TRANSPOWER

Distributed Energy Resource Management Briefing to IPAG #2

Richard Hobbs, Conrad Edwards, Che Lewis, 21 October 2020

Transpower's proposals for DERM discussions with IPAG

22 July 2020	21 October	1 December	2021
Focus on learnings from Transpower's programme			Focus on how to move forward

• Introduction
• Transpower's RCP2 DR programme
• Transpower's DERMS platform
	• Continuation:
	  • RCP2 outcomes
	  • Mechanics of our DERMS platform
	• Operationalising DERM: overview
	• Pricing interactions and value stack
		• Continuation:
		  • Any 'parked' or clarification issues
		• Operationalising DERM: detail
		• DERM market development	

Agenda

- Introduction (5 minutes)
- Transpower's DR pilot (10 minutes)
  - Performance against RCP2 objectives
  - Key learnings (continued from presentation to IPAG in July)
- Mechanics of our DERMS platform (recap from presentation to IPAG in July) (10 minutes)
- Operationalising DERM (40 minutes)
  - A vision for DERMS market evolution
  - How Transpower would decide on and operate a regulated DERM programme
  - Transpower's DERMS plan for RCP3
- Pricing interactions and value stack (40 minutes)
- Discussion and next steps (15 minutes)

Transpower's Demand Response (DR) pilot

Performance against RCP2 objectives 1/2

Objective	Reference	Comment
Work with the EA on a DR protocol	CC 5.173	Achieved: agreed TP and EA November 2014 here
Report on compliance with the DR protocol (including commitments TP has made)	CC 5.185	Achieved, with each commitment addressed in the 'DROP' references below
Be a development programme for DR capability and so not: • provide benefits in its own right • fund the deferral of any transmission investment	CC 5.183 TP 7.2	Achieved: run as a pilot, not an operational programme
Exclude delivery of any market related products that allow participants to respond to wholesale energy prices	TP 4.2, 4.3, 7.2 DROP 5h	Achieved: Transpower as grid owner has not used its DERM platform to assist DER to respond to energy prices
Consider the use of transmission alternatives in investment decision-making	DROP 5f	Achieved: transmission alternatives are considered for all MCPs (Grid Support Contracts, reviewed 2016) and base capex, for transmission deferral or avoidance and for risk management. Also, we are actively working with EDBs on their use of DERM programmes to avoid transmission investment

References

CC: Commerce Commission's *Setting Transpower's individual price-quality path for 2015—2020* [2014] NZCC 23, August 2014 (link)
TP: Transpower's *Development of demand response as a transmission alternative RCP2 proposal*, June 2014 (link)
DROP: Transpower and Electricity Authority *Demand response operational protocol*, November 2014 (link)

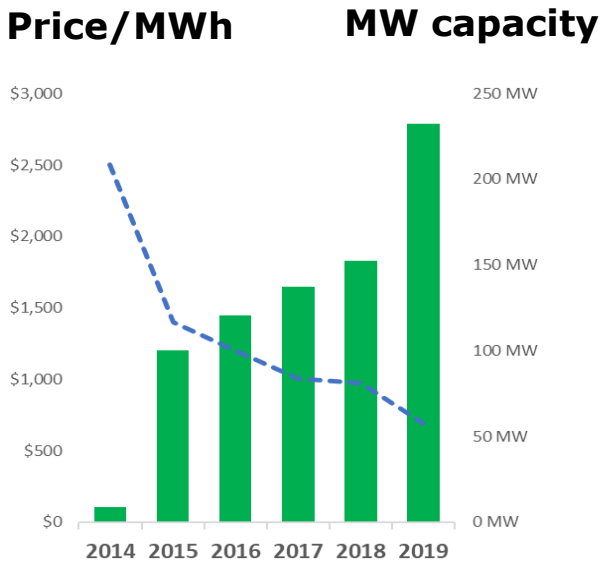
Performance against RCP2 objectives 2/2

Objective	Reference	Comment
Develop and operate a DRMS	CC 5.183	Achieved
Make call and maybe availability payments	CC 5.181	Achieved
Reduce barriers to entry	TP 6.1 DROP 5e	Achieved: enhanced DRMS MUI, mobile app, online videos, simplified contracts, replaced RFP with MUI, introduced OpenADR, DREDs enabled and other smart IOT devices
Run annual programmes targeting different consumers, including the commercial and agricultural business sectors	TP 6.2	Achieved, with other consumer types targeted too: batteries, irrigation, wastewater treatment, wood processing, hot water, smart air conditioning, and standby generation
Report on DR plans and activities	CC 5.185 DROP 5b, c	Comprehensive and up-to-date website, annual industry updates, presentations (incl. MEUG, EECA, Downstream, IPAG)
Ongoing, two way, open and transparent engagement with stakeholders and consumers	CC 5.185 DROP 5a	Achieved. Active customer and potential new participant engagement
Demonstrate that consumers are obtaining benefits from DR investment	CC 5.185	Achieved (within the limits of a targeted pilot): Transpower's battery report, Transmission Tomorrow, TMH and WiTMH have quantified the potential benefits of DR markets
Ensure that transmission alternative costs are as competitive as possible	DROP 5d	Achieved (within the limits of a targeted pilot): DER procured through using competitive tenders, and through contracting with existing DER: significant decrease in prices observed

For references please see previous slide

Key learnings from RCP2 - Participation

- During RCP2 we developed a flexible DERM platform and grew the available DER capacity which allowed us to:
  - Understand and reduce **costs** – average DR price points reduced 70% as capacity grew and participants matured
  - Expand and diversify **DER scope** – batteries, irrigation, wastewater treatment, wood processing, hot water, smart a/c, standby gen etc.
  - Improve **usability** – developed the mobile app to improve consumer engagement, enhanced DERMS for greater operator flexibility and wider industry use
  - Understand and reduce **barriers** to entry with above plus simplified registration and contract process
  - Understand and resolve issues with **verification** and **snap-back**



$695/MWh

Average event price in 2020

2,000

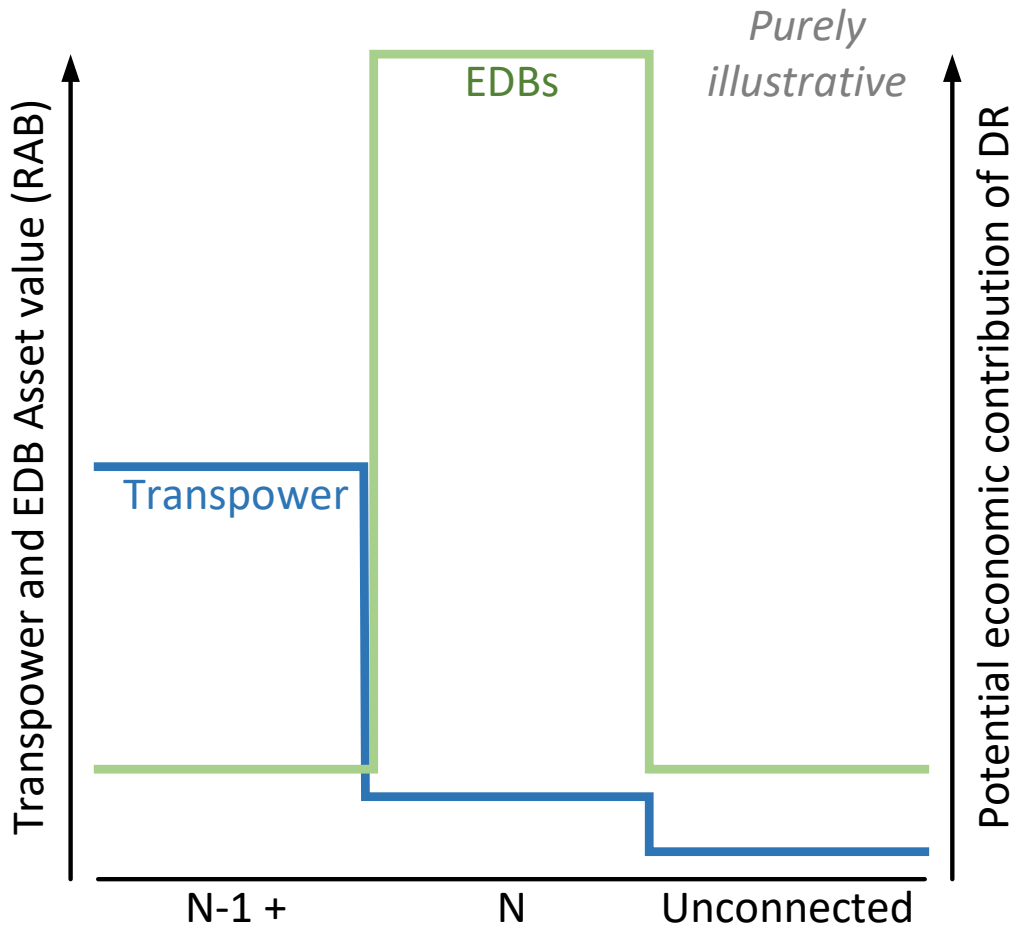
Total batteries

232 MW

Registered in programme

Key learnings from RCP2 - Use cases

- For N security assets, pre-contingent DERM (current DR pilot approach) is valuable
- For N-1 security assets, pre-contingent DERM (current DR pilot approach) competes with post-contingent load-shedding SPSs*
- As illustrated here:
  - Most Transpower assets have N-1 security
  - Many EDB assets have N security
  - Hence pre-contingent DR is generally more suited to EDBs
- Transpower can still derive significant value e.g. when assets are at N security, e.g. during outages
- Post-contingent DERM – if proven effective – will significantly expand the application of DERM to Transpower's N-1 security assets



** A load-shedding special protection system (SPS) is a Transpower-owned control system to shed load immediately after a contingency which might otherwise cause an overload of transmission equipment (e.g. a circuit or transformer).*

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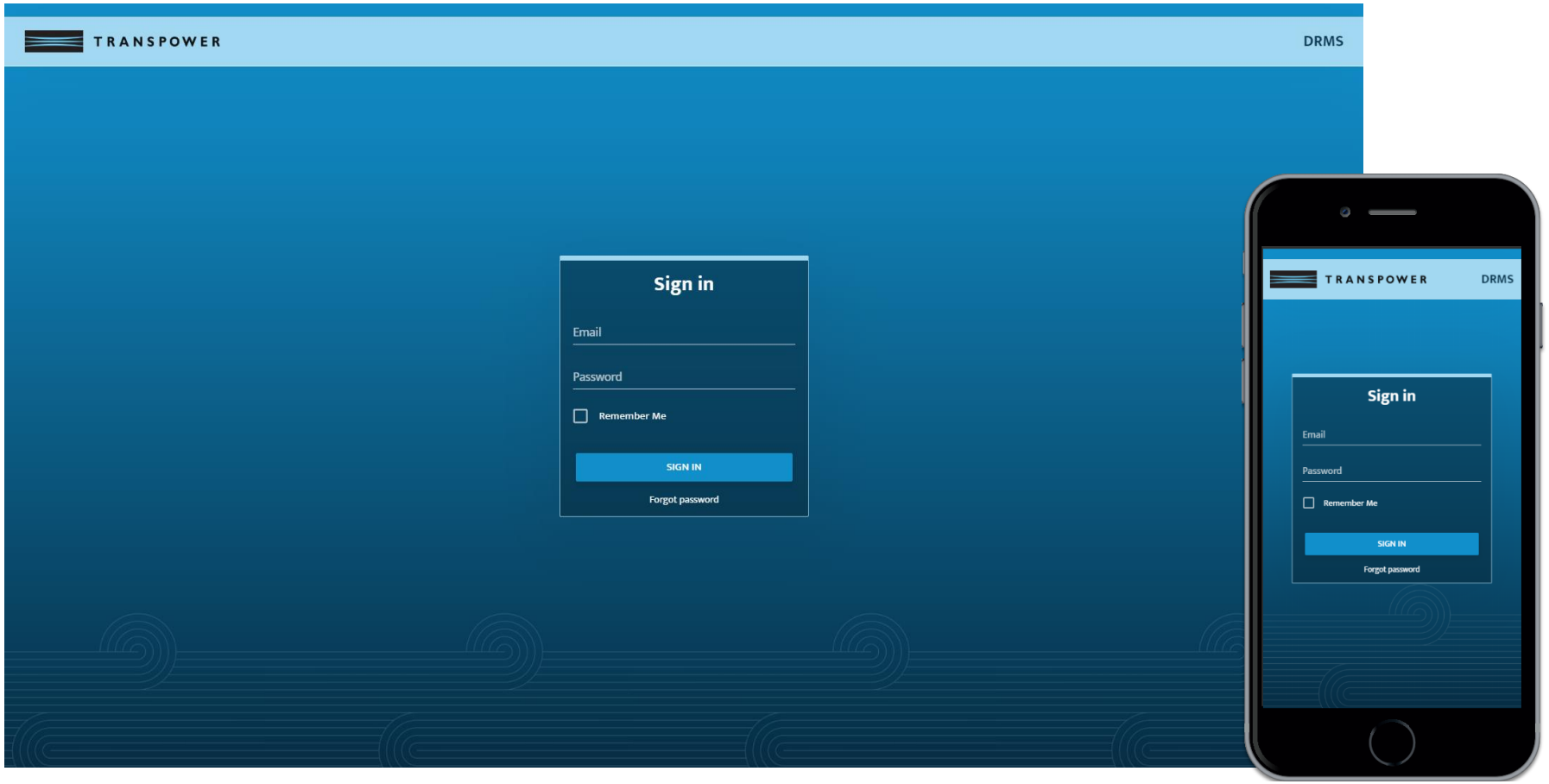
Mechanics of our DERMS platform

