



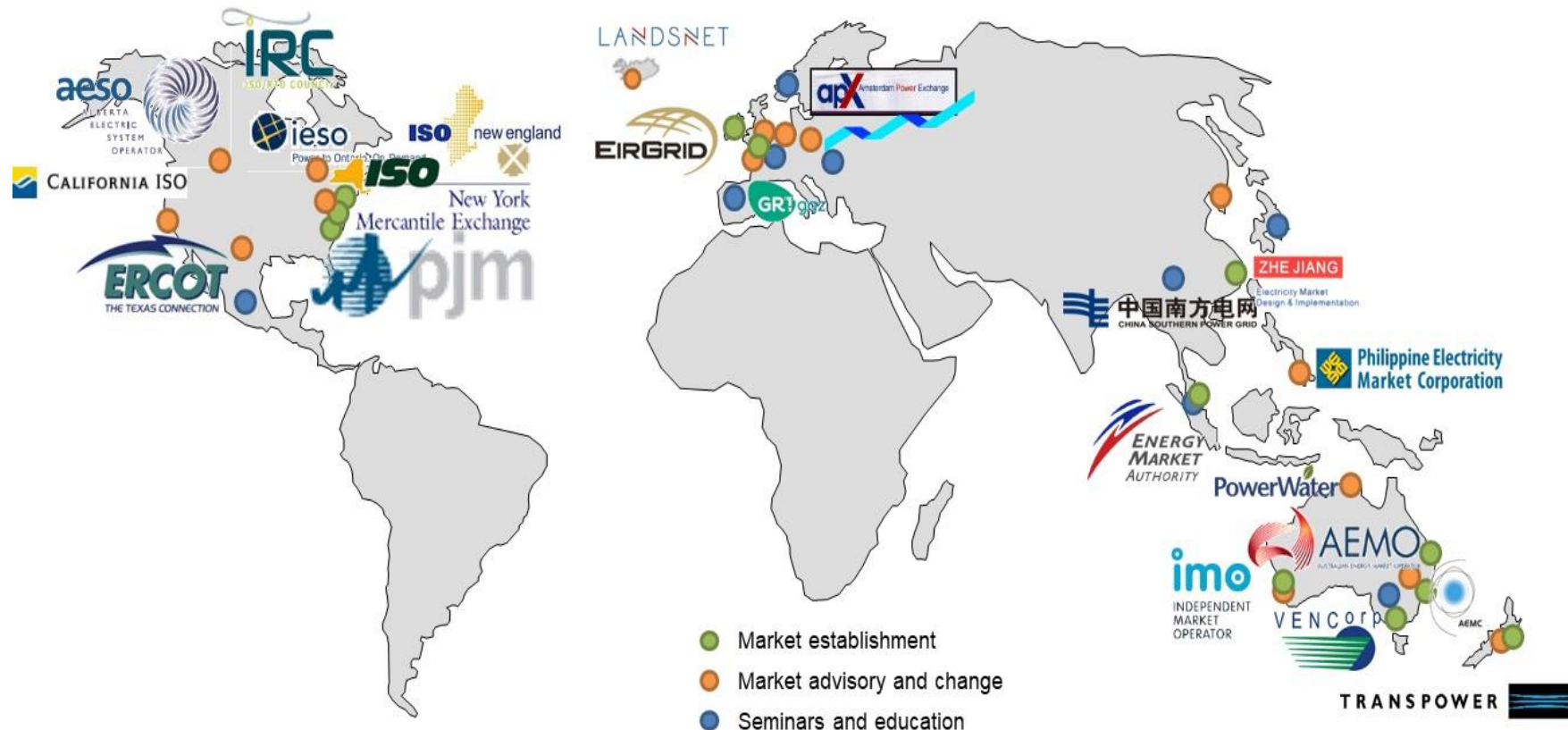
Price discovery in the New Zealand wholesale electricity market under 100% renewable electricity supply

Presentation to the Electricity Authority
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28 July 2021

About Market Reform

Market Reform is an international consultancy specialising in industries undergoing structural change, with a particular focus on energy, water and environmental markets.



Scope

Basics of Price Discovery

NZ Challenges

Toolbox of Potential Market Designs

Case Studies

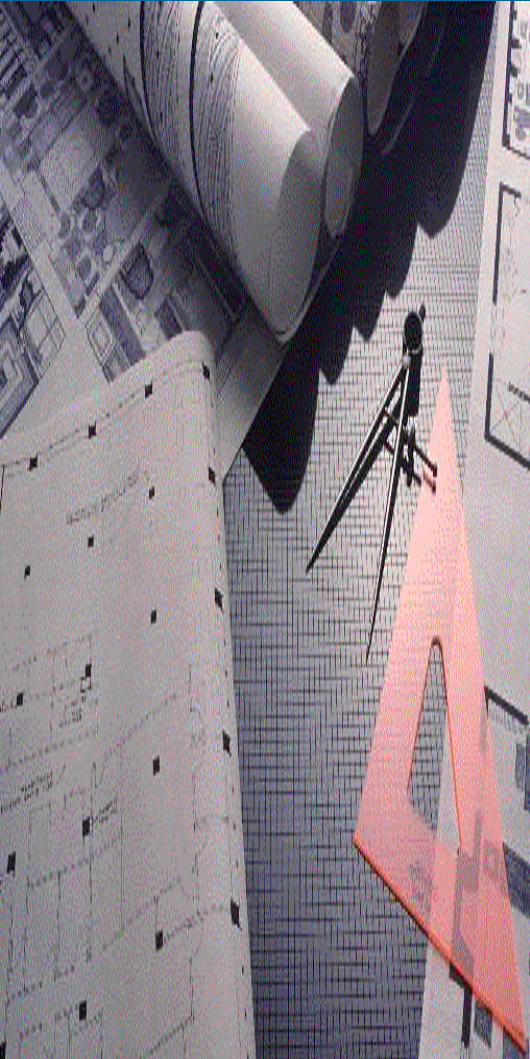
Iceland – ~100% renewable

Ireland – 15 years into major renewable shift

Australia – multiple market design responses to wind and solar

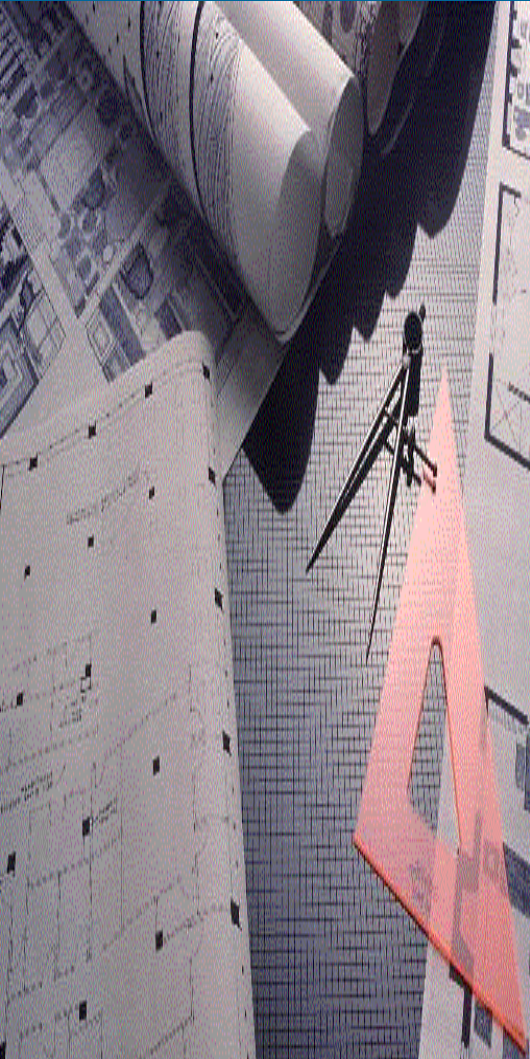
US – review of innovation and challenges with changing technology mix

Approach to Assessing Options



The Market Development Advisory Group has sought advice in relation to the following:

- Problem definition
 - An outline of the consultant's understanding of the problem – price discovery under 100% renewable electricity supply in the New Zealand wholesale electricity market.
 - An outline of the consultant's experience in dealing with the issue, and understanding of the approaches other relevant jurisdictions are exploring and have taken to the issue.
 - An outline of the consultant's understanding of the challenges for New Zealand in dealing with this issue.
- Option identification and analysis
 - The approach the consultant would propose for identifying options and for selecting the preferred option.



