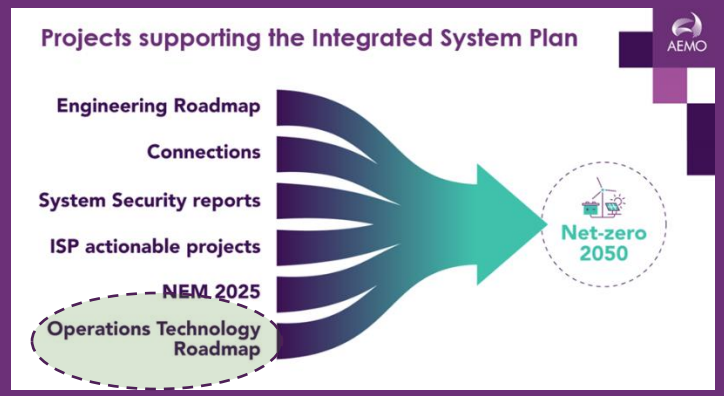


Operations Technology Program

Executive Joint Planning Committee (EJPC)

25th May 2023

We acknowledge the Traditional Owners of country throughout Australia and recognise their continuing connection to land, waters and culture.

We pay respect to their Elders past, present and emerging.

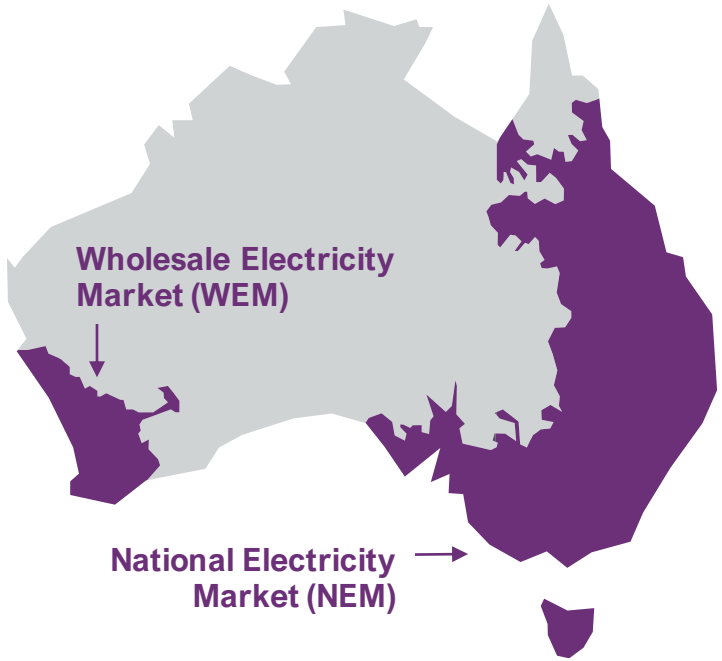
About AEMO

- AEMO is a member-based, not-for-profit organisation.
- We are the independent energy market and system operator and system planner for the National Electricity Market (NEM) and the WA Wholesale Electricity Market (WEM).
- We also operate retail and wholesale gas markets across south-eastern Australia and Victoria's gas pipeline grid.

AEMO SERVICES

AEMO Services is an independent subsidiary of AEMO, established in 2021 to enable the transparent provision of advisory and energy services to National Electricity Market jurisdictions.

Electricity



Gas

Declared Wholesale Gas Market (DWGM)

Short Term Trading Market (STTM)

and

Gas Supply Hub (GSH)

Operations Technology Program

Alignment to our Corporate Plan

PRIORITY 1

Operating today's systems and markets

PRIORITY 2

Navigating the energy future

PRIORITY 3

Engaging our stakeholders

PRIORITY 4

Evolve the way we work

Strategic Objectives

Priority 1 – Operating today's systems and markets

Deliver our core responsibilities in accordance with electricity, gas and other laws and regulations.

Our primary role is to ensure that Australia's energy systems and markets are operated reliably and securely every day.

In an environment where day-to-day operation of the nation's energy systems and markets has never been more challenging, AEMO will maintain our focus on constantly adapting our operations through FY2022 and meeting this ongoing commitment to Australian consumers.

We will maintain and enhance our focus on effective real-time system and market operations, power system resilience, cyber security and robust market and system intelligence.

How we will achieve this priority:

1. System and market operations

We ensure Australia's energy systems and markets can be securely and reliably operated under all foreseeable conditions.

In addition to delivering effective day-to-day real-time system and market operations, AEMO will:

- **Engage on, and manage emerging power system resilience issues** through cost-effective measures that improve the ability of the power system to ride through extreme events.
- **Ensure operational plans are in place** to manage increasingly common challenges that stem from a changing energy mix, including minimum electricity demand, lower levels of synchronous generation, and new ways to optimise ancillary services to maintain system strength and security.

2. Energy system and market insights

We publish statutory publications, reports and energy and market intelligence to the satisfaction of our stakeholders.

- **Deliver quality, timely reports and publications** that are valuable to AEMO stakeholders.

3. System and market technologies

We leverage technological innovations, uplift systems and invest in advanced analytics and forecasting capabilities to improve the efficient and secure operation of energy systems and markets.

