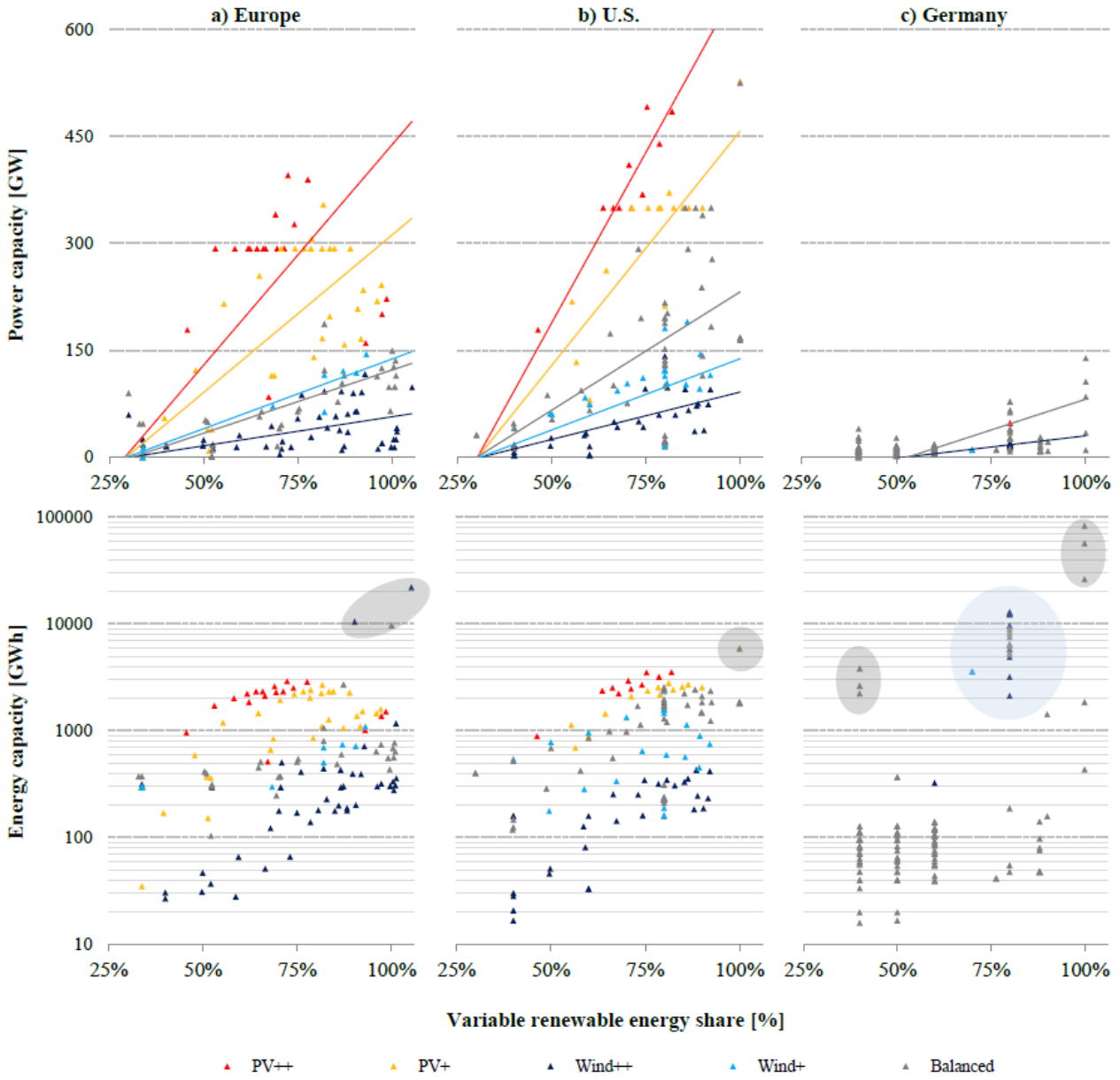
GW



Renewables penetration

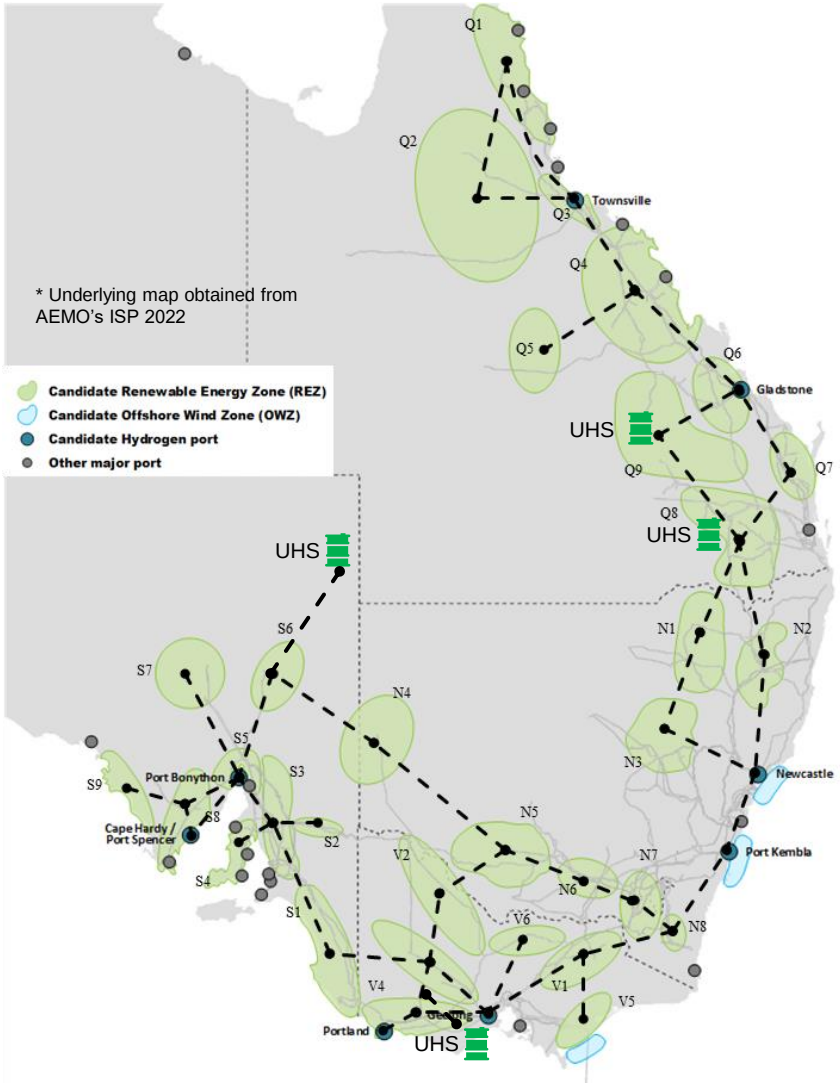