The following features of the MDAG broader scope are noted:

- Alternative or supplementary market mechanisms as well as the potential for dry year competition issues are within scope.
- Consideration of Government ownership is not in scope.
- While the transition path to 100% renewables is not directly in scope it is a relevant consideration.
 - A key market design lesson we have learnt is that the transition approach is part of the market design.
 - Any interventions / extra inducements through the transition should be to get to a new steady state that recognises the end design. That is helped by having some/all of the end design active at some point ahead of full renewables.

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Price discovery is simply the process / mechanism for determining a price in a market.

In the case of electricity market prices, this process should ideally:

- Be transparent, so that it is possible to predict prices into the future.
- Reflect competition between participants.
- Provide cost recovery for participants based on their bids or offers.
- Incentivise efficient energy use across time and across space, recognising network limitations, security and operational constraints. In practice this means that the prices should be those associated with the least cost feasible dispatch.
- Incentivise efficient investment over the longer term.



But there are a number of practical challenges:

- The capabilities, behaviours and cost structures of technologies differ.
- Electricity markets operate with uncertainty about future conditions.
- Levels of supply competition can vary with time and location, while for some services there is only one buyer (the market or system operator).
- Keeping electricity prices in a range acceptable to society.

This can require multiple markets for different timeframes and services.



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Approach to Assessing Options

Decarbonisation of non-energy sectors by switching supply to clean electricity will significantly increase electricity demand. The residential share of overall demand will decrease with the share of commercial/industry demand rising.

- The flexibility of the increased demand will have significant ramifications for the cost of supplying that demand.

Gas has been a useful and important backstop in dry year scenarios but will no longer be in the mix.

- The solutions could be many and varied, including price-responsive demand, pumped storage, and the production/import of clean fuels that can be used in more traditional generation technologies.
- The role of the market is to provide efficient price signals (recognising the uncertainties).

The system will face new challenges in responding to contingency events

- Risks of interruptions in flow between the two main islands will be more extreme unless supply and demand become more balanced in each island or greater transmission redundancy is added between islands
- New or revised system/ancillary services will be required, though need will vary with the nature of technology mix. e.g. the system could have high inertia or lower inertia, the latter requiring more services to support frequency.



Future solutions to dry conditions may involve much greater coordination between generation, demand, networks, distribution, other industries, while also involving a broader range of participants and aggregators. It is important to maximise the potential of prices in achieving this coordination.

- A good design uses prices to coordinate the global availability and use of key resources, while staying away from imposing solutions/restrictions on how commercial arrangements deliver resources or react to prices.
- A negative trend we have observed in some markets is for rules to try and define how commercial parties interact, in ways that can actually undermine efficient outcomes.



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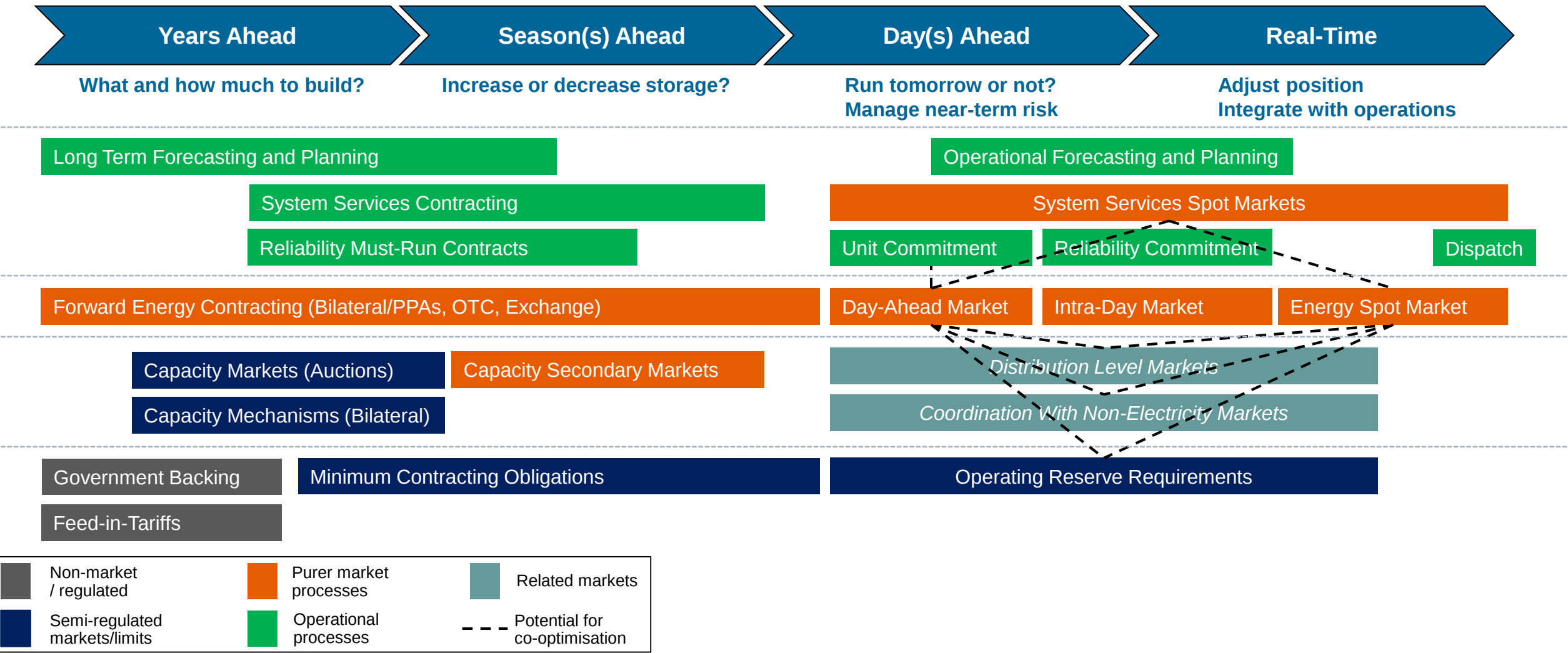
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Approach to Assessing Options

Market Design Toolbox



Investment Timeframe



Long Term Forecasting and Planning

Reliability Must-Run Contracts

Forward Energy Contracting (Bilateral/PPAs, OTC, Exchange)

Capacity Markets (Auctions)

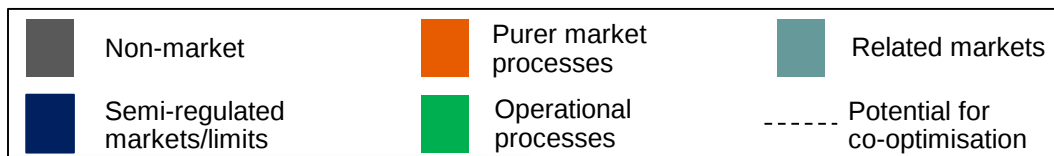
Capacity Mechanisms (Bilateral)