Significant investment is being made to better deliver system performance at a reduced cost.

- **Upgrade and/or replace legacy grid and market IT systems** with more intelligent and scalable technology that meets the evolving demands of the industry.
- **Enhance our forecasting and real-time operations capabilities** to streamline control room decision-making processes. New technologies will provide access to timely and accurate data, advanced analytics and workflow-driven visualisations and forecast through a common platform.
- **Ensure enhancements to IT systems and procedures can manage the energy system** at lower levels of demand, synchronous generation dispatch and increasing levels of variability (including improved forecasting).

4. Cyber security

We work with government and industry to safeguard AEMO's and Australia's energy systems and data from malicious intent and intrusion.

- **Mature our cyber security capability** by enhancing our monitoring and detection of malicous activities through automated tools and Security Operations centre and enhancing our threat response by upgrading system recovery and back up options.
- **Actively engage with governments and industry to strengthen cyber security** by supporting industry insights and readiness assessments regarding cyber threats and activities, providing input into Commonwealth Critical Infrastructure Systems of National Significance Legislation, and sharing cyber information with members.

A Critical Decade of Change

Australia is experiencing the world's fastest and most profound power system transformation.

The '4 x Ds' of **decarbonisation**, **digitisation**, **democratisation** and **decentralisation** are directly impacting the system, accelerated by a complex range of societal, technological, economic and commercial shifts.

In recognition of the sheer pace and scale of change now confronting Australia's power systems, EF notes:

"Traditional, legacy approaches will need to be maintained in the near term, but inherent structural limitations will eventually constrain the pace of transition. Parallel to this, it is critical that designing a step change in power system capability starts today"

Daniel Westerman, AEMO's CEO

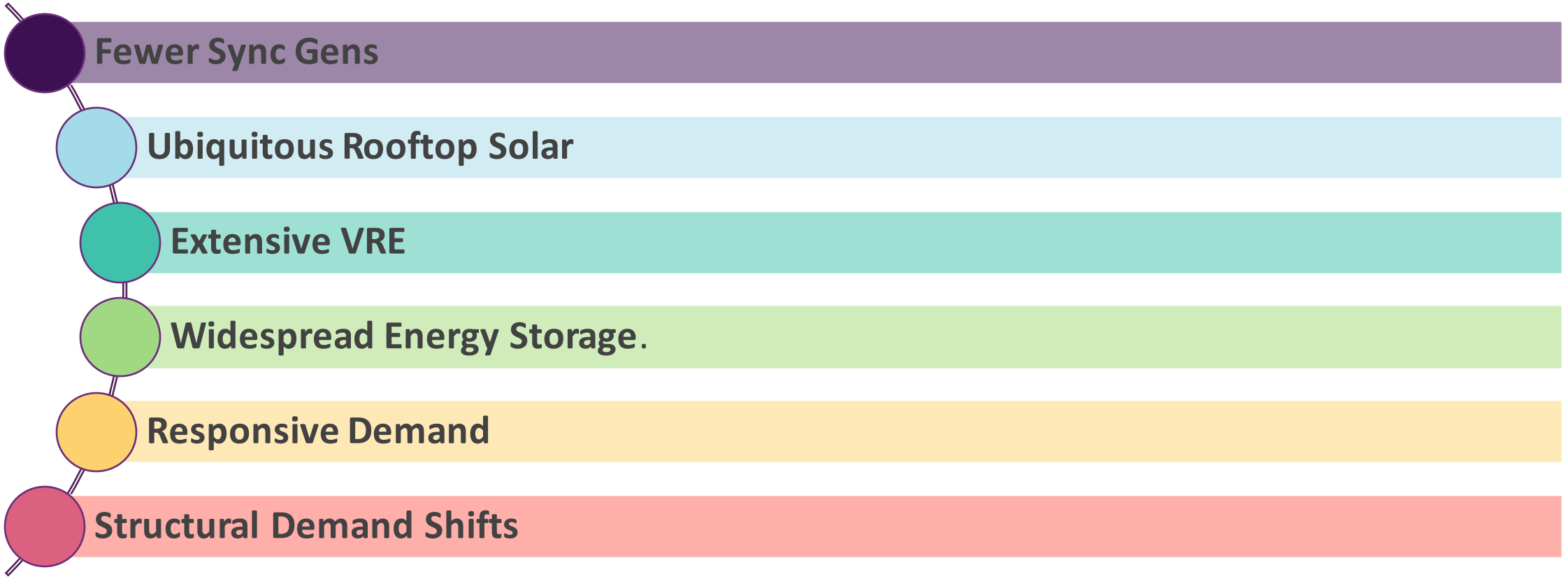
"It is a stunning democratisation of power."

"It's a transformation: turning historically passive electricity consumers into active generators."

"And a capital transfer, too. Power infrastructure investment decisions that were once the preserve of our nation's boardrooms are now being made around the kitchen tables in our towns and suburbs."

How the Operational Need is Changing

Engineering Framework Operational Conditions



The six identified future operational conditions from AEMO Engineering Framework, https://aemo.com.au/-/media/files/initiatives/engineering-framework/2021/nem-engineering-framework-initial-roadmap.pdf?la=en&hash=258E0F1A2E8E6EE6C00437E75BB170FF

Operations Technology Program

Uber Problem Statement…

How might we maintain system security & reliability in an increasingly complex network of more connections, more devices, more data, more variability and less time to respond to external events?