GWh





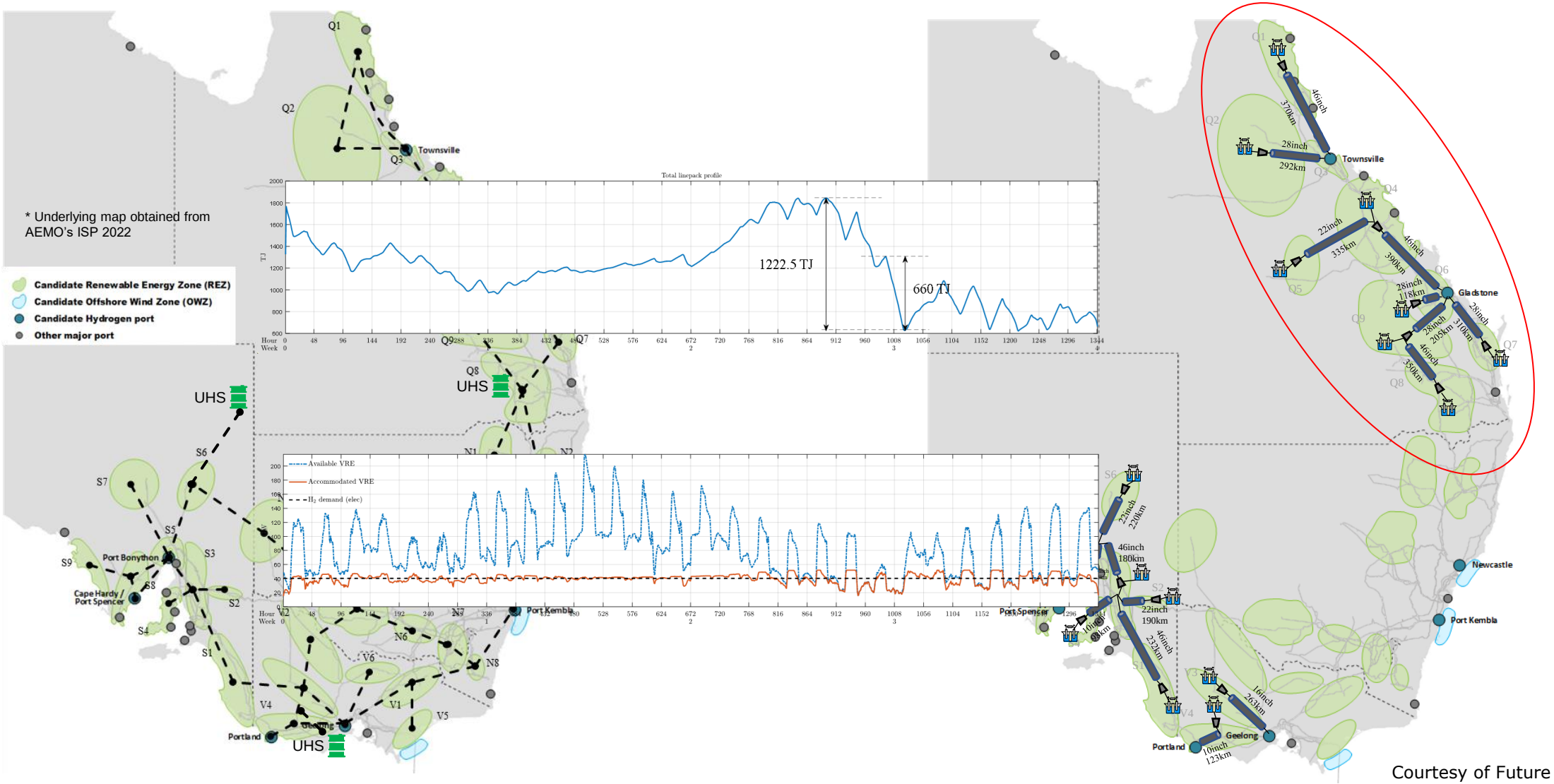
F. Cebulla, *et al.*, "How much electrical energy storage do we need?", *Journal of Cleaner Production*, Volume 181, 20 April 2018, 449-459