Government Backing

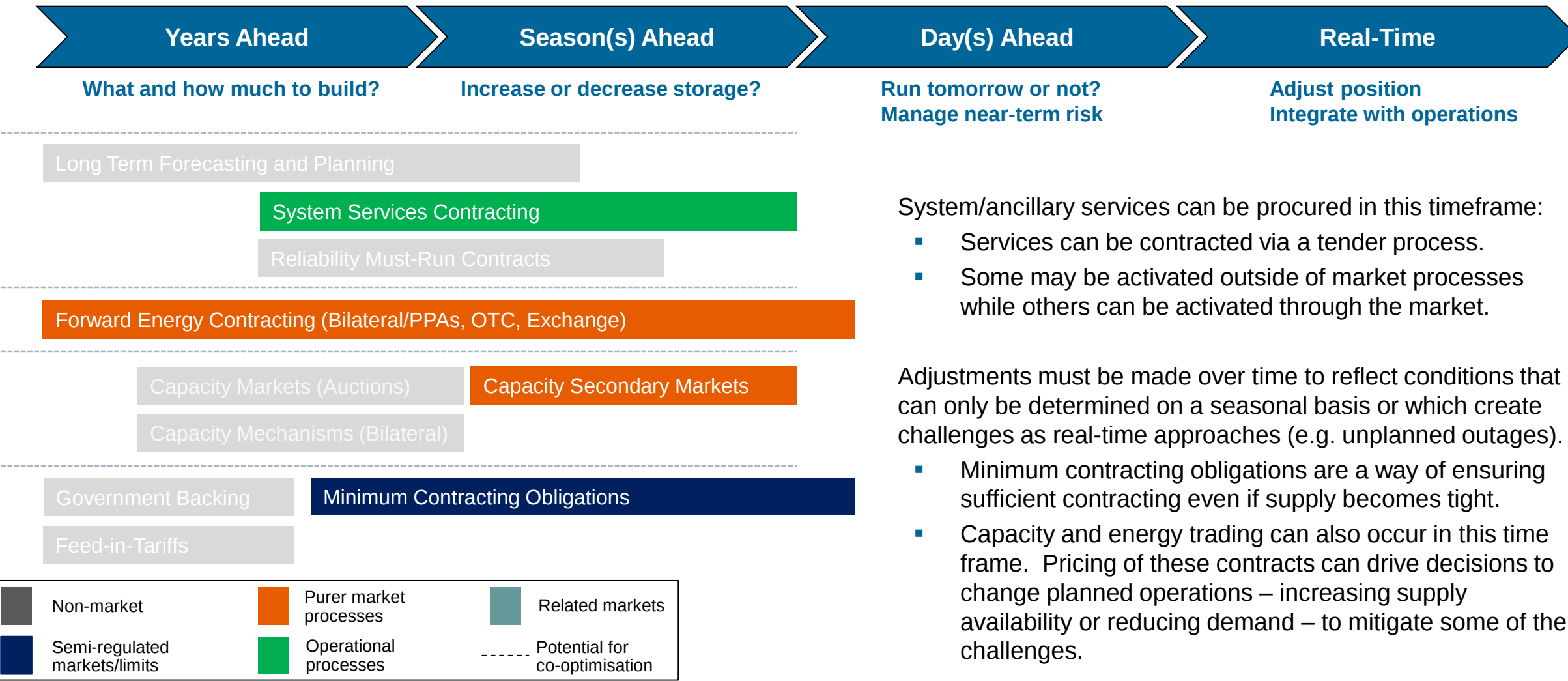
Feed-in-Tariffs

Informed by long term forecasting and planning, sufficient capacity can be maintained by:

- Direct government backing (non-market solution)
- Capacity markets/mechanisms – impose obligations on participants to fund capacity. These are administrative instruments in terms of requirements and limits on pricing. Can be auction-based or bilaterally traded.
- Energy contracts between suppliers and consumers – whether entered into bilaterally (PPAs) or facilitated.
- Support mechanisms – such as feed-in-tariffs, which are effectively contracts imposed on buyers of energy.
- Reliability-must-run contracts – provide funding to prevent the exit of otherwise uneconomic plant required for system security.



Annual/Seasonal Timeframe



System/ancillary services can be procured in this timeframe:

- Services can be contracted via a tender process.
- Some may be activated outside of market processes while others can be activated through the market.

Adjustments must be made over time to reflect conditions that can only be determined on a seasonal basis or which create challenges as real-time approaches (e.g. unplanned outages).

- Minimum contracting obligations are a way of ensuring sufficient contracting even if supply becomes tight.
- Capacity and energy trading can also occur in this time frame. Pricing of these contracts can drive decisions to change planned operations – increasing supply availability or reducing demand – to mitigate some of the challenges.

Operational Timeframe



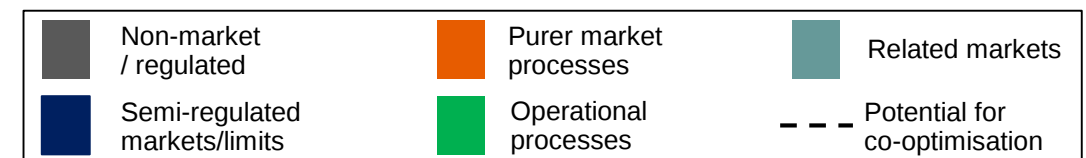
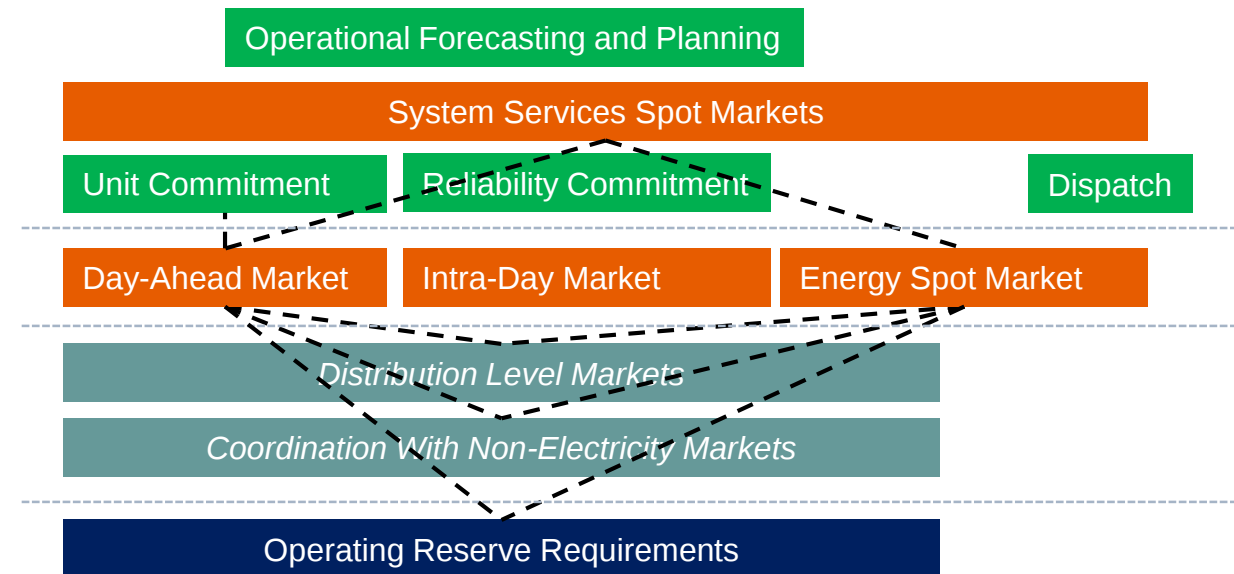
In the day-ahead timeframe:

- Participants can plan the self commitment of their units, or a central commitment process can be used. This is typically operationally driven, and integrated with a day-ahead market.
- A day-ahead market gives financial certainty for participants to commit supply/demand resources ahead of real-time.
- Reliability commitment allows a system operator to adjust the market-based commitment for security and reliability reasons.
- Intra-day markets allow adjustment of positions

The real time markets schedule energy and market-based system services.

- Operating reserve provides additional revenue for dispatchable capacity available to deliver within, for example, 30 minutes.

Distribution-level and non-electricity (e.g. gas) markets can be linked with, potentially or even incorporated within, day-ahead and real-time market processes.



A Technology Neutral Approach



Governments and regulators – and most companies for that matter – aren’t good at picking winners. For example:

- When Australia was first preparing its Renewable Energy Credit scheme, government predictions were that landfill gas would be the largest source – it ended up being wind.
- When entering the second round of the scheme, predictions were for wind to predominate – rooftop solar ended up doing so instead.

Pricing (and scheduling) in markets is about efficiently managing constraints and limitations so is more about supporting *potential properties of technology* rather than requiring knowledge of the specific technologies.

It may be tempting to implement a market solution that encompasses the full-range of foreseeable services and technical characteristics.

- Even if they may have no value today, they may become valuable in the future.
- However, this has cost and complexity implications

The real challenge is achieving a market design that provides “the best bang for your buck”.

A Technology Neutral Approach

Examples of characteristics that often need to be considered in the market design process – generally due to their impact on operations/reliability – include:



- Costs:
 - high investment, low running cost vs. lower investment cost, higher running cost.
 - whether fixed startup costs are incurred (independent of output)
 - whether a minimum output level must be maintained (implying a fixed cost per period)
- Availability:
 - Is it firm and generally available or is its availability limited by time or quite variable.
 - Is availability dependent on weather, river flows, fuels, storage etc.
- Other properties:
 - Does it produce or consume services (energy, system services)
 - How fast does it start, stop, ramp, etc.
 - In the case of networks, whether they are AC or DC, their level of losses, and additional services they might provide.

Pricing and Zero Marginal Cost Resources

In some circles it has become accepted dogma that:

- Renewable resources offering energy at zero marginal costs will give rise to zero-valued marginal energy prices.
- The energy market will consequently become unworkable without additional support (e.g. capacity markets).



The most obvious flaw in this argument is it ignores the response of demand.

- If energy prices are low in the short-term and load has visibility of this, their demand will increase.
- If prices are expected to be low in the long-run, then new demand-side investments (e.g. heavy industry) will increase demand until the price rises to a level which makes further demand increase unsupportable.
- In the context of increasing electrification of industry and transport, there will likely be many new sources of price responsive demand.

Pricing and Zero Marginal Cost Resources

Further, limitations on the storage of energy (in batteries, as water in reservoirs, or in other ways) creates non-zero value of energy.

- As is well known in the context of NZ hydro storage, the value of stored energy reflects the future value of that storage – which might be defined by the value demand places on it.
- If that is higher than the current market price, it is better to store it than release it. And storage is certainly limited on a seasonal basis.