Transpower's DERMS platform

- Transpower developed its platform to suit the New Zealand context
- We intend to continue using the platform to explore DER transmission support
- We have designed it with interoperability in mind to allow us to access other programmes where other industry participants may have established them
- Both DER owners and industry participants benefit when there are more incentives to participate in flexibility markets
- Transpower can make entry into DER programme management easy for other industry players
- To achieve this, we will offer our platform to industry players with wraparound services including registered capacity across New Zealand, programme design and rules, and participant agreements

Distributed Energy Resource Management System (DERMS)

- The platform is accessible from both desktop browsers and mobile devices
- The multi-tenant architecture allows Transpower and distribution companies the ability to run their own DER programmes within the same platform and if enabled share DERs



DRMS

Events

Transpower
Start 26/06/2020 14:00 — End 26/06/2020 18:00 — Scheduled 1.63MW — Completed

Transpower
Start 12/06/2020 13:00 — End 12/06/2020 17:00 — Scheduled 26.72MW — Completed

Transpower
Start 12/06/2020 13:00 — End 12/06/2020 15:00 — Scheduled 0.5MW — Completed

Transpower
Start 09/06/2020 15:00 — End 09/06/2020 19:00 — Scheduled 15.56MW — Completed

Transpower
Start 09/06/2020 15:00 — End 09/06/2020 17:00 — Scheduled 3MW — Completed

Transpower
Start 23/03/2020 18:00 — End 23/03/2020 20:00 — Scheduled 5.66MW — Completed

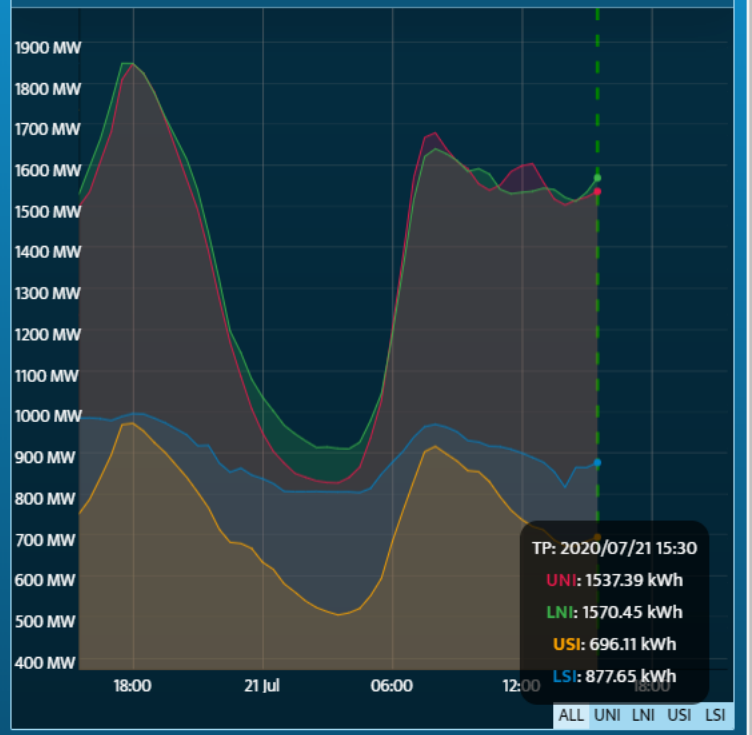
SEE ALL EVENTS >

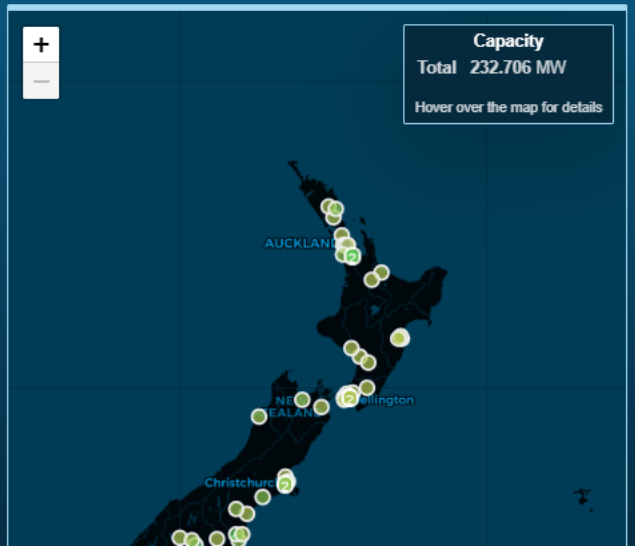
232.71MW
Total DR Capacity

Tasks

34 Child Events Pending Payment
39 Child Events Pending Invoice

RCPD



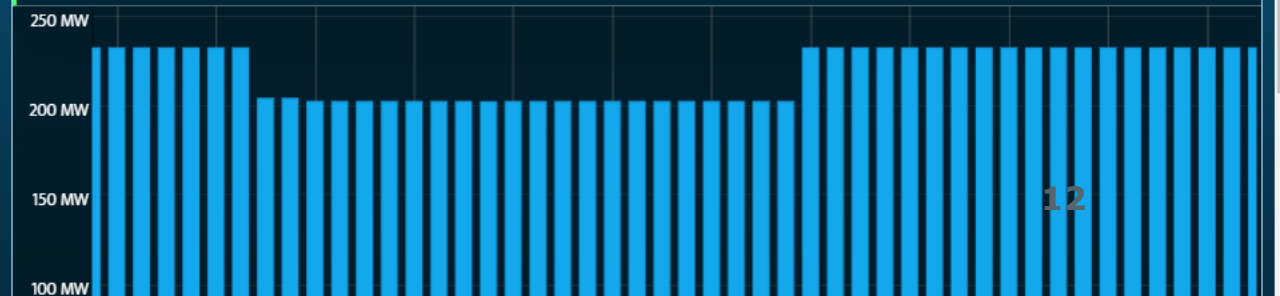


Notifications

- DR event was completed — DR event was completed
- DR event is active — DR event is active
- DR event was scheduled — DR event was scheduled
- DR event was completed — DR event was completed
- DR event was completed — DR event was completed
- DR event is active — DR event is active

Availability Forecast

From 21/07/20 15:30 — To 22/07/20 15:30 — Registration
Programme Name — Organisation — Tags



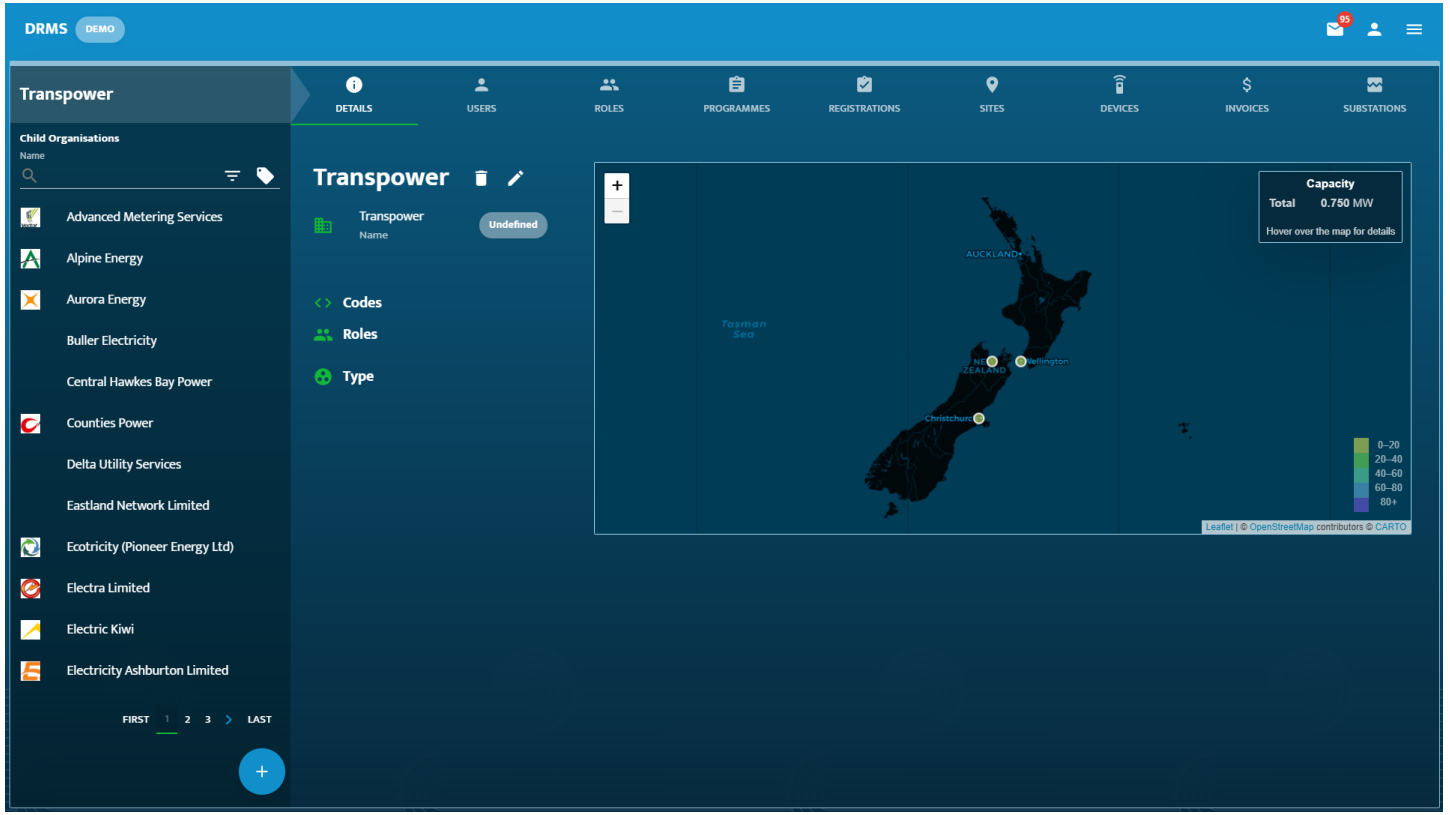
Portfolio management

The DERMS allows Operators to manage their portfolio of Demand Response Service Providers.

The DERMS can accommodate many different market participants such as retailers, meter data providers and DER providers so that they can all access the platform and information that relates only to them.