Whole-system planning:
Electricity, gas, hydrogen and other commodities



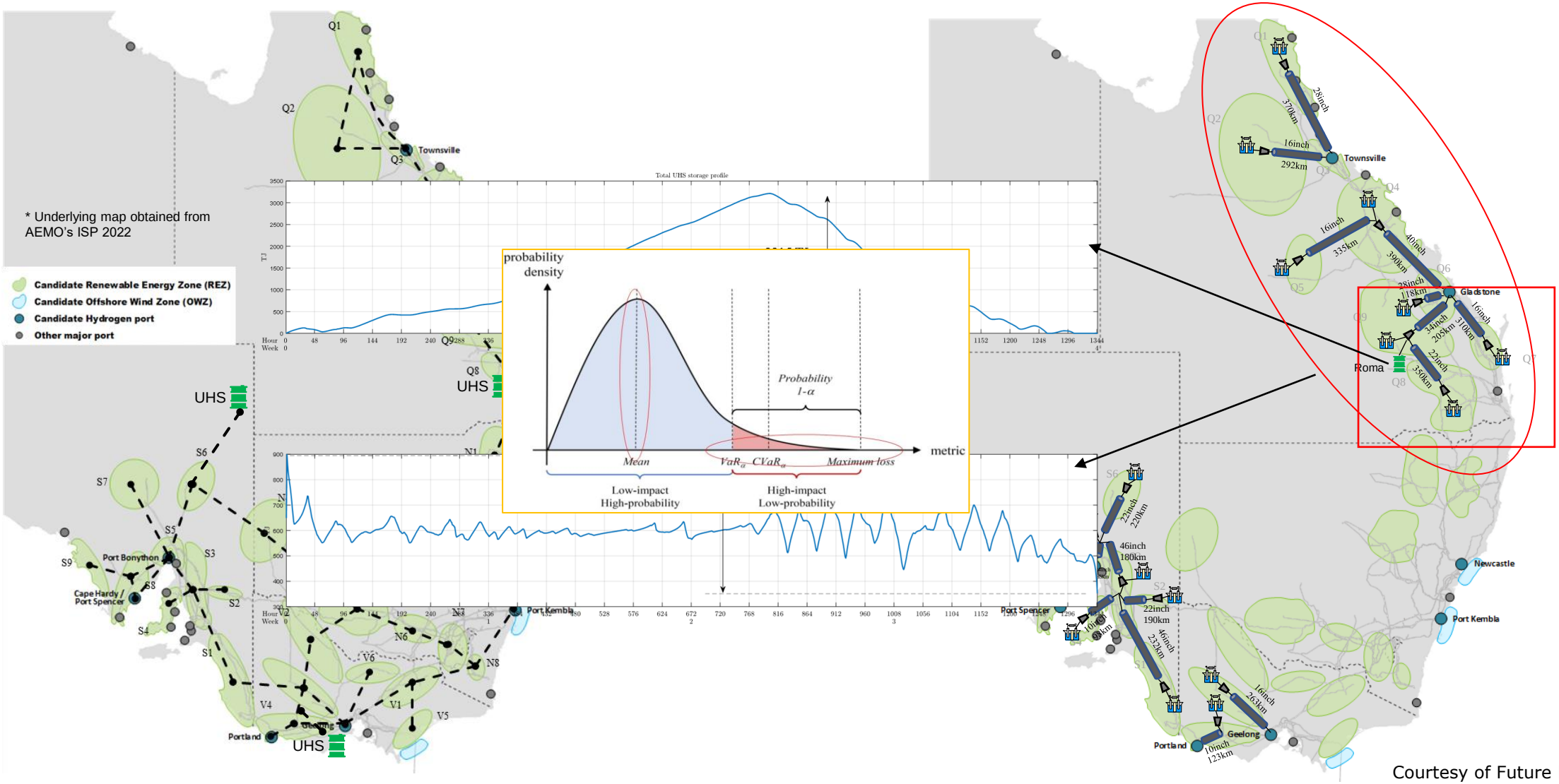
Courtesy of Future Fuels CRC

Whole-system planning:
Electricity, gas, hydrogen and other commodities



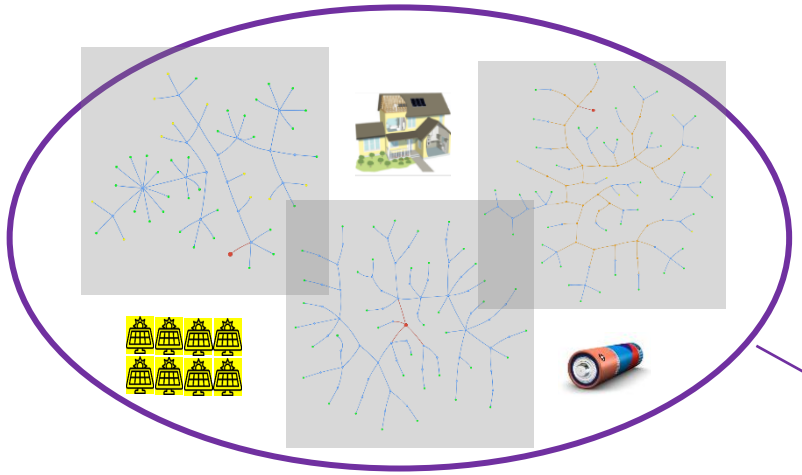
Courtesy of Future Fuels CRC

Whole-system planning:
Electricity, gas, hydrogen and other commodities

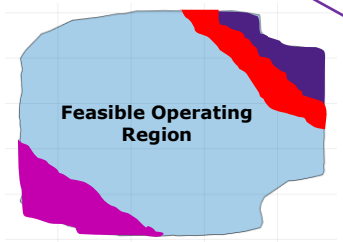


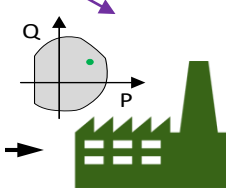
Courtesy of Future Fuels CRC

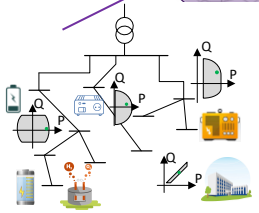
Whole-system planning:
DER and investment co-optimization