It would be logical, in the context of moving more of industry to electric power, to think about how that load interacts with the electricity market to provide flexibility in tight supply situations and to drive pricing.

- Dispatching demand (through day-ahead or real-time processes) based on bids to consume is an economically more rational approach than mechanisms that assume a right to consume and pay consumers not to consume relative to what they might otherwise have done.





Recapping the fundamentals – an effective forward market requires

- Fair competition in the physical market, with equal access to supply and transportation
- Plurality of buyers and sellers
- Elimination or mitigation of market power concerns
- Price volatility in the cash/spot market
- Sufficient volumes available for open trading and not locked in long-term bilaterals, or other opaque deals

The likely increase in volatility in the spot/real-time market revenues underlines the importance of forward contracting.

- Many renewables supported by ‘power purchase agreements’ (PPAs).
- These arrangements are bilateral and opaque, and thus don’t contribute to forward price transparency

As system services become a more important part of the revenue mix, forward contracting would be valuable for revenue certainty.

- However, in many markets, the System Operator is a monopoly buyer of system services
- Would need to structure to create multiple buyers as well as sellers.

Some More Universal Challenges



The transition to 100% renewables cannot be divorced from the enduring market design.

- In the extreme case, if a purely interventionist approach were taken to achieve the transition, with investments backed by contracts based only on recovering the cost of the investment, then there is likely to be a major disconnect between capacity, capability and market price.
- Similar problems arose with panicked government driven/backed investments triggered by the 1970's energy shock, with over-investment resulting. Californian utilities were still buying energy from independent power producers based on an oil price of \$US100/barrel 30 years later when oil prices were \$US20/barrel.
- A key market design lesson we have learnt is that *the transition approach is part of the market design*.

With any price-impacting reform the political reality of keeping consumer costs in an “acceptable range” is always an important consideration.

- Important not to blunt signals to address shortages – high prices and volatility have benefits in the short run (with price caps and cumulative price thresholds controlling excessive outcomes).
- There is a real-trade off to be considered between volatility and risk.
- The short-term relationship between retailers and their customers is a challenge to long-term contracts that protect against risk. Capacity markets/mechanisms and obligations on contracting are potential methods of manage this challenge.

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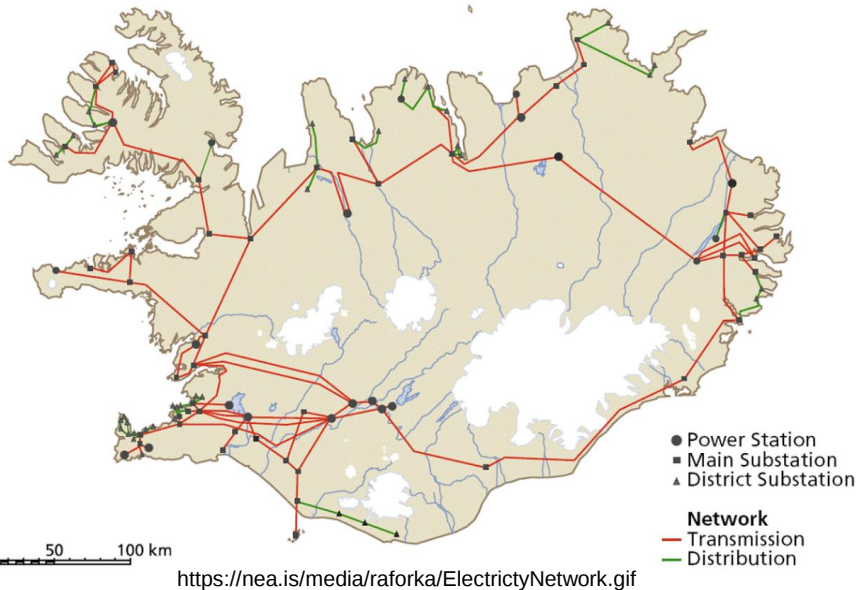
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Approach to Assessing Options

Case Study 1 – Iceland



- Peak demand > 2000 MW
- Annual consumption = 19 TWh (≈ 50% of NZ)
- Population ≈ 300,000
- 80% industrial load (smelters, data centers)
- ≈ 85% of homes have geothermal heating.
- 73% hydro (fed by winter snow melt); 27% baseload geothermal
- Diesel (<1%) for non-spinning reserve capacity.

Iceland is essentially 100% renewable though lacks a modern market. Market Reform was engaged by Landsnet (the transmission company) to explore potential future designs.

Iceland provides a useful case study as it has some similarities to a potential NZ power system of 2050 under a 100% renewable scenario, having both hydro and geothermal generation and with residential usage being only a small part of total load.

Industry Characteristics

- One dominant (75%) generator (not a retailer) with four competing gentailers.
- More capacity will be needed in future. Wind generation is planned.
- Transmission network congestion is a material issue.

Nature of Current Trading Arrangements

- Power Intensive Users (PIUs) exist as a separate market
 - supplied under very long term (20+ year) contracts (fixed in USD)
 - restrictions prevent reselling energy (allowing price discrimination).
 - not well suited for data centers or for efficient use of energy.
- A basic, real-time regulating market for matching supply and demand in real-time.

Iceland – Components of Proposed Design



Capacity Mechanism

- All energy users must fund capacity providers.
- Ensures adequate capacity
- Certainty over cost recovery



Ancillary Services

- Current arrangements persist
- Revised frequency regulation arrangements



Bilateral Contracts



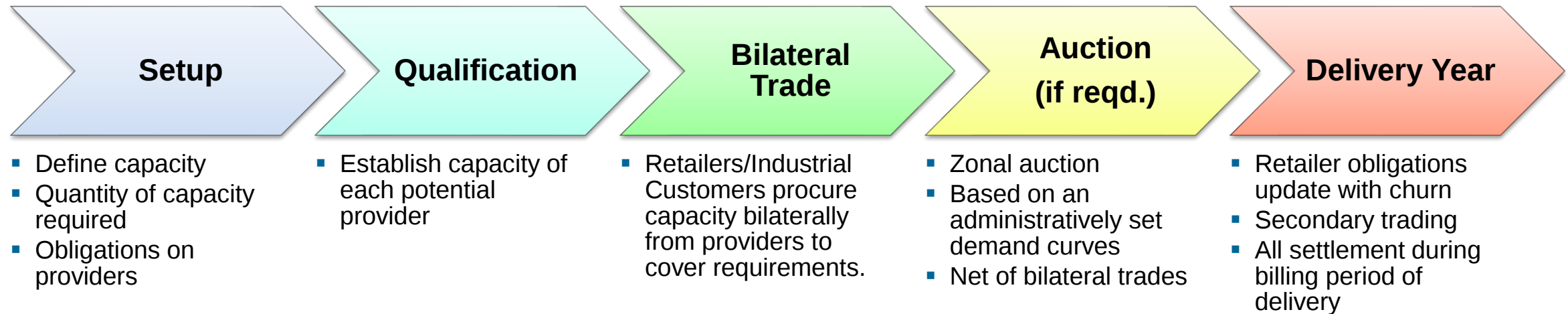
- Capacity and energy
- Accommodates both physical and financial forms
- Basis for self-scheduling

Real Time Market



- Adjustment to self schedules
- Match supply and demand
- Integrated with physical dispatch
- Locational price signals

Iceland – Potential Capacity Market Process





- Market power is a concern:
 - dominant state-owned generator
 - some individual smelters have demand similar to *total* non-industrial demand
 - currently prevented from reselling surplus contracted energy
- Policy / political options are the most effective way of addressing market power:
 - Restructuring / disaggregation
 - Vesting contracts - but can lower liquidity, best used transitionally
 - Imposing minimum levels of contracting with limits on contract prices
 - Contracts to be sold through a contestable tender process to drive forward trading liquidity
 - Requirements on the minimum capacity to be sold through a capacity mechanism.
 - Imposing limits on bidding behaviours (e.g. cost-based bids)
- Market design cannot resolve market power, but can mitigate it being exercised:
 - An open market with transparent pricing mitigates price discrimination and asymmetry of information
 - Overt market monitoring and policing of market power abuses by an empowered independent regulator
 - Bid screening systems that test the ability of a supplier to exert influence on locational prices through its bidding and then impose limits on bids (e.g. based on cost or historic bids)

Iceland – Relevant Learnings

- 
- Iceland resembles at least one of the potential futures for NZ: $\uparrow$ demand $\uparrow$ geothermal.
 - New Zealand has advantage of already having nodal pricing.
 - While a DAM is not deemed relevant for Iceland, various supply/demand scenarios for NZ – e.g. a need for supply and demand commitment decisions – might result in a different assessment.
 - Increasing the flexibility of demand is a key requirement for, and benefit of, reform.
 - Will play an increasingly important role in setting marginal price in the operational timeframe
 - Also likely to be valuable in managing seasonal variation risk, and decisions in the investment timeframe
 - Capacity mechanism attempts to address capacity quality issues and political risks, without getting too bogged down on administrative settings.