Operations Technology Program

Quick Recap on Journey To Date

The OTR focusses on the control room responsibilities for operating the grid, as well as the supporting functions of Operations -planning, -forecasting, -monitoring, -reporting and analytics. It includes software, hardware, data and automation requirements. The OTR places emphasis on the importance of cultivating a dexterous workforce through a technology architecture that empowers self-taught innovation, and expediates development of agile, modular, robust software systems which can continue to adapt to the ongoing energy industry evolution.

energy transition for the NEM and WEM, and to develop a roadmap for bridging the identified capability gaps. Development of the roadmap provided an opportunity for Operations to reflect on the capabilities required to operate an evolving system and to consider tools being developed by System Operators globally. This led to a more mature understanding of the investment required over a 5 – 10 year horizon, and dependencies on supporting initiatives such as uplift of data and model quality. The roadmap was developed in conjunction with the Engineering Framework (EF), ESB NEM 2025, and Digitals' Future State Architecture (FSA). For WA, the WEM Reform target state serves as a baseline upon which the WEM roadmap can build.

3. BACKGROUND

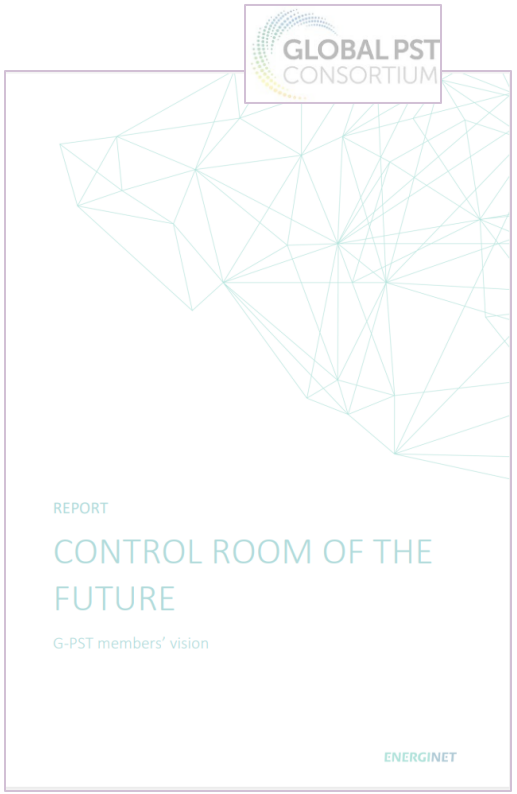
The first paper was presented to the TARC in August 2021 (agenda item 7), followed by an update in February 2022 (agenda item 4.1). As at May 2022, a final draft of the roadmap is under review and a summary report (Attachment 1) is planned for publication in June 2022.

The OTR focusses on the control room responsibilities for operating the grid, as well as the supporting functions of Operations -planning, -forecasting, -monitoring, -reporting and analytics. It includes software, hardware, data and automation requirements. The OTR places emphasis on the importance of cultivating a dexterous workforce through a technology architecture that empowers self-taught innovation, and expediates development of agile, modular, robust software systems which can continue to adapt to the ongoing energy industry evolution.

Nov 21 — Jun 22 — Jun 22 — May 23

Operations Technology Program

Quick Recap on Journey To Date



Nov 21

Jun

Acknowledgements

The project team would like to acknowledge and thank everybody involved in the development and production of the OTR. It was truly a collaborative effort across all organisations.

In particular, and in no order

AEMO: Luke Robinson, Tjaart van der Walt, Karin Rodrigues, Tony Chenco, Teresa Smit, Darren Spoor, Basilisa Choi, Maddy Binet

And the many people not mentioned who gave their time and effort to contribute to the document.

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Operations Technology Program

About the Global Power System Transformation Consortium

Global Power System Transformation (G-PST) Consortium

In 2019, the CEOs of the six fastest decarbonizing energy systems in the world established the G-PST Consortium.

AEMO · California ISO · EirGrid GROUP · ENERGINET · nationalgridESO · ercot

G-PST's Role

Convene expertise across
- A network of system operators,
- Manufacturers
- utilities
- Standards bodies,
- Research institutions

Coordinate and contribute expertise to its technical pillars and inform G-PST's strategic approach.

Lead and disseminate cutting-edge, applied research to solve pressing challenges for the world's leading system operators

They aim to accelerate solutions that

- Enable grids across the world to run on 100% renewable energy
- Help keep global temperature rises below 1.5°C

G-PST also coordinates peer learning networks and country-level technical assistance delivery efforts for Africa, Asia, and Latin America and the Caribbean through regional partner organisations.

Current G-PST's secretariat:
The U.S. Department of Energy's National Renewable Energy Laboratory

International agencies and multilateral and regional development banks are key implementing partners to ensure G-PST activities complement and reinforce existing programs.