The platform features relating to portfolio management include:

- **Organisation Management** - Create, update and edit DR organisations
- **Organisation Meta Data Management** - Location, contract details, key contacts
- **User Management** - Contact details, set permissions and notification preferences



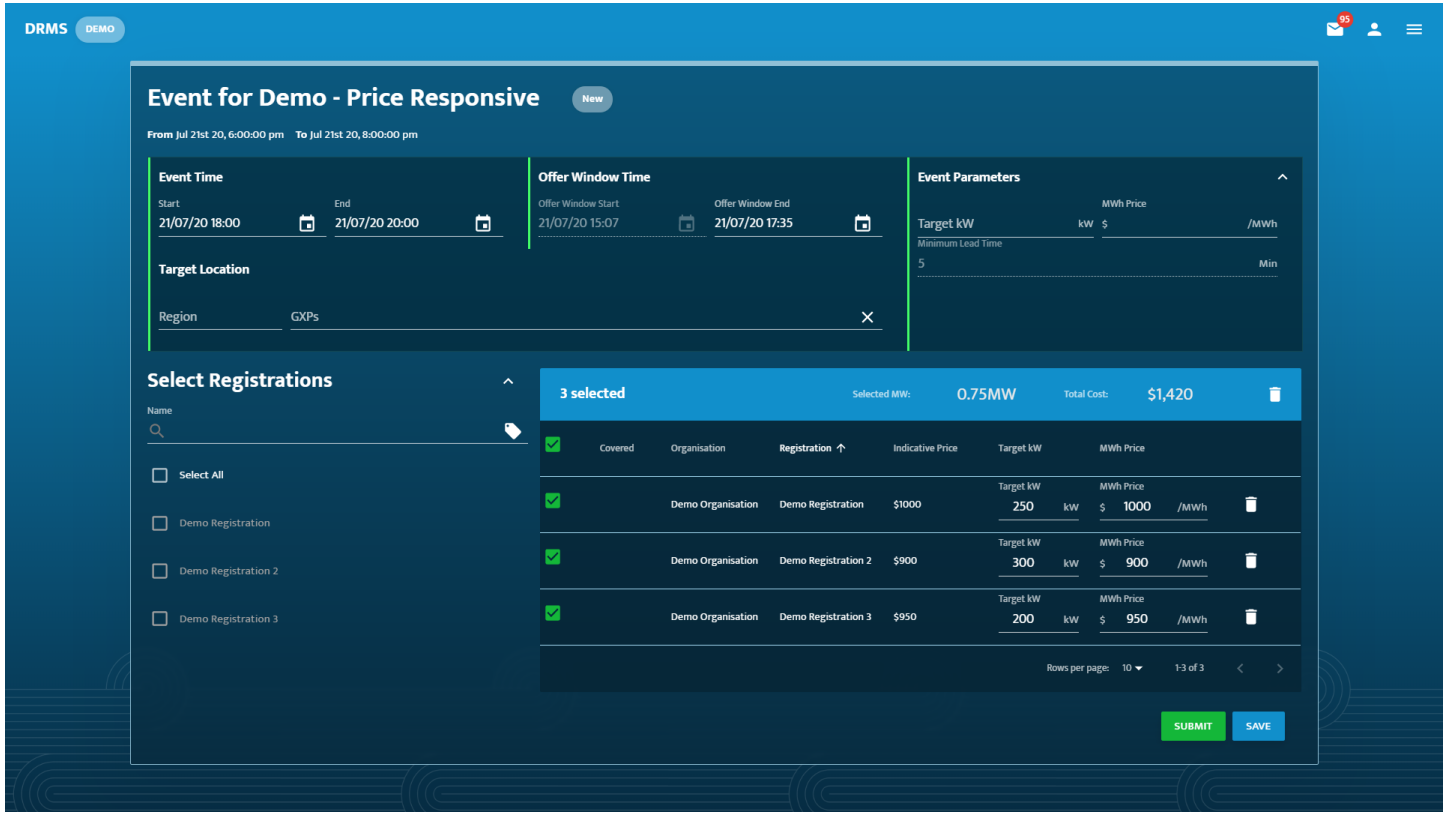
Event Management

The DERMS enables Operators to co-ordinate and send signals to registered DERs

The DERMS can accommodate many different market participants such as retailers, meter data providers and DRSPs so that they can all access the platform and information that relates only to them.

The platform features relating to Events include:

- **Event Management** – Create, manage and co-ordinate targeted DERs for a specified event time
- **Optimised Events** – target DER providers by lowest cost, resource type and/or location
- **Comms Methods** – email, text, API, OpenADR 2.0b and DREDS AS/NZ 4755

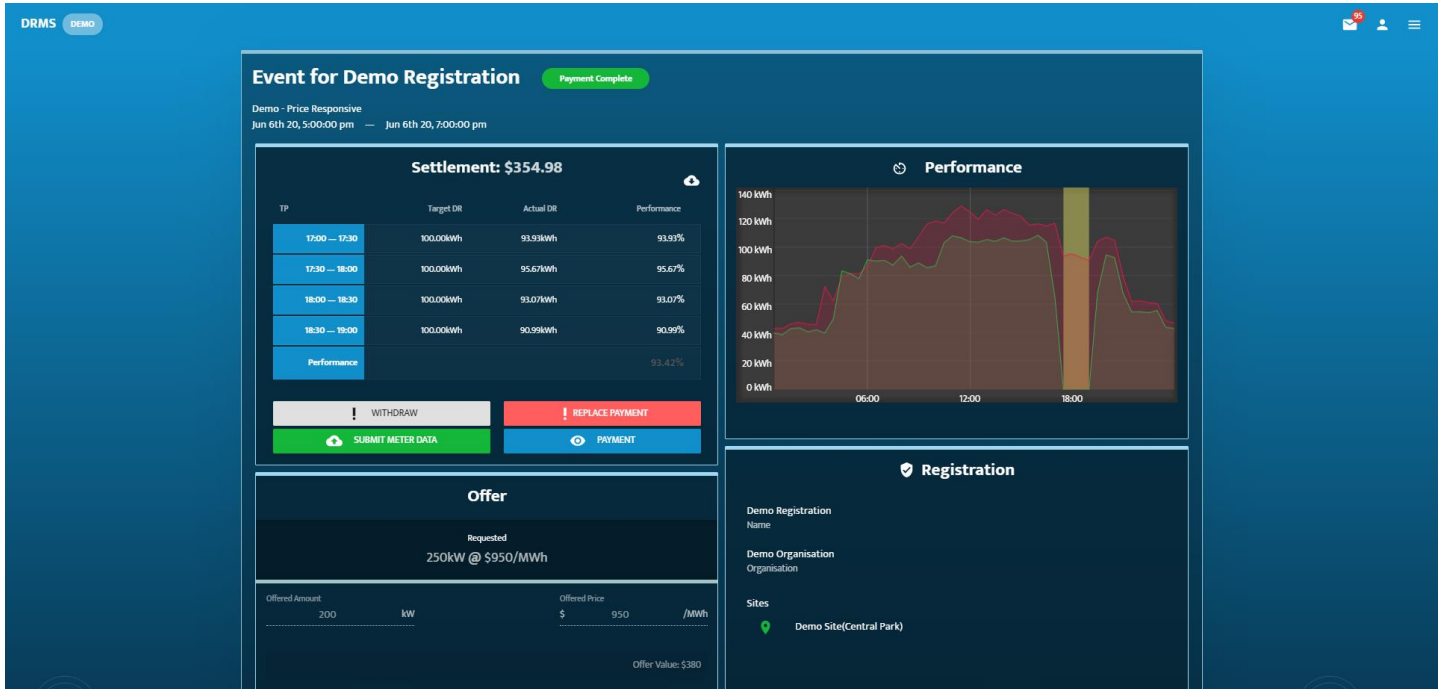


Measurement and verification

The DERMS platform enables measurement and verification to be calculated within the system.
By combining a DER's meter data, event dispatch times, $/MWh prices and selected baseline the platform calculate a site's performance and settlement values.

The platform features relating to measurement and verification include:

- **Calculated Event Baselines** – Baselines for a settlement are calculated for each interval based on the DER's selected baseline
- **Calculated Performance Percentage** – Enables operators and DER providers to view the performance of a DER's Demand Response event
- **Calculated Settlements** – Calculated baseline – Meter Data) x $/MWh dispatch price = Per Interval settlement record



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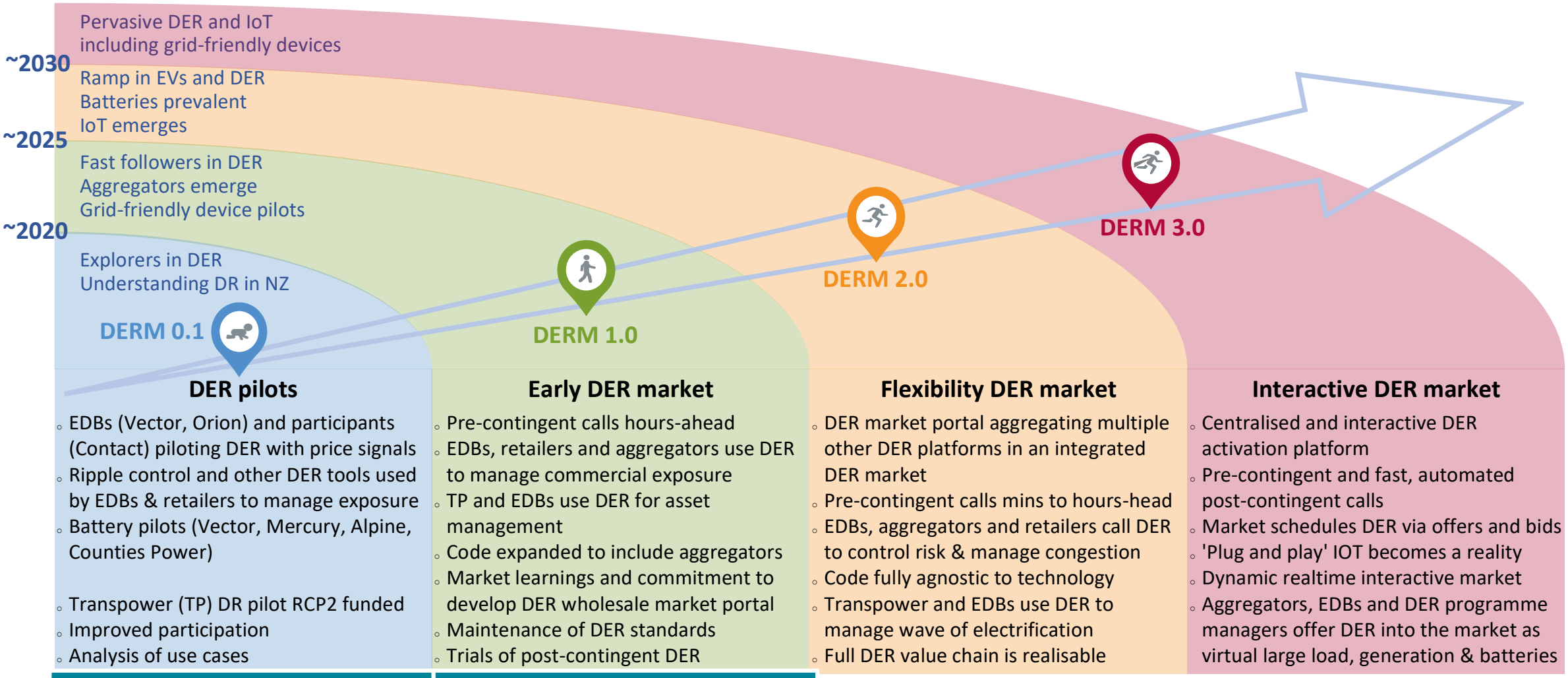
Operationalising DERM

DR markets could develop as DER and participants are supported



DER pilots

- EDBs (Vector, Orion) and participants (Contact) piloting DER with price signals
- Ripple control and other DER tools used by EDBs & retailers to manage exposure
- Battery pilots (Vector, Mercury, Alpine, Counties Power)
- Transpower (TP) DR pilot RCP2 funded
- Improved participation
- Analysis of use cases

Early DER market

- Pre-contingent calls hours-ahead
- EDBs, retailers and aggregators use DER to manage commercial exposure
- TP and EDBs use DER for asset management
- Code expanded to include aggregators
- Market learnings and commitment to develop DER wholesale market portal
- Maintenance of DER standards
- Trials of post-contingent DER

Flexibility DER market

- DER market portal aggregating multiple other DER platforms in an integrated DER market
- Pre-contingent calls mins to hours-head
- EDBs, aggregators and retailers call DER to control risk & manage congestion
- Code fully agnostic to technology
- Transpower and EDBs use DER to manage wave of electrification
- Full DER value chain is realisable

Interactive DER market

- Centralised and interactive DER activation platform
- Pre-contingent and fast, automated post-contingent calls
- Market schedules DER via offers and bids
- 'Plug and play' IOT becomes a reality
- Dynamic realtime interactive market
- Aggregators, EDBs and DER programme managers offer DER into the market as virtual large load, generation & batteries

RCP2 period | **RCP3 period**

Transition from DR pilot to DERM operations

RCP2 period

- DR Programme = ‘DERM 0.1’ pilot
- Regulated RCP funding of the pilot
- Consideration of DERM in all investments (MCP and base capex)
- Potential economic use cases found for the RCP2 period were deferred into RCP3 due to investment prioritisation
- A number of use cases trialled at GXPs

RCP3 period

- Exploring evolutionary development of DERM from pilots to ‘DERM 1.0’
- We did not propose continued specific RCP funding of further DERM pilots. We will support the future development of DERMS for transmission deferral or risk management, through prioritisation of the base capex and opex portfolio
- Where DERM is an economic solution for transmission deferral or risk management, then RCP capex will be converted into RCP opex to fund the DERM solution
- Any development or service offerings for external parties will be commercially funded, external to our regulated funding.