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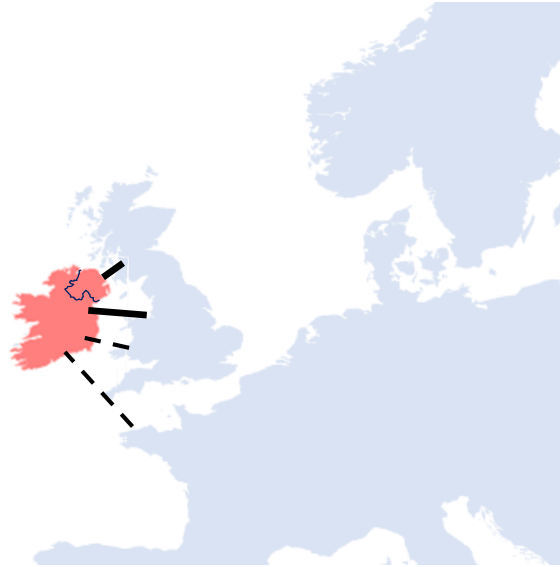
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Case Study 2 – Ireland



- Two jurisdictions (RoI and NI). Operates as Single Electricity Market (SEM). € and £
- Peak demand = 6,878 MW
- Annual consumption = 38 TWh (≈ NZ)
- Population ≈ 6.8m
- Traditionally coal, gas; significant wind in last 15 years
- Interconnectors: 2 x 500 MW (EI-GB, NI-GB); plan 500 MW (EI-GB), 700 MW (EI-FR)

Ireland is well advanced in a transition from a thermal system to a largely renewable system. Market Reform advised EirGrid (market/system operator) in implementing the all-island market (SEM, 2007) and in integration with European arrangements (I-SEM, 2018).

While the context of Ireland is different from New Zealand, it is 15 years into an energy transition and provides a useful case study of how the market arrangements have evolved, as well as illustrating some design options that are not used in New Zealand.

Industry Characteristics

- Largest generator = 42% market; largest 8 generators ≈ 90% market share.
- 12 major retailers; ≈300 participants (many very small).
- Targeting 70% renewable MWh (100% instantaneous) by 2030
- Significant increase in demand from data centres (esp. around Dublin)

Nature of Current Trading Arrangements

- Participate in European day-ahead market
 - due to Brexit, currently not directly connected to European arrangements
- Intra-day auction between Ireland and GB, with additional intraday continuous trading
- Central capacity market with additional support mechanisms for renewables.
- Real-time balancing market with single price for EI/NI. Contracted ancillary services.

Ireland – Day-Ahead Market Operation (Pre-Brexit)

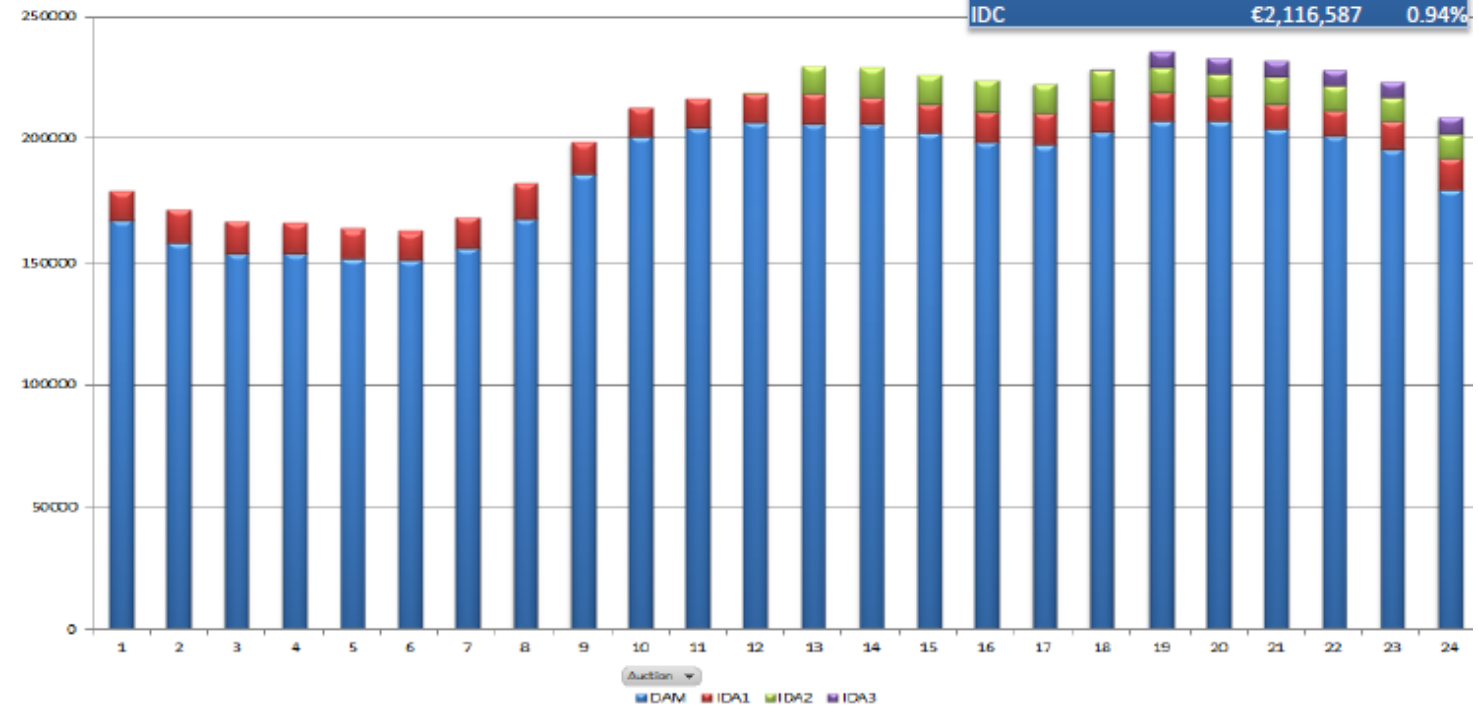
- Ahead market provides a way of locking in a price for a quantity before having to commit to run plant or consume energy.
- The Pan-European day-ahead auction (DAM) is highly liquid.
- Closes 12 hours ahead of trading day.
- Renewables participate in DAM (renewable support contracts referenced to DAM).
- Three Intra-Day auctions (IDA) with Britain and continuous trading (IDC) in Ireland allow adjustment to positions ahead of real time
- Performance reduced since Brexit with separate DAMs in each of Ireland and GB, Interconnectors scheduled later based on intraday auctions.

- Volumes from ex-ante (28th Mar – 8th May)