Operations Technology Program

Latest Vision for the Control Room of the Future Report continues to inform our thinking

New

GLOBAL PST CONSORTIUM

Vision for the

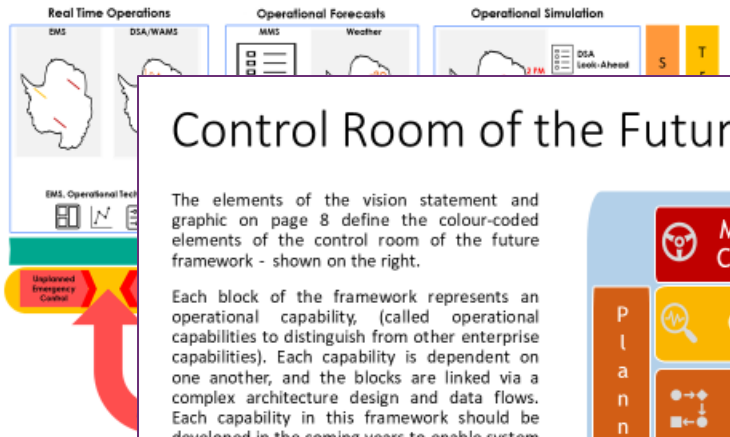
A product of the Global Po

Control Room of the Future Vision Statement

Accurate, validated, centrally managed, dynamic models, and streamlined operational data, feed the operational technology (OT) toolkit in a modularized, service-oriented architecture. The operational toolkit provides secure automated control actions to network assets and market participants, with decision support to allow operators to adjust the system or intervene if necessary.

The OT toolkit has parallel processes for reliability and security assessment in real time, and for forecasted future states to be assessed by the operator, allowing them to adjust the system ahead of time. Machine learning applications, trained on operational datasets, are deployed to enhance the monitoring and assessment domains of operation and decision support.

Manual processes are automated and there should be clear linkage between both, as well as processes in the operational and training simulator or operations readiness centre. Each process should have a consistent display design on leading edge display equipment within secure and pandemic-resilient control room facilities.



Operators focus o
trajectories in para
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have advanced kn
forecasted risks.

G-PST Vision for C

Control Room of the Future Capabilities

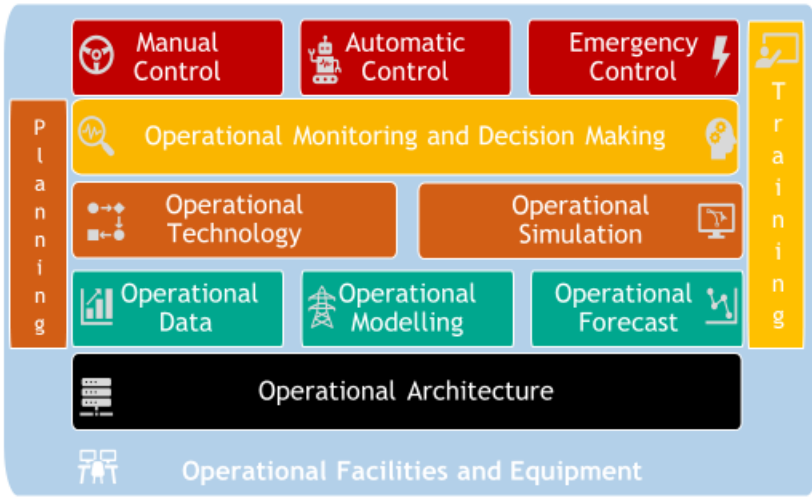
The elements of the vision statement and graphic on page 8 define the colour-coded elements of the control room of the future framework - shown on the right.

Each block of the framework represents an operational capability, (called operational capabilities to distinguish from other enterprise capabilities). Each capability is dependent on one another, and the blocks are linked via a complex architecture design and data flows. Each capability in this framework should be developed in the coming years to enable system operation of the network of the future.

The control room operators are in the control loop focusing on:

- Monitoring and decision making
- Operational processes and the operational technology toolkit for reliability and security risk assessment
- Control (manual, automatic and emergency)

These domains will be expanded upon in the following sections.



G-PST Vision for Control Room of the Future 9

Control Room of the Future (CROF)