Transpower's DERM programme for 2020-2025 (RCP3)

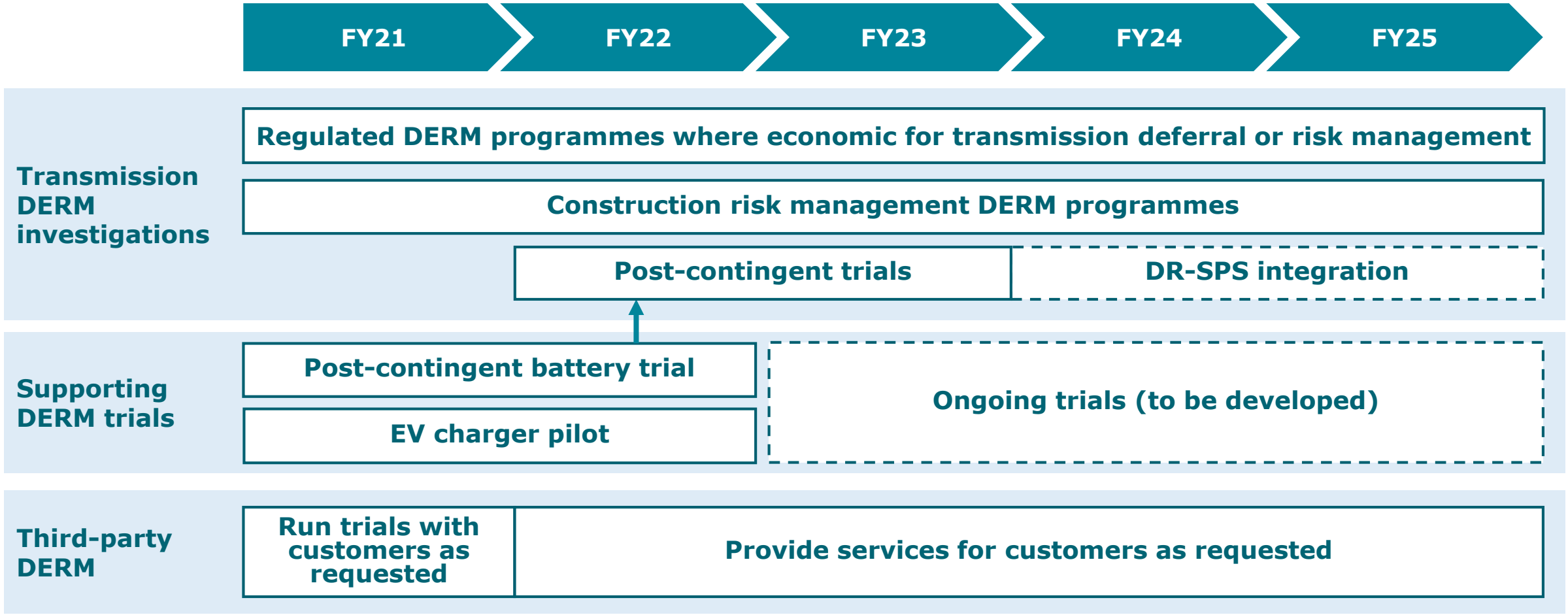
Regulated

- **Manage construction risk**
  - Use DERM on projects where commissioning is delayed and/or demand growth has accelerated
- **Defer network investments**
  - Use DERM for transmission investment deferral wherever possible and economic
- **Increase grid flexibility and reliability**
  - SPSs could be designed to call short-notice post-contingent DER events while retaining backstop load shedding, subject to successful:
  - Post-contingent trials with a battery fleet owner and possibly EV charging company
- **Evolve processes for deciding on and running a DERM programme**

Unregulated

- **Investigate potential for DERMS platform services to EDBs**
  - Consider where Transpower could assist EDBs with running their own DERM programmes to manage their networks
  - Mutually beneficial, as Grid Owner could then contract with EDB for access to their demand flexibility
- **Develop capability**
  - Offer trials of the DERMS platform to EDBs to assist with capability building and mutual learning

RCP3 plan to build on DERM capability and deliver industry value



Planned | Proposed

How Transpower proposes to runs it DERM programmes

Regulated DERM programmes where economic for transmission deferral or risk management

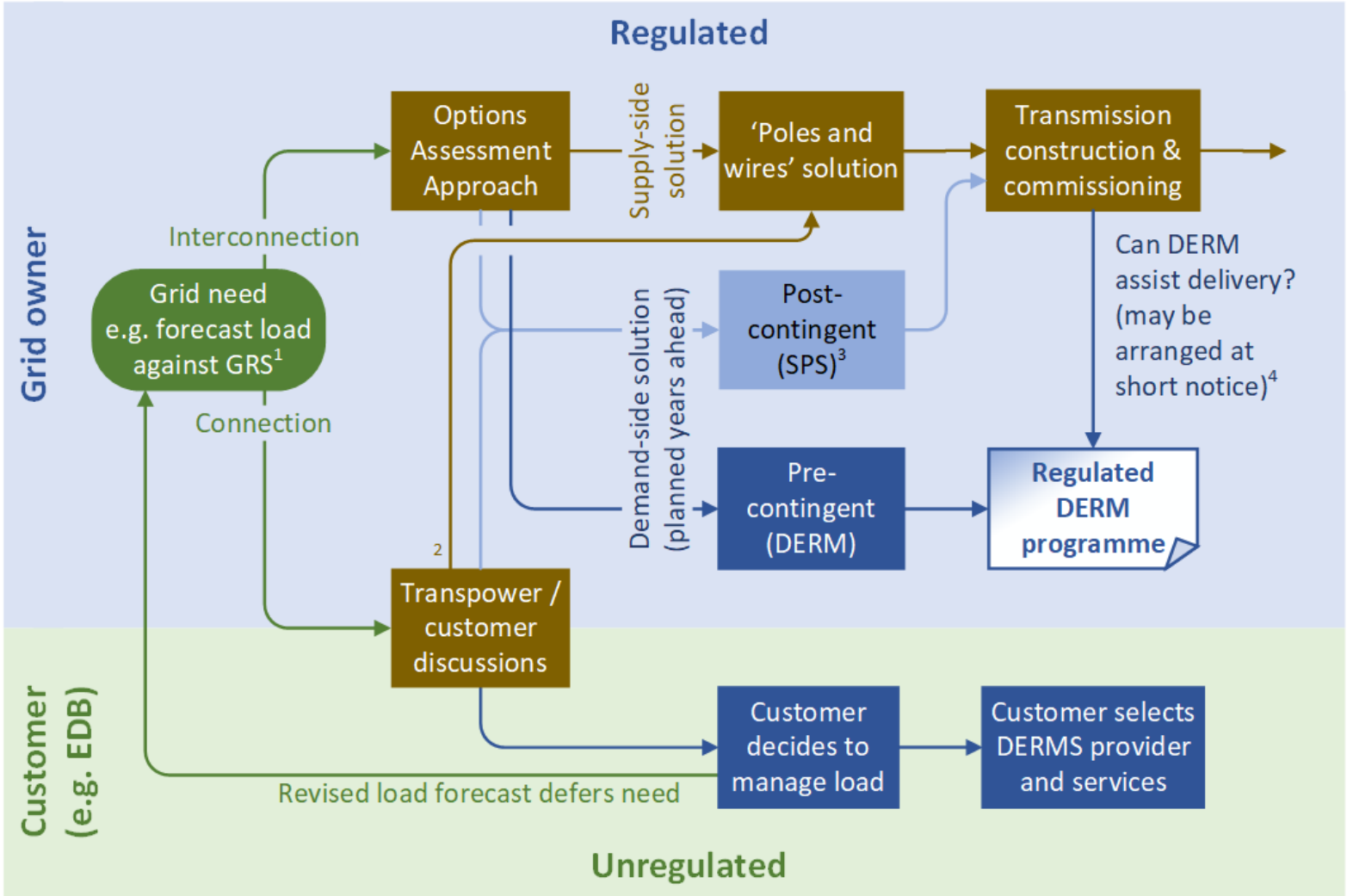
Construction risk management DERM programmes

Provide services for customers as requested

Need and economics will drive Transpower's operational DERM

This slide and the next few illustrate Transpower's current processes for deciding on and running a DERMS programme

We expect to evolve these processes with further work and experience



1 *Grid Reliability Report (Code 12.76) identifies capacity need, to which GRS is applied to determine if action required*

2 *Customer transmission or SPS investments funded through base capex or, where customer need exceeds grid need, as an investment contract*

3 *Transpower is planning post-contingent DERM trials to investigate whether DERM can be integrated with an SPS*

4 *Could be planned e.g. to cover temporary need, or unforeseen to cover risk of delayed commissioning or higher than forecast demand growth*

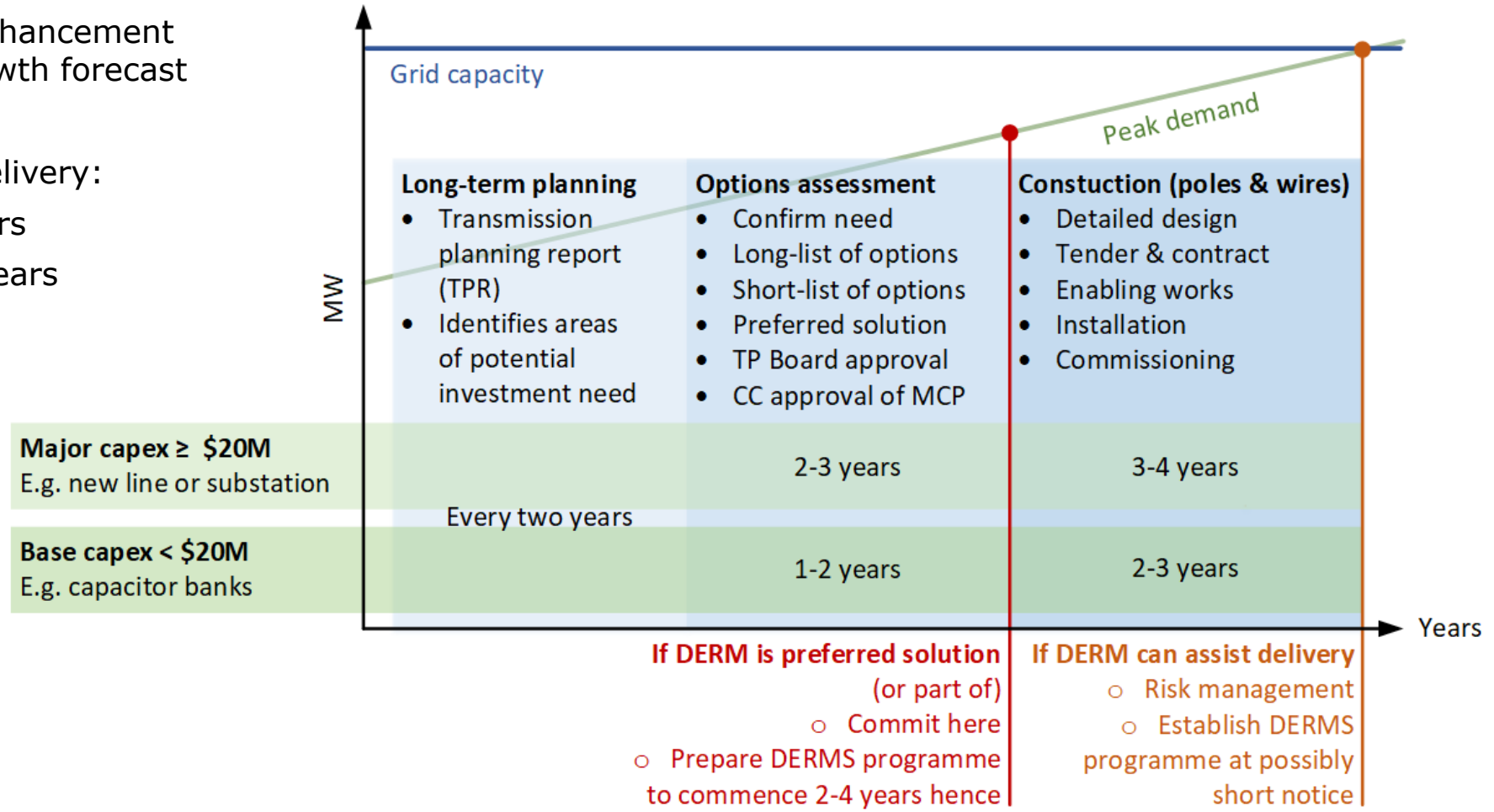
Timings for operational DERM decisions typically driven by 'poles and wires' solution timings

Timings for a typical capacity enhancement investment driven by a load growth forecast