- DAM is dominant

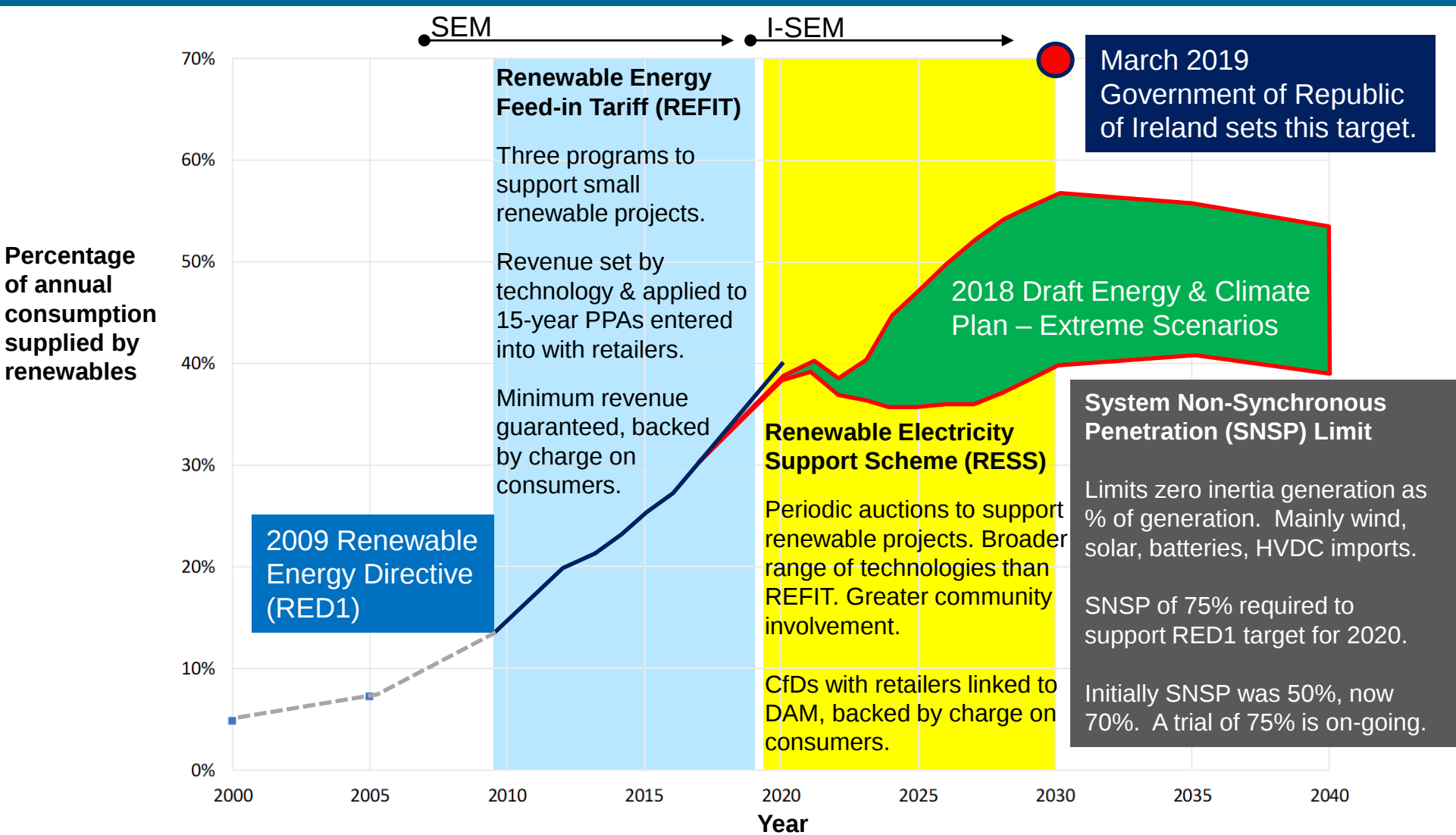
- *Using approx. prices*

Market	Value	% of DAM
DAM	€224,533,941	
IDA1	€14,021,080	6.24%
IDA2	€6,997,254	3.12%
IDA3	€2,362,355	1.05%
IDC	€2,116,587	0.94%



Source: EirGrid and SONI, Market Operators User Group Slides, 3 April 2019

Ireland – Evolution of Renewables Policy and Support



- “Delivering a Secure, Sustainable Electricity System” (DS3) was a program to meet Ireland's 2020 electricity targets by increasing the amount of renewable energy on the Irish power system in a safe and secure manner.
- DS30 is an extension of this program to achieve the newer 2030 target.
- This slide describes the services implemented under DS3 and the methods for procuring them.
- A key feature of this approach is to give investors confidence that there will be funding for features of their plant that support increased renewables.

Procurement

Usually participants apply to provide service and get a regulated Tariff Rate. System operators tenders for primary, secondary and tertiary operating reserve (one volume for all per unit) from high availability technologies to cover requirement and a pay-as-bid rate is set.

The 14 Services

Synchronous Inertial Response
Primary Operating Reserve
Secondary Operating Reserve
Tertiary Operating Reserve (2 time frames)
Replacement Reserve – Synchronised
Replacement Reserve – Desynchronised
Ramping Margin (3 time frames)
Steady State Reactive Power
Fast Frequency Response
Fast Post Fault Active Power Recovery
Dynamic Reactive Response

Services Funding

System operators pay services per period as follows :

$$\text{Amount} = \text{Rate} \times \text{Availability} \times \text{Scalars}$$

Rate is either Tariff Rate or Pay-as-Bid price.

Scalars increase/decrease payment rate based on performance and locational/temporal scarcity/excess.

Providers are eligible for payment if available, regardless of the real-time need for the service (though this may change the scalars).

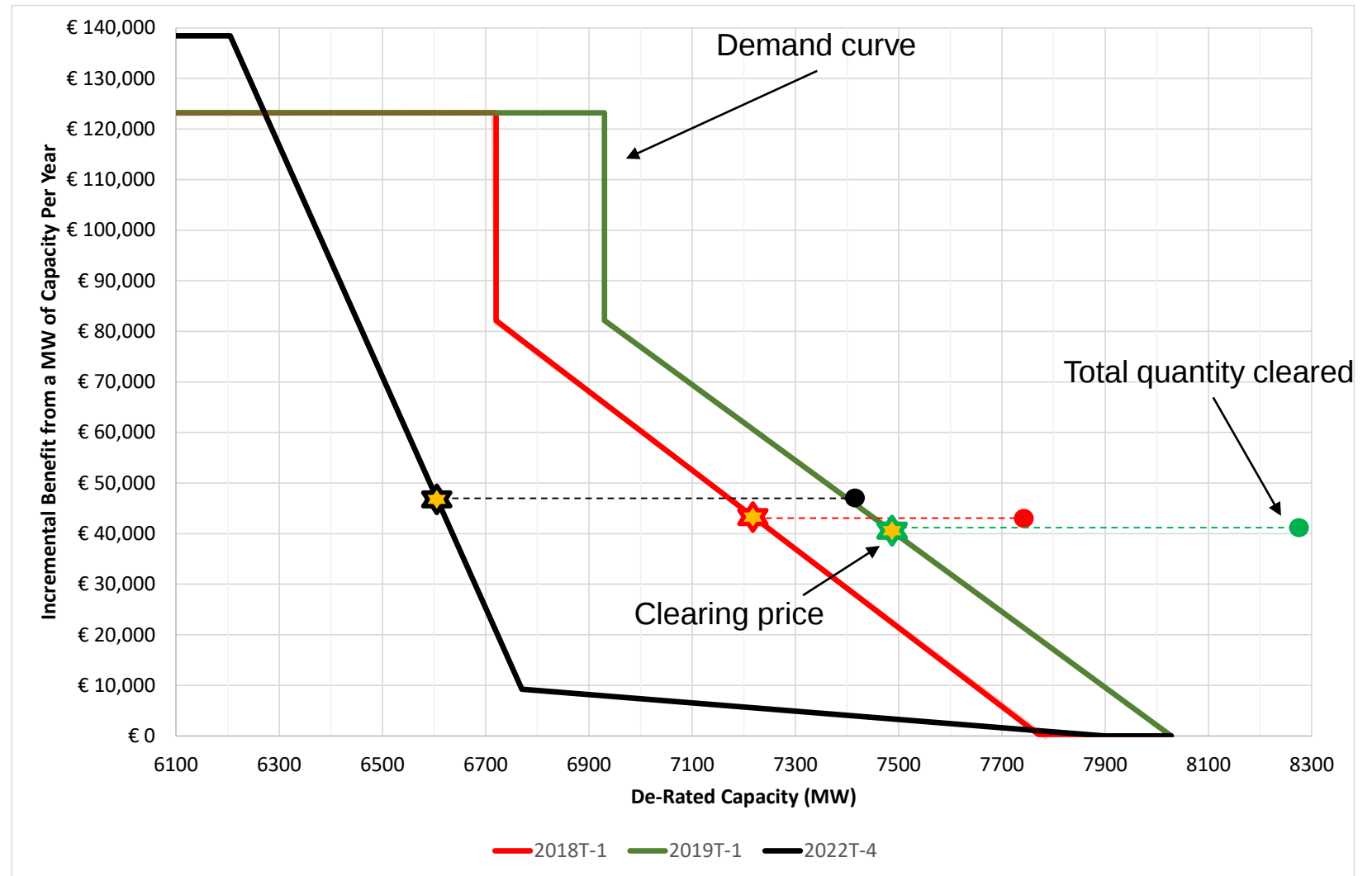
System operators funded DS3 from their regulated revenue (which includes an allowance for DS3) and can financially gain or lose, giving them an incentive to manage services.