Vision Statement

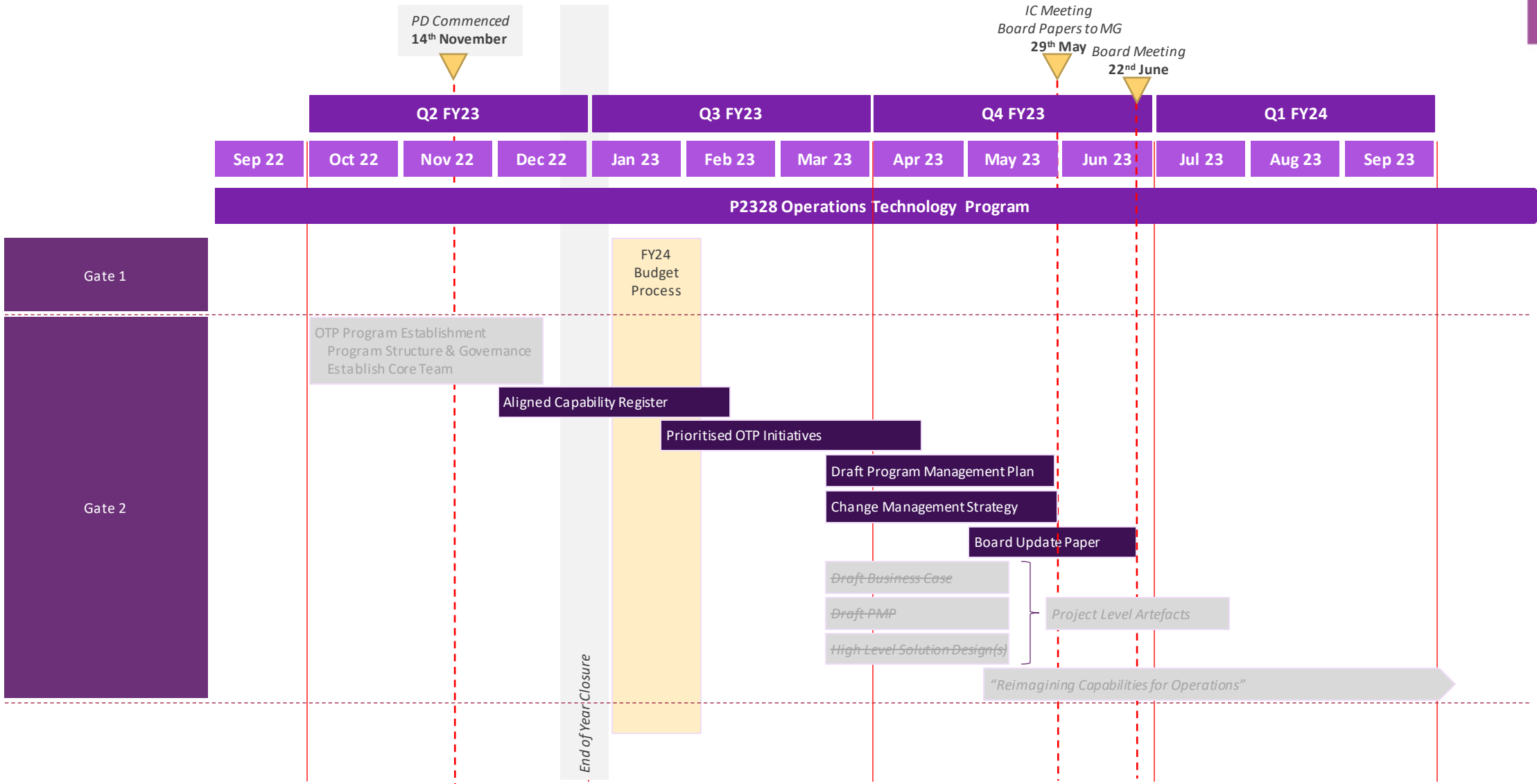
"A secure, flexible, adaptable, space where systems are integrated, interoperable and automated. All resources are maximised, and personnel are highly trained, in simulators to make data-driven decisions based on accurate forecasts."

Purpose

Secure, reliable, resilient, safe and flexible operations, which facilitate a goal of 100% renewable operation