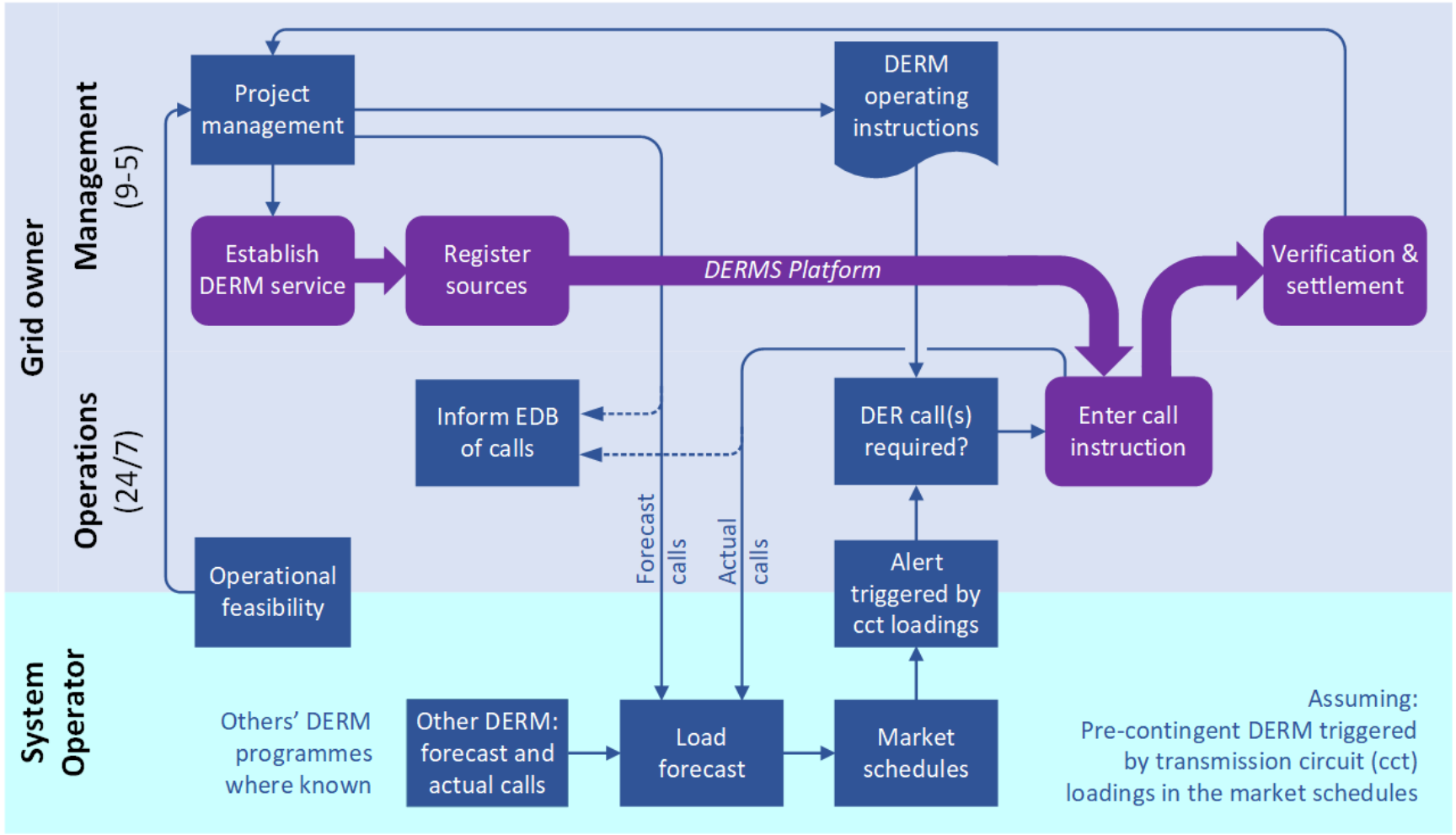
From identification of need to delivery:

- Major capex can take 5-7 years
- Smaller capex can take 3-5 years

In both cases, decision to proceed is almost half of project duration



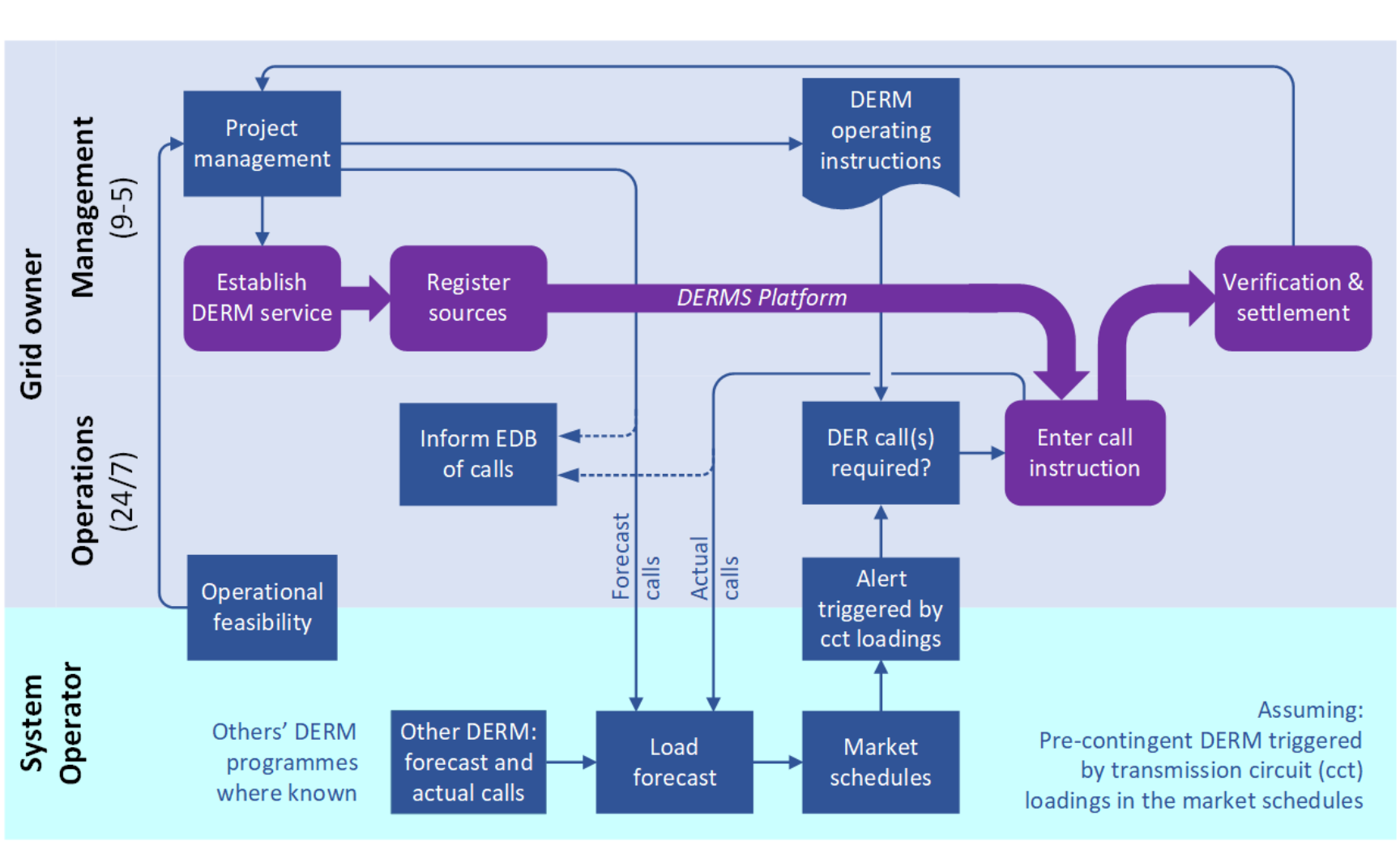
Our proposed process to deliver regulated transmission DERM…



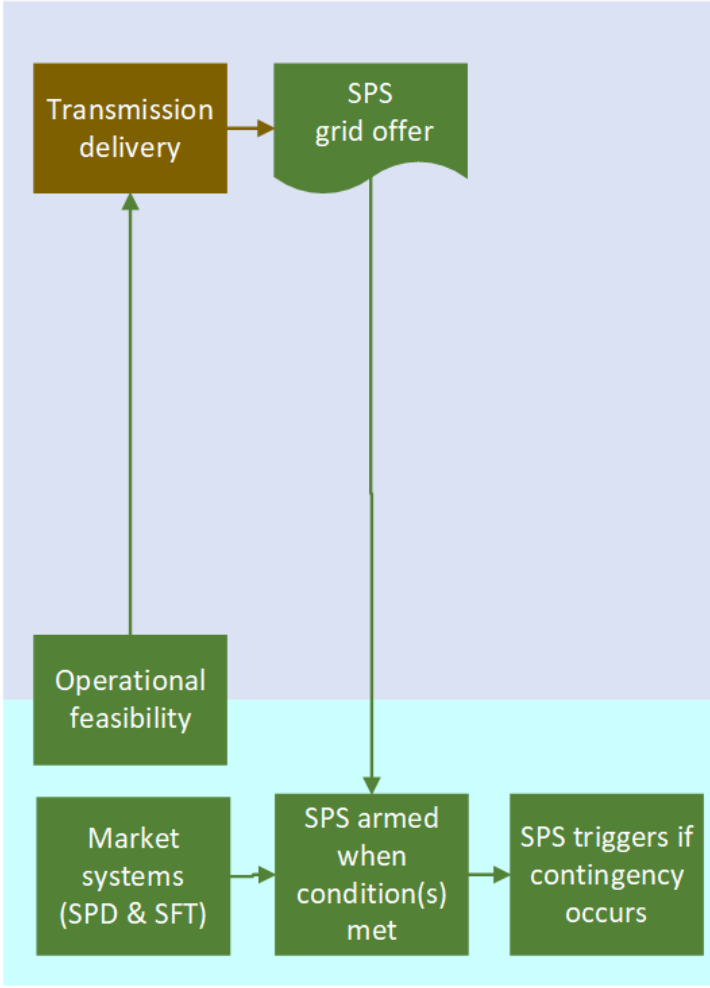
DERM operating instructions

- A key process document
- Instruction to operations on when and how to call DER, and when not
- Entirely objective – no operational discretion required or allowed
- Purely physical – economic considerations paramount in developing the operating instructions, but not in their implementation
- Owned by Grid Owner
- Agreed by SO
- Actions taken by Grid Owner's operational team
- Continually reviewed
- Some similarity to an SPS offer from Grid Owner to SO (next slide)

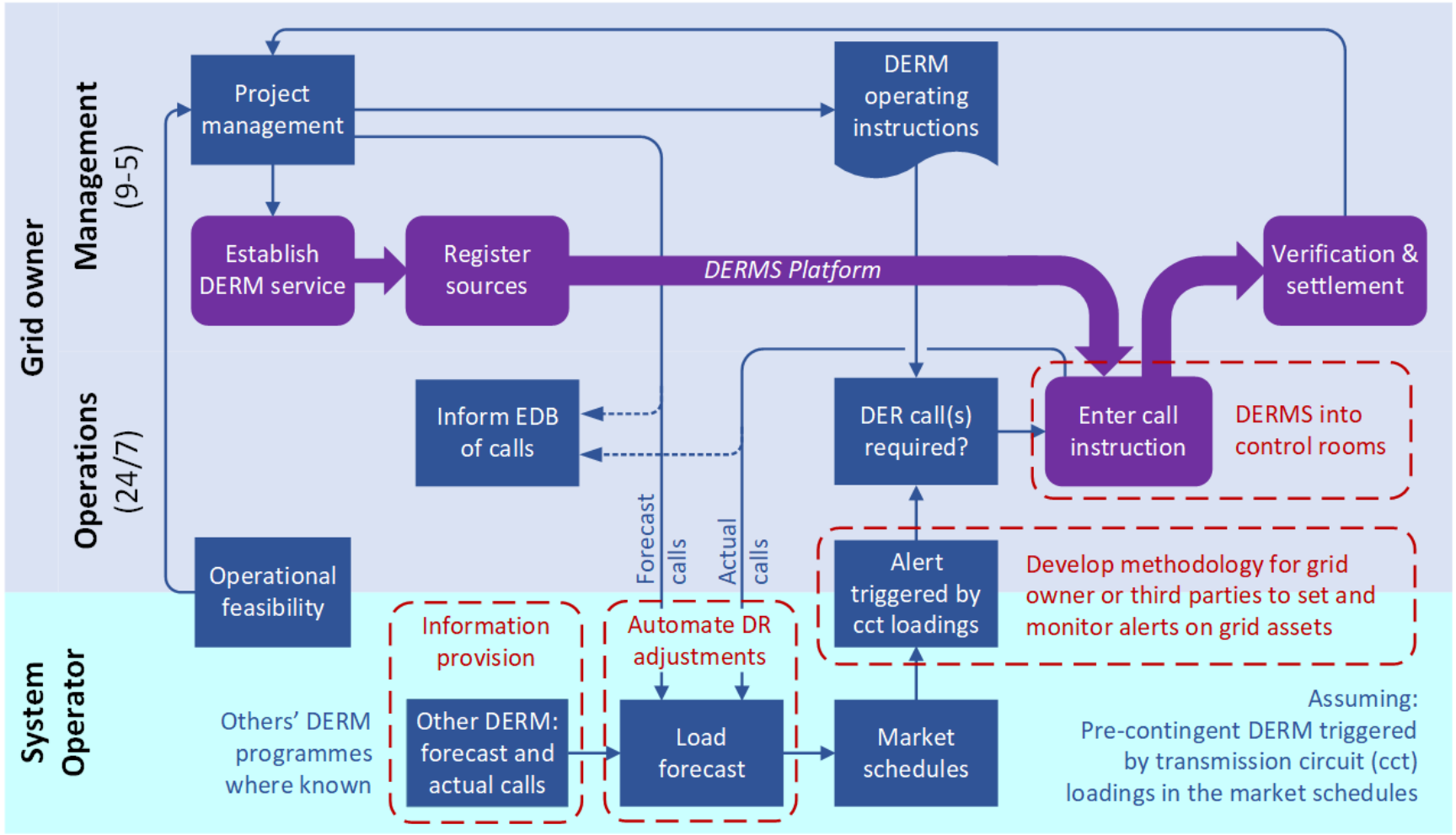
Is a bit more complicated than operating an SPS scheme