DSO





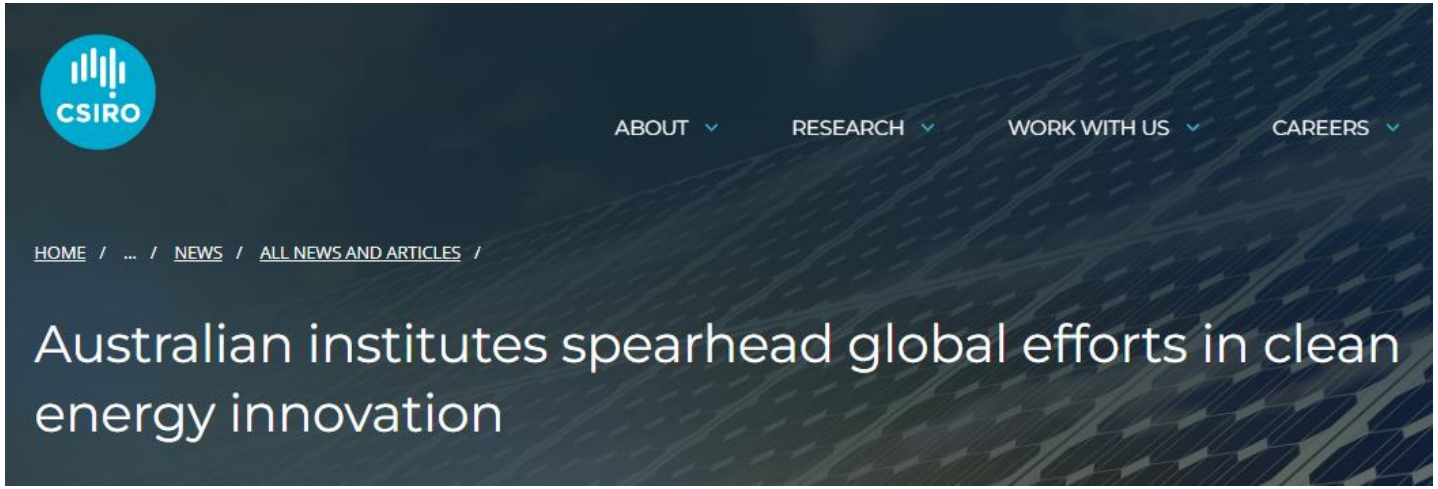


NSF Global Centre on Climate Change and Clean Energy

Electric Power Innovation for a Carbon-free Society (EPICS)

New Global Research Centre to provide EPIC clean energy boost

The new Electric Power Innovation for a Carbon-Free Society (EPICS) Centre will address challenges in clean energy production and storage.



https://www.csiro.au/en/news/All/News/2023/September/Australian-institutes-spearhead-global-efforts-in-clean-energy-innovation

https://www.unimelb.edu.au/newsroom/news/2023/september/new-global-research-centre-to-provide-epic-clean-energy-boost

Acknowledgments

- CSIRO, AEMO, and the GPST consortium
- Future Fuels CRC
- The AEMC
- National Grid ESO, UK
- My research team, and in particular Dr Sebastian Puschel, Dr Sleiman Mhanna, Mr Pablo Apablaza Donoso

Thank you!

Feedback Survey Webinar 1 – Planning with Purpose

See you soon!

Webinar 2
Demand-side solutions for a least-cost transition

13 October
9am-10.30am AEDT

Webinar 3
Integrating transmission and distribution planning

20 October
9am-10.30am AEDT

Webinar 4
The future of gas network planning

27 October
9am-10.30am AEDT

ENERGY CONSUMERS AUSTRALIA

Energy Consumers Australia

A **national voice** for residential and small business energy consumers.

We work to **understand and ensure consumers have their expectations and needs met** through a modern, flexible and resilient energy system.

We proactively shape a vision for the future, **influence and work with others** to drive change across the energy system to benefit consumers.

We influence the shape of the energy system **now and in the future** by **creating a trusted voice** for residential and small business consumers.