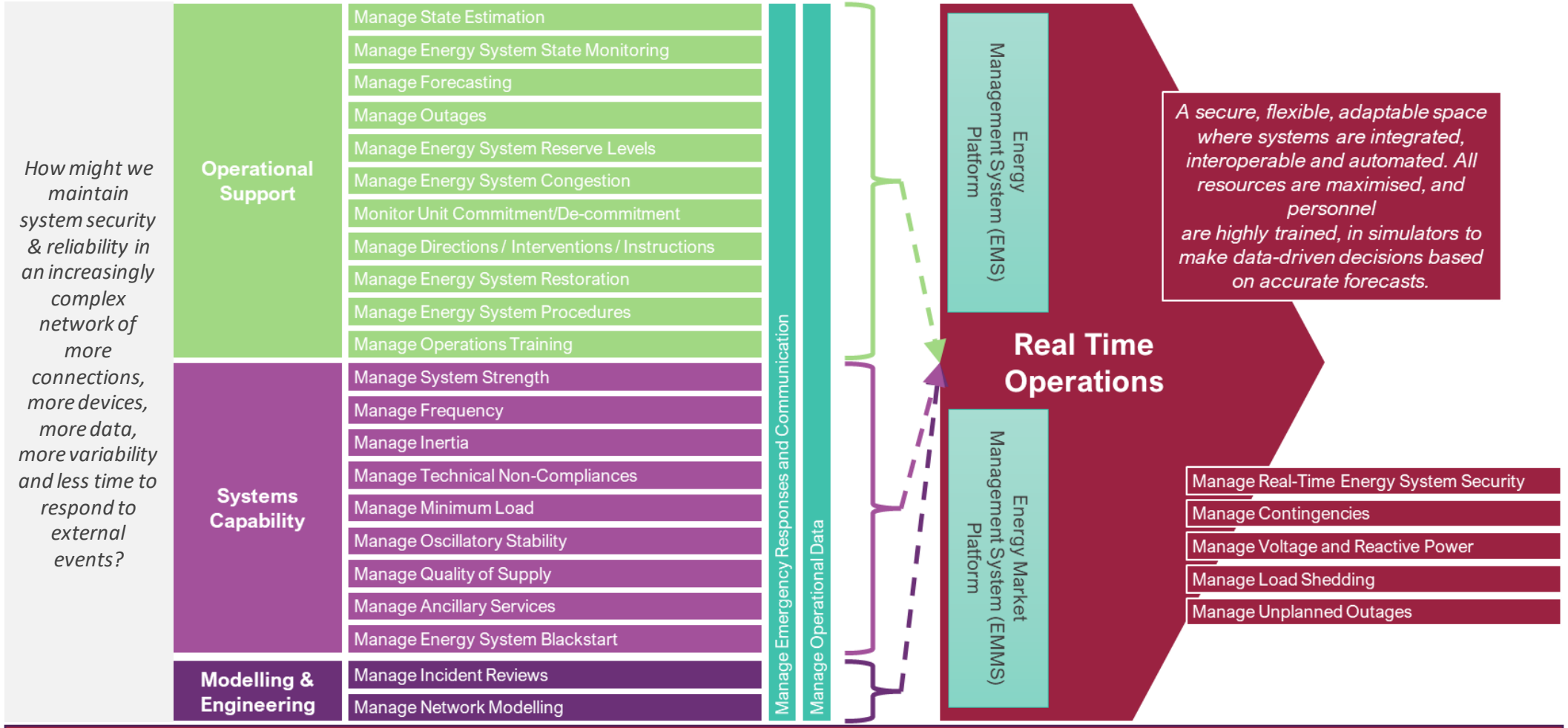
Operations Technology Program

Bringing the Vision and the Roadmap to life…



Control Room of the Future (CROF)

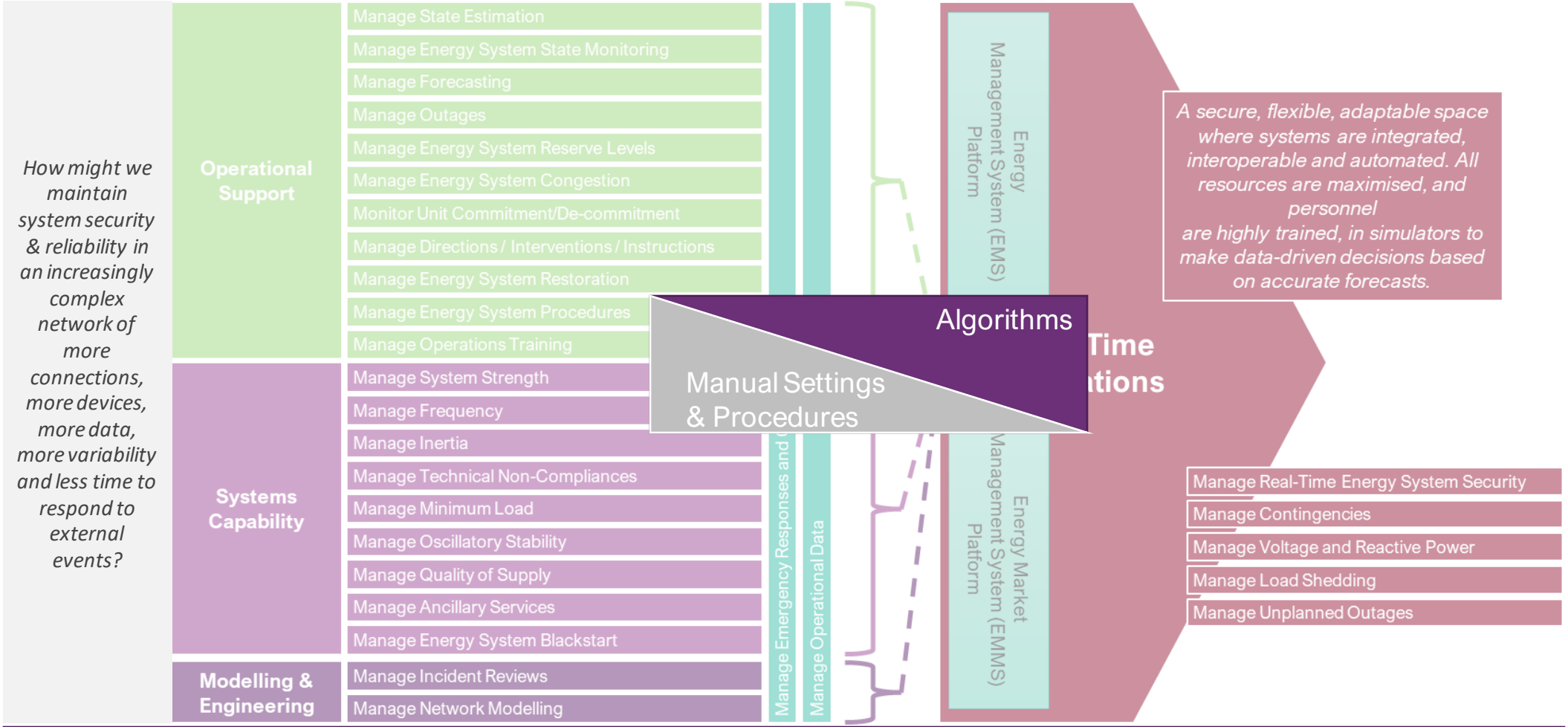
Secure, reliable, resilient, safe and flexible operations, which facilitate a goal of 100% renewable operation