SPS process for comparison



And some aspects will need enhancement as volumes increase



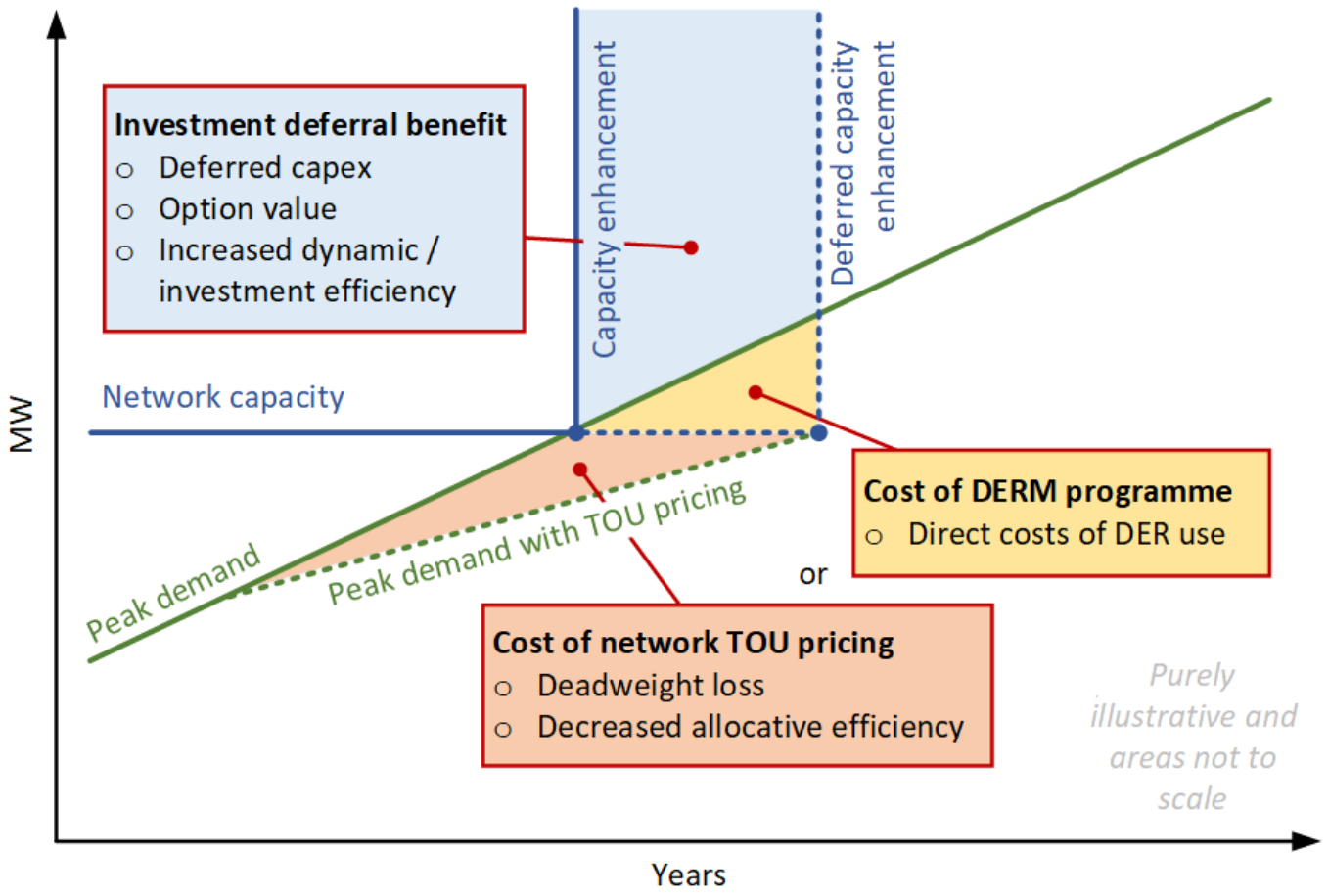
Enhancements needed

- Automate the currently manual process of adjusting the load forecast for planned and actual DER calls
- Obtain information from third-parties with active DER programs to inform the SO of planned and actual DER calls in a timely manner
- Integrate the DERMS platform into the control rooms to support 24/7 operations
- Develop methodology for grid owner or third parties to set and monitor alerts on grid assets from the market schedules

Pricing interactions and value stack

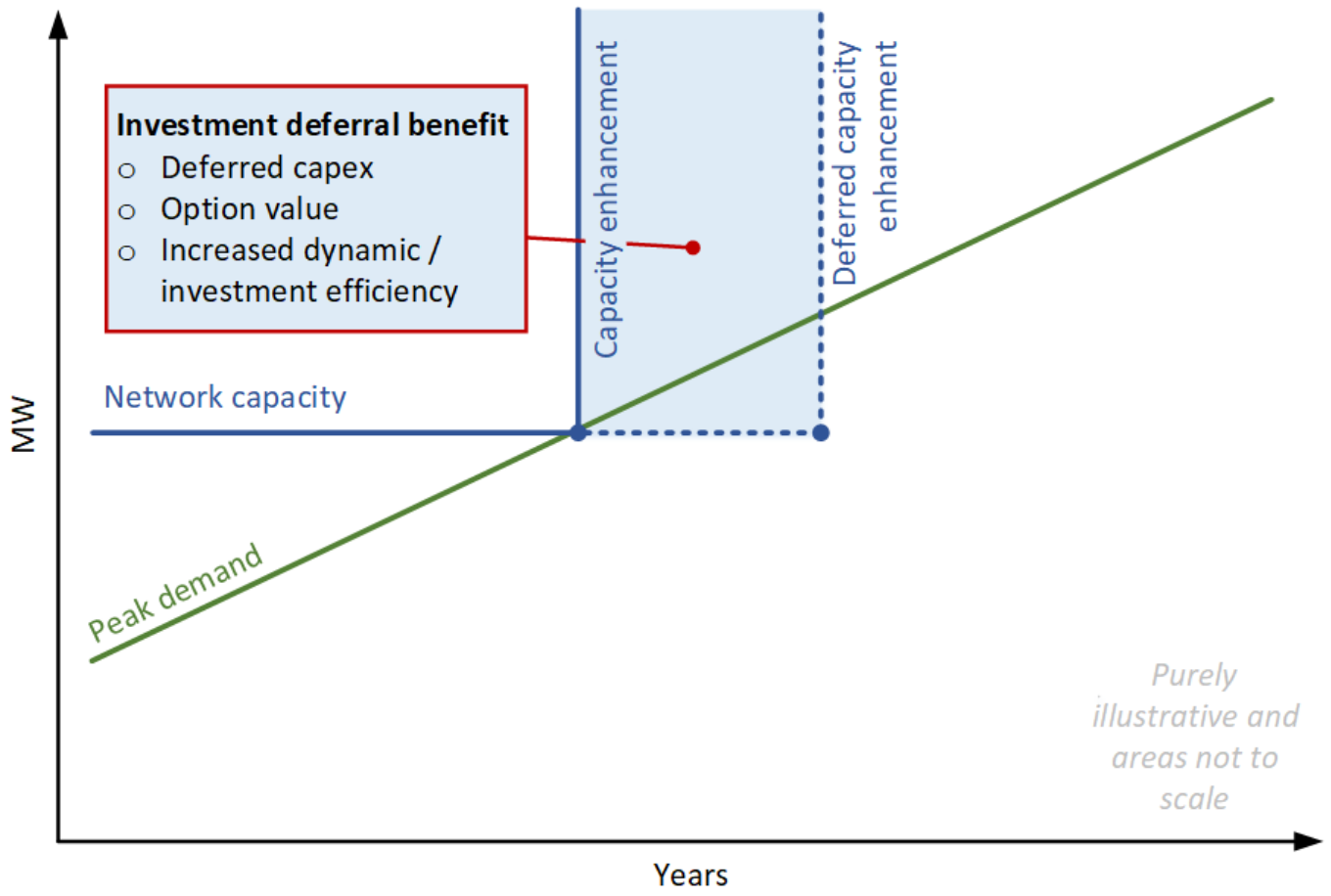
How to optimise network investment deferral

- For overall economic efficiency we need to balance:
  - the benefits of network deferral
  - the costs and efficacy of any network TOU pricing
  - the cost of any DERM programme
- This is explored in the next few slides



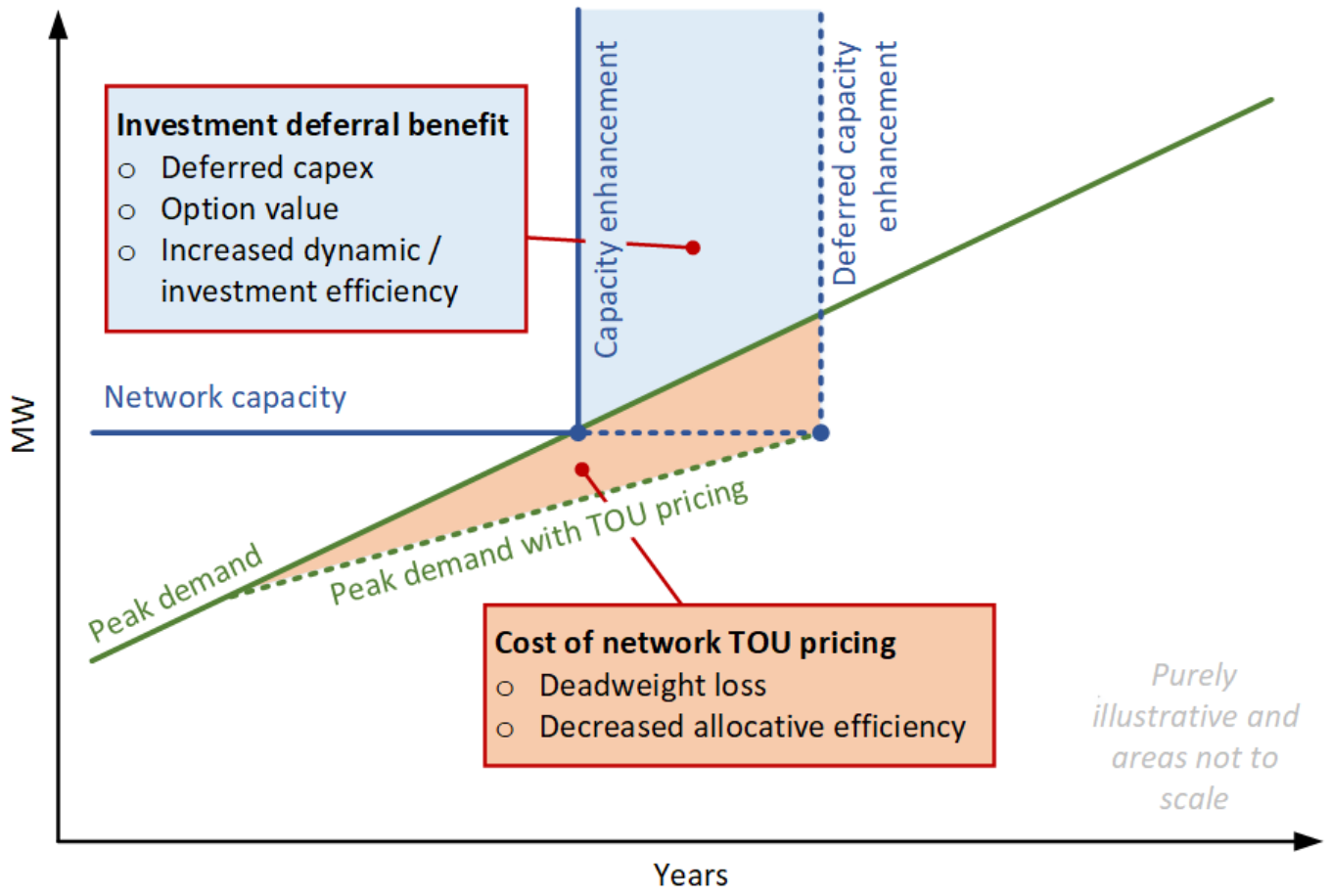
There are potential benefits of network investment deferral