Use of Services

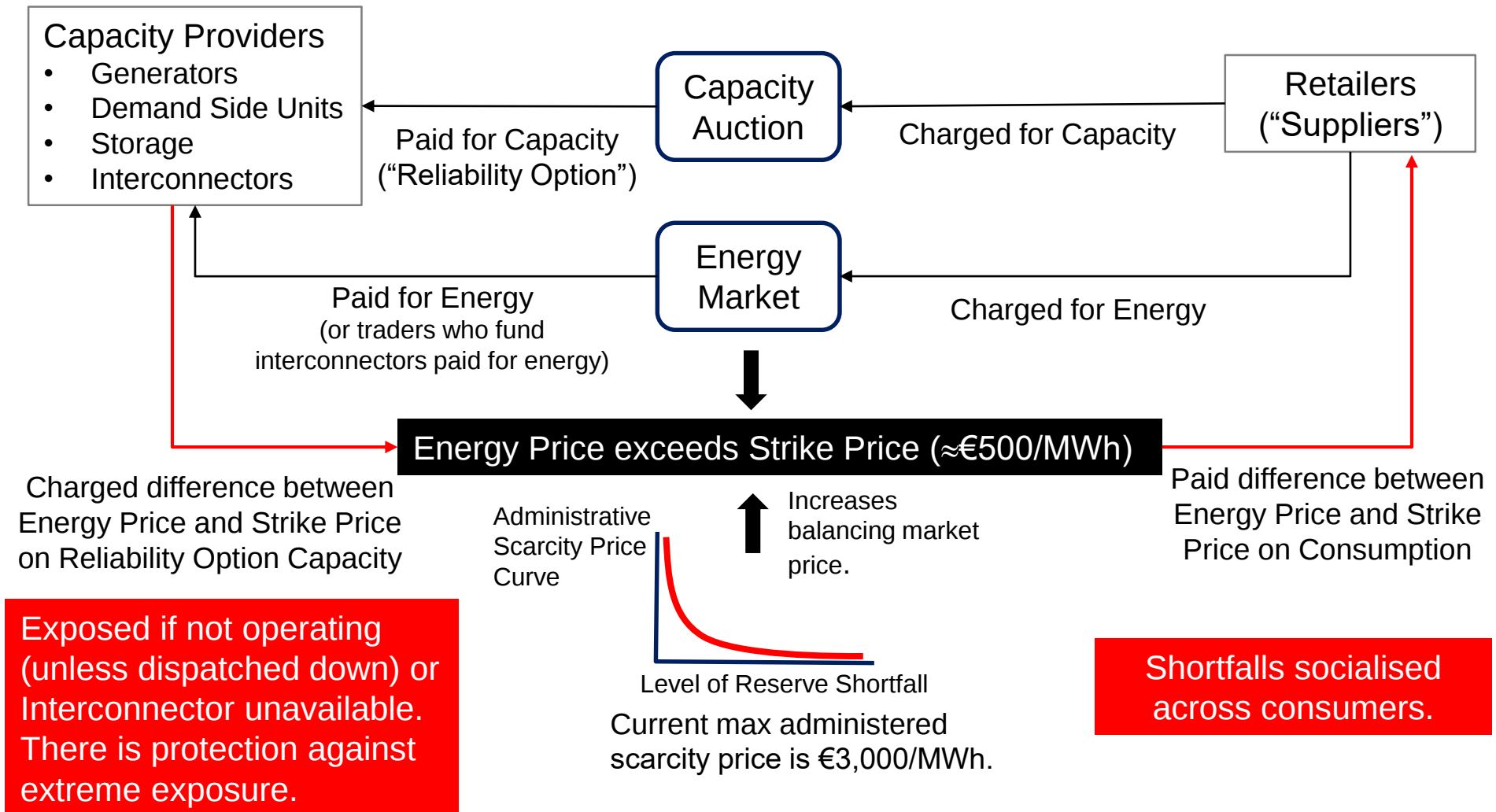
Scheduled/activated either automatically or dispatched depending on service.

Ireland - Capacity Market Auctions

- Capacity auctions first run 4 years ahead (T-4). Transitional one year ahead auctions (T-1) run to fill gap.
- First two T-1 auctions (2018 & 2019) run before first T-4 auction (2022).
 - 2020 & 2021 auctions run later.
 - Unnecessary risk for investors.
- A very administrative process.
 - Regulators set demand curves
 - Clearing prices where supply and demand curve crossed.
 - 2018/19 accepted what cleared based on price then cleared more to cover zonal constraints.
 - 2022 covered zonal constraints first, then cleared more based on improved net benefit.



Ireland – Reliability Options



Ireland – Some Challenges



- Ireland has never adequately addressed congestion
 - European target model doesn't provide intra-regional price incentives.
 - New transmission build is unpopular.
 - Capacity market has zonal constraints but incentive is not sufficient, and provides no signal where load should locate.
- Capacity market requirements are based on future forecasts of load, but these can be volatile. e.g. growth in data centers.
- New capacity procured through the capacity market has not always eventuated (even with financial penalties).
- Demand side units were a successful innovation in energy market but have had issues fulfilling their capacity market obligations.
- There is limited coordination between the capacity market, the additional mechanisms for supporting renewable investment, and DS3/DS30.
- Brexit has impacted interconnector scheduling. Flows no longer scheduled through DAM. Workarounds using intra-day auction and forward scheduling

DUBLIN, 1 July 2021 — The Government is taking steps to provide emergency power generation in Dublin because of serious constraints on the electricity network that have raised concern about supplies next winter.

Irish Times



- Lack of locational pricing, coupled with inability to get transmission built, is creating locational shortfalls and leading to out-of-market policy responses. Reinforces value of locational pricing in NZ.
- Capacity markets provide a means for managing a transition but are very administrative – driven more by regulatory decisions than market demand – and imperfect.
- In transitioning to an (unknown) future mix of technologies, the various support mechanisms should be aligned. A solution might reflect the following elements:
 - Map each resource and load to technical characteristics reflecting its contributions and its costs to the system. Should be defined in a broad, technology independent manner, to accommodate any resource mix.
 - Desirable mixes of resources could be imposed as constraints in a capacity market or incentives could be imposed on purely market-based investment processes.
- High levels of renewable participation in the DAM provides greater financial certainty heading into real-time. However, the real-time market bears significant out-of-market costs in achieving an efficient real-time dispatch reflecting actual conditions (and congestion).

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Case Study 3 – Australia and Increased Intermittent Generation

NTEM

- Gas system with 300 MW peak. To be 50% renewable by 2030.
- 90 MW of behind meter solar, 70 MW of grid scale solar planned
- Forecast availability of intermittent generators must be firm by real-time.

Key ideas being proposed:

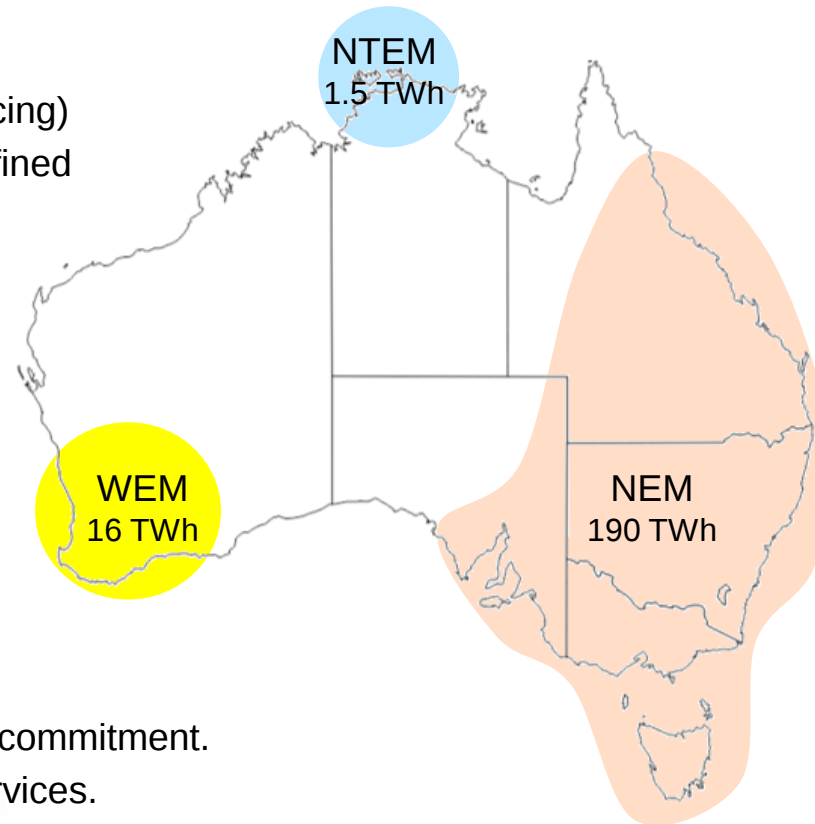
- Central unit commitment
- Two zone energy market (ex post pricing)
- Essential system services to be redefined and procured under contract

WEM

- Main fuels are coal, gas, wind.
- 1.5 TWh of behind the meter solar.
- “Aspirational policy” to be 100% renewable by 2050.

Redesigned market being implemented:

- Retaining capacity mechanism, self-commitment.
- Real-time pricing of most system services.