Aligning our Capabilities to an integrated Future Mode of Operation

Control Room of the Future (CROF)

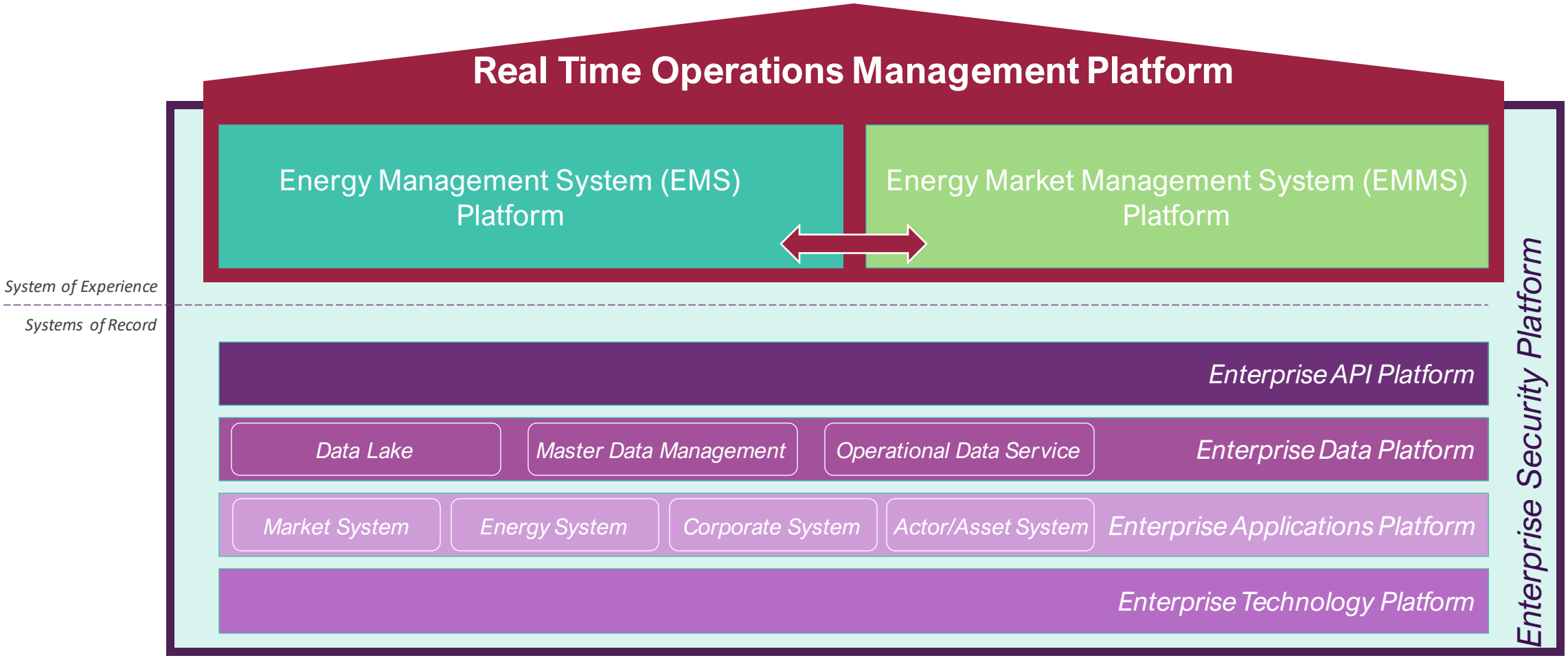
Secure, reliable, resilient, safe and flexible operations, which facilitate a goal of 100% renewable operation



The trend over time must be a reduction in manual activities as we increase our use of algorithms and automation

Real Time Operations Management Platform

Conceptual Design



Aligning with Digital, we can quickly bring the vision to life based on the work products developed in the Operations Decision Making Tools project.