- If a network company could efficiently encourage peak demand reduction, it could capture the benefits of deferring network investment
- This would defer capex and provide optionality given an uncertain future
- It could therefore improve investment efficiency, or in economic-speak dynamic efficiency



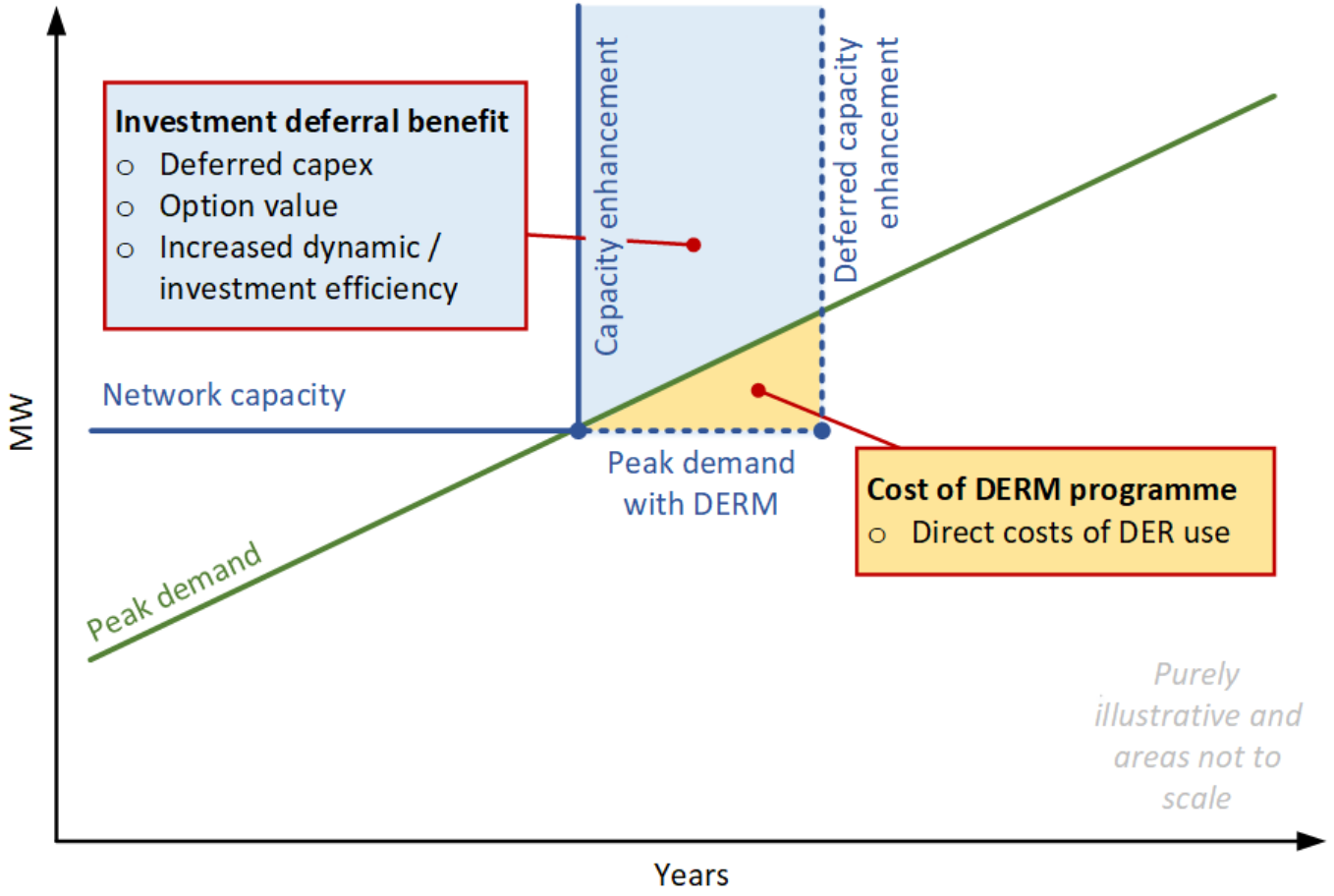
We could defer network investment with network TOU pricing

- We could achieve network investment deferral through time of use (TOU) pricing
- However, prices would then have to rise above marginal direct costs. This could create counter-veiling inefficiencies in use and resource allocation. In economic-terms this would create deadweight loss and allocative inefficiencies
- Current network TOU pricing e.g. distribution pricing can also have practical limitations:
  - TOU tariffs can have low granularity e.g. day/night rather than half-hourly
  - Given the choice, consumers often prefer simple, flat-rate retail tariffs



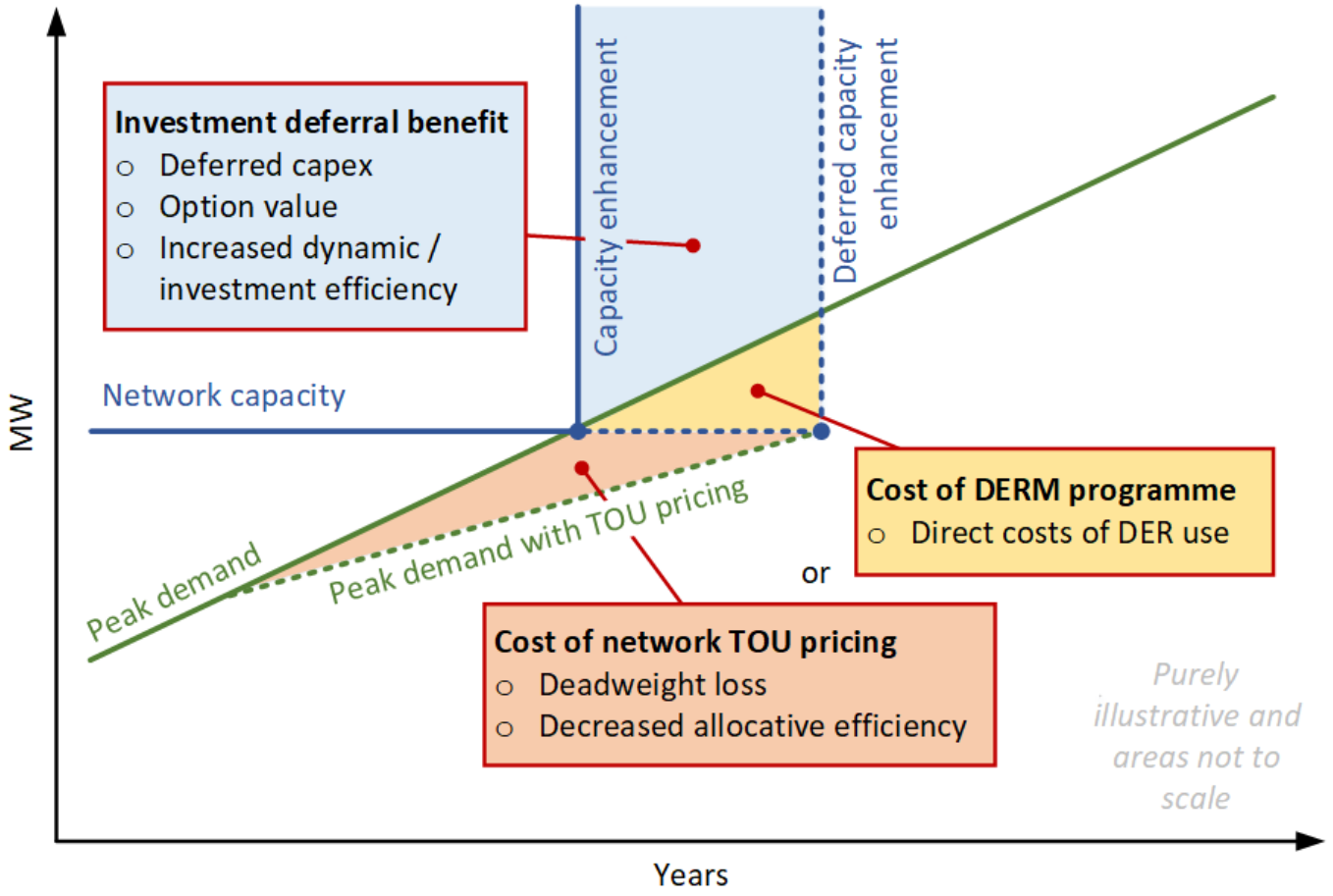
Or, we could defer network investment with DERM

- Alternatively (or as well) we could achieve network investment deferral through a DERM programme
- This would have a direct cost in payment to DER providers but (managed carefully) can preserve the allocative efficiency of the nodal prices
- Such a DERM programme could be used also for network investment risk management, to manage risk of:
  - Delayed commissioning
  - Higher than forecast demand growth



How to optimise network investment deferral

- So, for overall economic efficiency we need to balance:
  - the benefits of network deferral
  - the costs and efficacy of any network TOU pricing
  - the cost of any DERM programme
- Often, the costs of TOU pricing (beyond nodal prices) and DERMS programmes will be too great, and the network investment should proceed
- Sometimes, one or other (or both) of TOU pricing and DERMS could be an economically optimal solution for a limited period

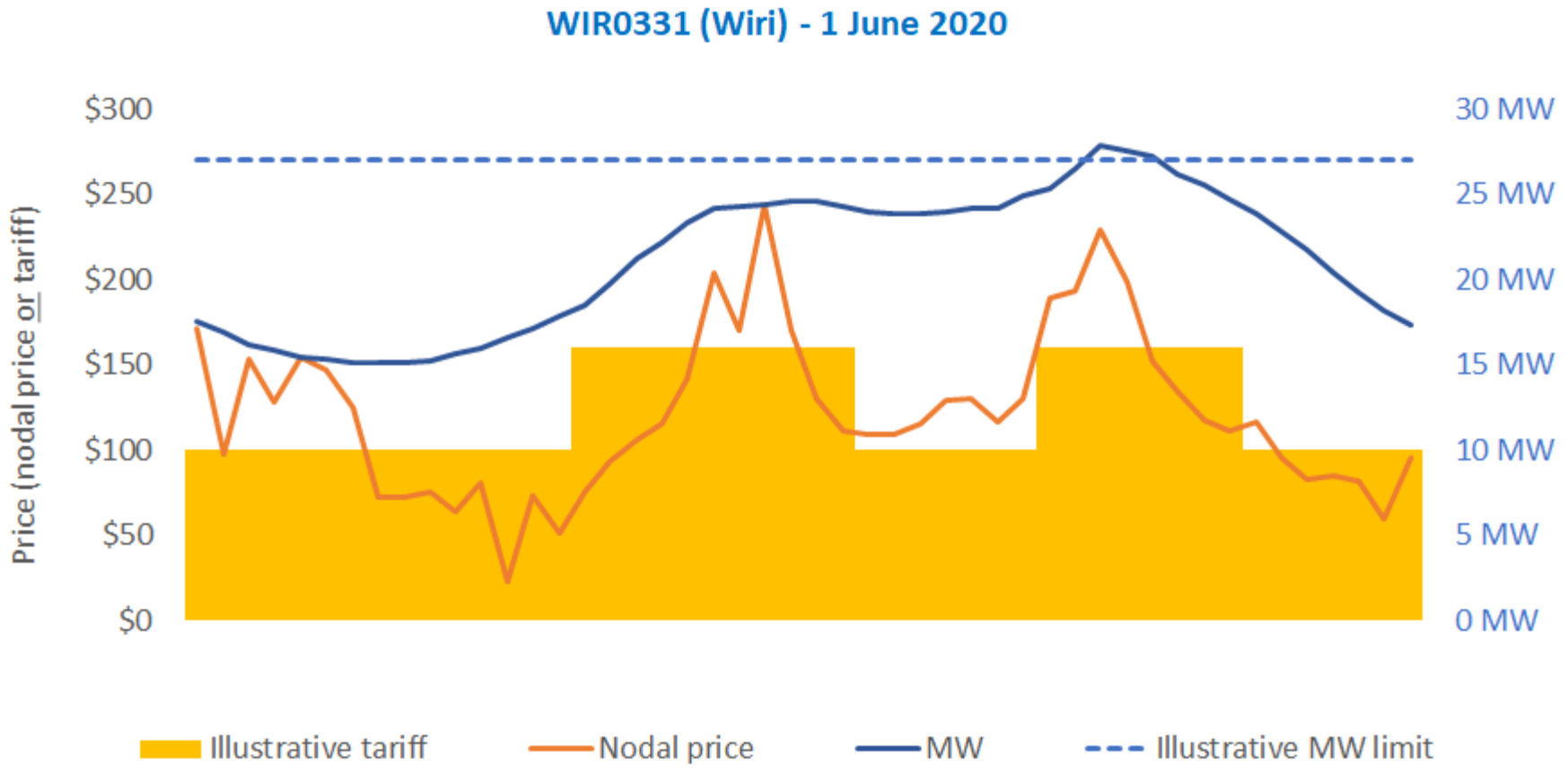


Network TOU pricing could increase network investment efficiency

- The main price is the nodal price, made up of:
  - the 'baseload' energy price, being the offer price of the marginal generator on the unconstrained grid
  - losses
  - when there's a grid constraint, a congestion component based on the offer price of the marginal generator in the constrained region
- The nodal price is very accurate at reflecting the marginal cost of energy and leads to high allocative efficiency in real-time