NEM

- 75% fossil, 8% hydro, 11% wind, 4% grid solar.
- 10 TWh of behind the meter solar.
- Renewable energy zones + other state-based investment support initiatives being developed.

Key ideas being proposed (NEM 2025 review):

- Retailers currently must hold minimum levels of contracting if a risk of shortage:
 - Make it permanent, and/or
 - Introduce standard “capacity certificates”
- Locational pricing (currently zonal)
- New fast frequency response services
- While a self commitment market, allow central commitment for security near to real-time
- Longer-term interest in market mechanisms for system strength and inertia

Australia – Relevant Learnings



- A mixture of forward contract and capacity market approaches in investment timeframe.
- A spectrum of different approaches to unit commitment.
- Moves to make intermittent generator availability firmer and more dispatchable.
- Focused on enhancing system services in real-time to accommodate intermittency.
- Renewable energy zones under development to simplify renewable investment.

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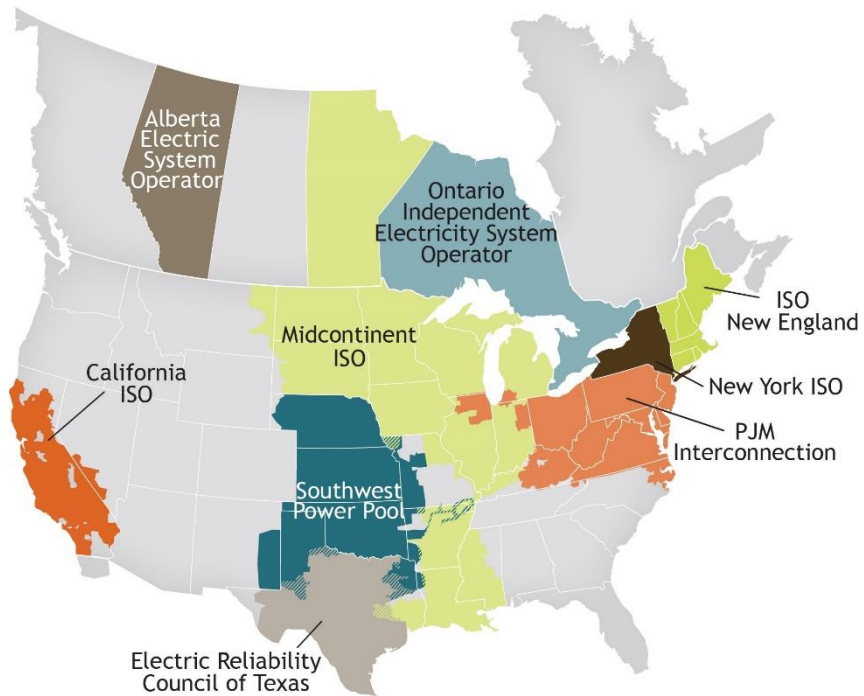
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Case Study 3 – US Experience



The US comprises a mixture of state of reform. Some regions still operate with regulated utilities while others have advanced markets with significant supply side and retail competition. There are different policies on renewables by regions though the economics of renewables has still driven significant investment more broadly across the US, though specific technologies in use vary with climate and level of energy prices.

We focus on a few relevant examples of experience with different market designs and features.

Source: ISO/RTO Council from the report:
Market Reform, *Resource Investment in the Golden Age of Energy Finance*, May 2015

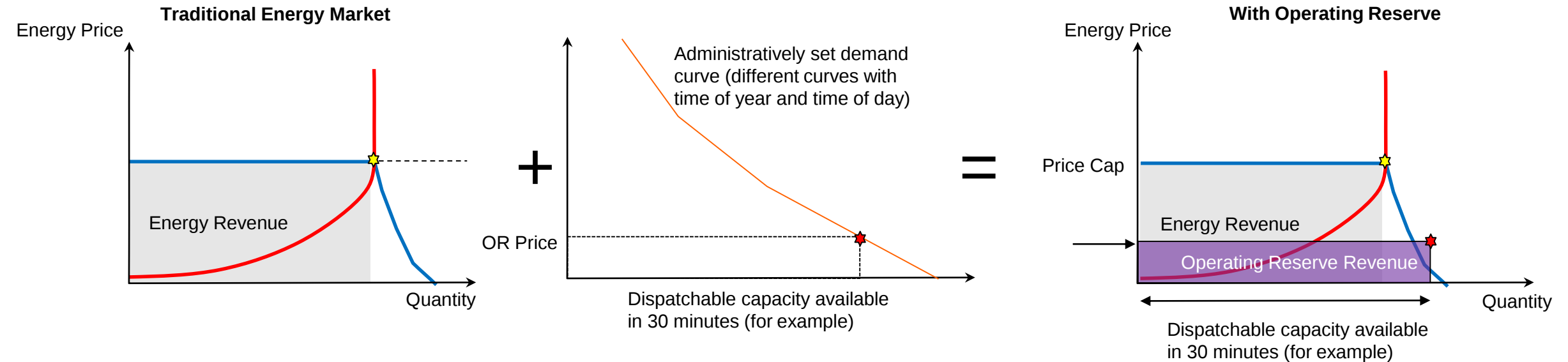
US Capacity Markets

Evolution of PJM's Reliability Pricing Model (RPM)



Challenge	Solution
Energy market with low price cap doesn't provide adequate incentive for peaker plant	Installed capacity (ICAP) market with fixed 'installed reserve margin'
Plants unavailable due to forced outages	Unforced capacity (UCAP) derating based on forced outages
Fixed capacity target; no incentive beyond that point	Sloping demand curve
Inadequate incentive to bring capacity to congested areas	Locational (zonal) demand curves for defined regions
Annual market supports existing plant, but little to encourage participation of new build	Capacity auctions conducted for present year, and +1, +2 and +3 years out.
Generation-centric	Open participation to demand-side, energy efficiency
Performance problems with significant amounts of plant not available in extreme weather event	Higher payment for high availability, fuel secure Obligation to be available during 'capacity performance' events, with tough penalties
Proliferation of intermittent resources	Rate based on "effective load carrying capability"
Revenue volatility due to adjustment of parameters, leading investors to discount capacity revenues	[None yet]
Out-of-market state subsidies/incentives reduce capacity prices for all resources	Minimum offer price rule (MOPR) – highly contentious, and the subject of much regulatory activity

Operating Reserve ERCOT's Alternative to a Capacity Market



- Operating Reserve (OR) funds capacity to be available to be dispatched within a time frame following real-time, e.g. 30 or 60 minutes.
 - This provides a revenue source to fund flexible capacity required to mitigate variations in system load (e.g. due to variations in behind the meter solar) or generation (e.g. due to variations in solar farm or wind generation).
 - The price and volume purchased is based on an administratively set demand curves that vary by period, though a two-sided market could be used.
- ERCOT (Texas) is a gas dominated system with high levels of wind penetration. It has a day-ahead market but no capacity market.
 - 30 & 60 minute OR purchased day ahead based on administratively set demand curves defining the price as a function of volume procured.
 - Prices paid to all generators running in real-time (including variable resources) plus all unused dispatchable capacity deliverable in OR time frame.
 - Prior to introducing OR Texas went through a boom and bust capacity cycle so it may be smoothing out investment.
 - ERCOT is planning a move to have OR procured through both its day-ahead and real-time markets.



- Have more nuanced and developed capacity markets
- Highly driven by administrative parameters, leading to debate about the parameters themselves, as well as significant political/regulatory argument about market design.
- Clashes with purer market thinking, and has led to concern that the capacity market dulls the incentives generated by the energy market.
- ‘Operating reserve demand curve’ offered by ERCOT – which does not have a capacity market – as a more market-centric option.

Scope

Basics of Price Discovery

NZ Challenges

Toolbox of Potential Market Designs

Case Studies

Iceland – ~100% renewable

Ireland – 15 years into major renewable shift

Australia – multiple market design responses to wind and solar

US – review of innovation and challenges with changing technology mix

Approach to Assessing Options

Approach to Assessing Options



- Start with a clear statement of the problem and the desirable properties of the solution.
 - Identify expectations of the design for different timeframes
 - Express requirements in terms of desirable characteristics, not preferred technology
- Form a set of design components
 - Each design feature should be classified based on the elements of the problem it contributes to addressing.
- Vet design components to remove those unlikely to address the problem or provide desirable features.
- Form design options into sets of consistent high-level designs but which may take different philosophical approaches.
- Assess each option set relative to the problem statement and the desirable properties.
 - Supported by consultation and, where appropriate, modelling.
- Make recommendations on high-level design, based on how the options address the problem, noting trade offs with respect to cost.