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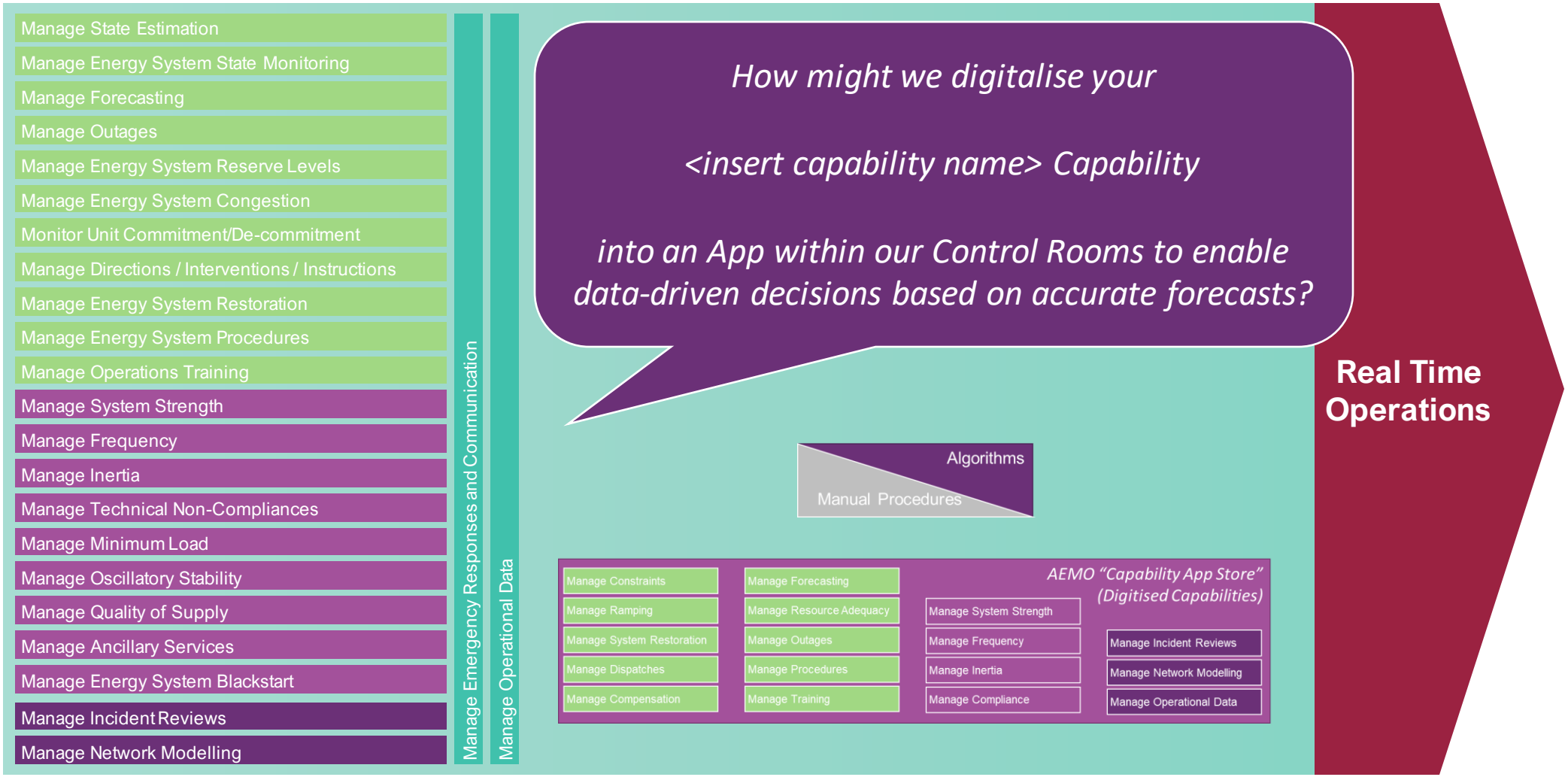
Capability Transformation Objective



Operations Technology Program

Facilitating the changes required to ensure a secure, reliable, resilient, safe and flexible operation, which facilitates the goal of 100% renewable operation. The program encompasses all non reform projects for Operations (NEM/WEM/Gas/Markets). It will be an enduring program that aims to ensure we have the right processes, systems, data and skills to manage & maintain a reliable energy system for Australia.

Support Capability Owners to enable the uplift of their processes, systems and data.

Partner with Digital to introduce technological innovations to increase the level of automation available to operate the system and the market

Together, develop an integrated suite of capabilities that enable near real time decision making

This will enable us to maintain system security in an increasingly complex network of more connections, more devices, more data, more variability and less time to respond to external events.

Below are the major projects confirmed for FY23/24.

Manage Real-Time Energy System Security		Manage Forecasting Supply & Demand	Manage Energy System Reserve Levels	Manage Oscillatory Stability	Manage Network Modelling
Real Time Operations Management Platform *(P1934)* Replace a range of unsupported complex systems with a contemporary Electricity Market Management System (EMMS).	**NEM/WEM Energy Management System (EMS) Upgrade** *(P2205)* Partnering with GE to upgrade our existing EMS to take advantage of new capabilities being brought to market	**Forecasting Platform** *(P2046)* Uplift our ability to forecast supply & demand across an increasing number of Distributed Energy Resources (DERs) & changing weather patterns.	**ST-PASA Replacement** *(P1608)* Uplift our ability to forecast energy resource levels & assess system adequacy.	**Phasor Management Units (PMU) Monitoring Platform** *(P1920)* Deploy PMUs with NSPs to detect small signal disturbances caused by Inverter Based Resources	**Power System Modelling Uplift** *(P1828, P2332)* A suite of initiatives that will uplift power system modelling capability, practices and tools

Operational Data Management Platform (ODMP) -P2160
Building a platform to better secure, govern, maintain and serve our real time data for our systems and scientists.

In addition to these, the program will also manage other prioritised projects across Electricity Operations, Gas Operations & Market Operations, as well as the dependencies with our major Reform Programs and Digital Lifecycle investments.

More information: email OTP@aemo.com OTP on Mo Executive Sponsor: Michael Gatt Program Director: Garry Tuckwell

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AUSTRALIAN ENERGY MARKET OPERATOR

For more information visit

aemo.com.au