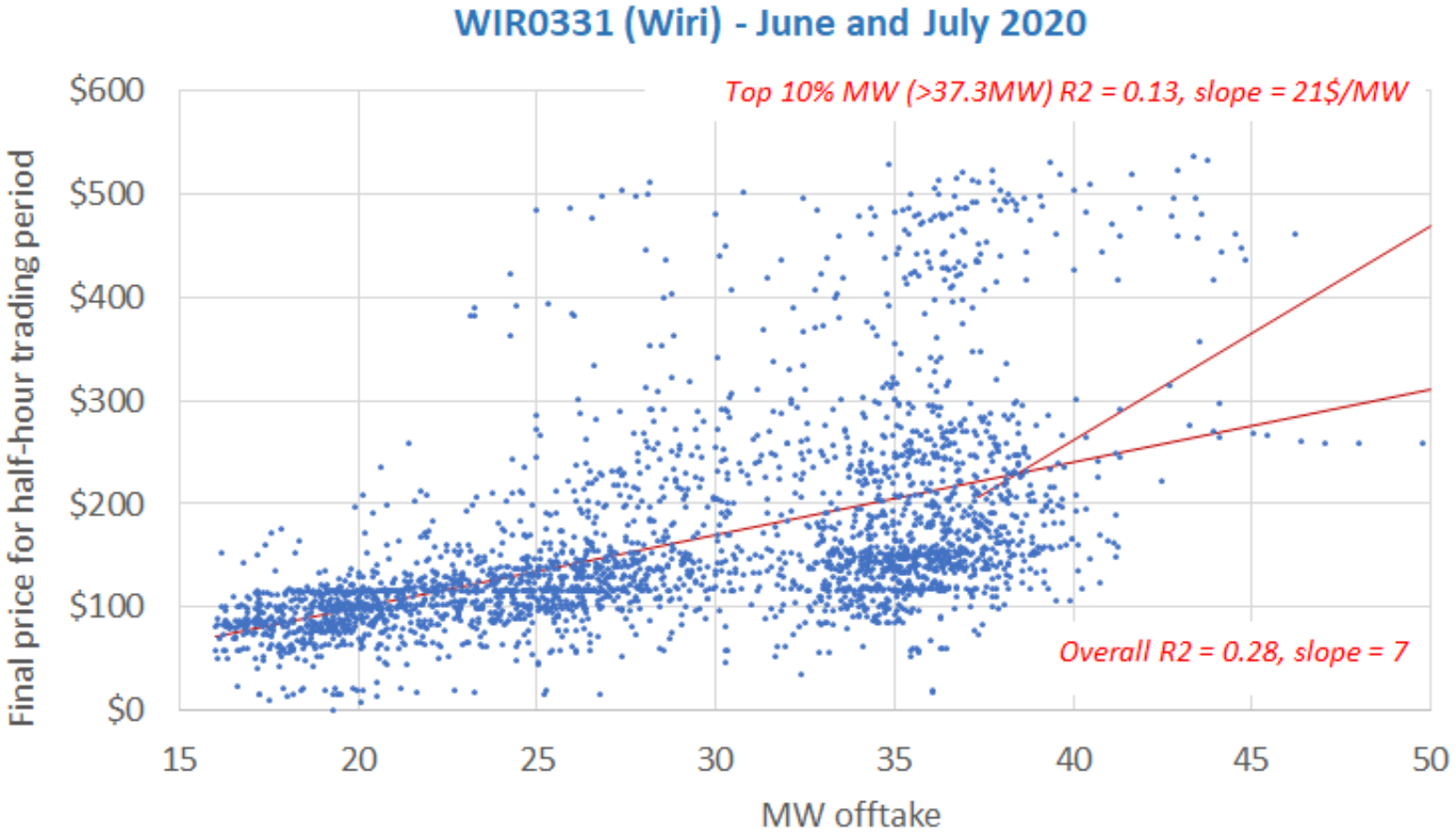
- Network deferral value is not included in the nodal price
  - for transmission, the nodal price is the same whether the next investment is $1M or $1B
  - for distribution, the nodal price only goes to GIP/GXP level, not deeper into the network
- Network TOU pricing - in effect - adds this component into a 'complete' price signal
- Usually the deferral value is zero:
  - when there is no imminent need for network investment
  - when it's not a local/regional peak
- But, at very specific places and times, this value-based price could be material

Nodal prices and TOU tariffs can do most of the work



DERM can 'top up' nodal prices to help defer network investment

- Of the GXPs we have discussed with customers as potential DERM use cases, the one with the best correlations between price and offtake, i.e. where nodal prices provide the best signals to avoid investment, is Wiri
- But, correlations still poor
- DERM can add value by capping demand on occasions where the nodal price is not high enough (the lower-right data points)



Wiri was unconstrained during these months

The value stack is the key to unlocking the value of DER

- DER will be great for consumers and for the system: not "disruptive", but empowering
- DER can add value in multiple ways
- We need to unlock those ways to maximise:
  - Direct benefits to consumers
  - Indirect benefits to consumers of lowering system costs

Potential distributed battery value streams by stakeholder

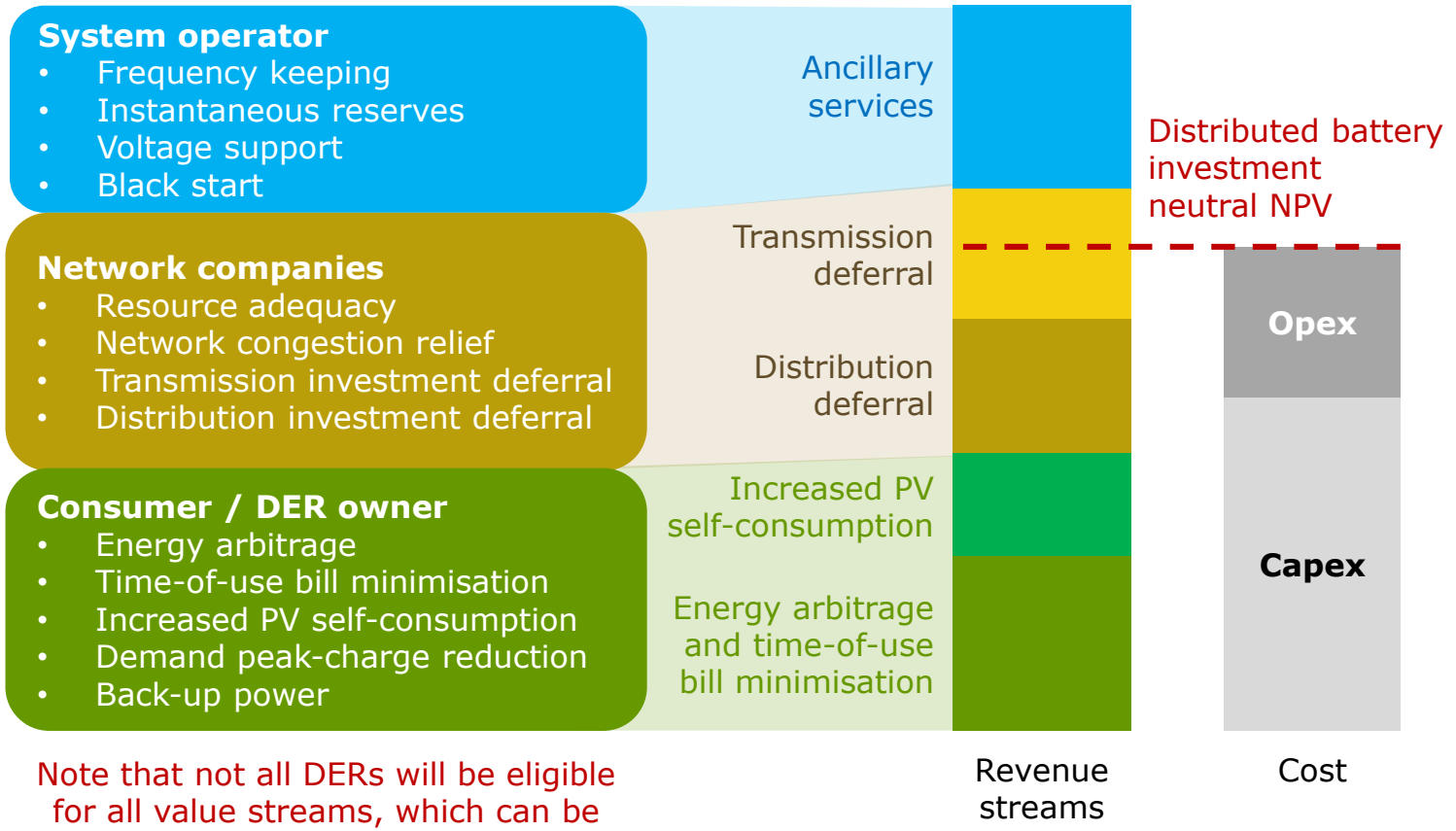
System operator
- Frequency keeping
- Instantaneous reserves
- Voltage support
- Black start

Network companies
- Resource adequacy
- Network congestion relief
- Transmission investment deferral
- Distribution investment deferral

Consumer / DER owner
- Energy arbitrage
- Time-of-use bill minimisation
- Increased PV self-consumption
- Demand peak-charge reduction
- Back-up power

Note that not all DERs will be eligible for all value streams, which can be very location and context-dependent

Illustration of potential distributed battery NPV contribution by value stream



Based on the Rock Mountain Institute's "The economics of Battery Energy Storage". See also Transpower's reports on this subject.

DER owners should be able to 'value stack' across markets

Value stacking is good...

- Obtains maximum economic value of and return from DER investment
- Provides efficient incentives for renewables investment and electrification
- Maximises DER's ability to support the system
- Increases competition
- Minimises unnecessary network and peaking generation investment
- Financial 'double dipping' across different markets can be economically efficient

...but must be done securely

- Need to avoid DER participating simultaneously in two physically different markets (physical 'double-dipping') where that could compromise security
- Transpower's Grid Support Contract (GSC) design is:
  - GSCs will not be offered if they would compromise other security products, including ancillary services and extended reserves, or the markets for these products
  - GSCs will require that there is no physical 'double dipping' between GSC operation and operation of the GSC resources in an ancillary service market
  - GSCs for DER or aggregators within distribution networks will require each DER, the aggregator or Transpower to notify its retailer and local distribution network

The DERM value stack

- From the authors of a recent independent report that the system operator commissioned
- The report's authors assessed the 'size of the pie' that DER providers may be able to access
- Values derived from current market pricing, including the assumed avoided costs of new grid generation and 'poles-and-wires' to meet the expected growth in demand from decarbonisation

$NZ million per annum	2020	2035	2050	Additive?
Energy arbitrage	$3	$21	$70	Yes
Resource adequacy	$24	$588	$861	Yes
Transmission	*$7*	*$166*	*$230*	
Distribution	*$10*	*$234*	*$324*	
Generation	*$7*	*$187*	*$306*	
Instantaneous reserve	$0	$20	$20	Yes
Frequency keeping	$0	$1	$0	Yes
Voltage	$0	$10	$14	No
Harmonics	$0	-$1	-$7	Yes
Simulated inertia	$0	$21	$85	Yes
Black start	$0	$0	$0	Yes
Total	**$26**	**$650**	**$1029**	

Report: Sapere, Distributed Energy Resources – Understanding the potential, July 2020 (link)

Next steps

Transpower's proposals for DERM discussions with IPAG

22 July 2020	21 October	1 December	2021
Focus on learnings from Transpower's programme			Focus on how to move forward

• Introduction
• Transpower's RCP2 DR programme
• Transpower's DERMS platform
	• Continuation:
	  • RCP2 outcomes
	  • Mechanics of our DERMS platform
	• Operationalising DERM: overview
	• Pricing interactions and value stack
		• Continuation:
		  • Any 'parked' or clarification issues
		• Operationalising DERM: detail
		• DERM market development	

For IPAG feedback please