Energy Transformation Implementation Unit

Transformation Design and Operation Working Group Meeting 4

GROUND RULES

- The Chair will aim to keep the meeting to time so that we can get through the large volume of material for discussion.
- Questions and issues raised must be kept relevant to the discussion. Other matters can be raised at the end of the meeting or via email to tdowg@energy.wa.gov.au
- Please state your name and organisation when you ask a question to assist with meeting minutes.
- This meeting will be recorded for minute-taking

TASKFORCE PUBLICATIONS

Available on:

https://www.wa.gov.au/government/document-collections/taskforce-publications

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Delivering the Future Power System

Following consultation, the Energy Transformation Taskforce will make decisions on elements of market and regulatory design. These decisions will form the basis for draft market rules and regulations.

Taskforce decisions, information papers and consultation drafts of rules and regulations will be published here as they are completed.

Issue	Information Paper/ Taskforce Decision	Draft Rules/ Regulations
Foundational Market Parameters	✔	
Power System Security and Reliability Regulatory Framework	✔	
Improving the Technical Rules Change Management Process	✔	
Scheduling and Dispatch (Energy)	✔	
Power System Constraints Equations Governance Framework	✔	
Essential System Services Technical Framework	✔	
Essential System Services Acquisition Framework - Frequency Control	✔	

Energy Transformation Implementation Unit

ESS Scheduling and Dispatch

TDOWG

19 November 2019

CONTENTS

1. Recap new ESS products
2. ESS accreditation
3. Offering to provide ESS
4. Dispatch process
5. Dealing with shortfalls of energy and ESS
6. Storage participation
7. Intermittent participation (incl co-located storage)
8. DER/DSR participation
9. Next steps

ESSENTIAL SYSTEM SERVICES

ESS	Risk being covered	Service description
Regulation	Upward/downward deviation from load and generation forecast and dispatch during dispatch interval which causes the frequency to drop below (Raise) or rise above 50 HZ (i.e. Lower)	Reserve MW headroom/footroom to respond to AGC signals upwards during dispatch interval when load>generation and downwards when load<generation
Contingency Reserve	Loss of generation (Contingency Raise) or large load (Contingency Lower) The function of the Contingency Reserve service is to ensure minimum frequency requirements are maintained, e.g. avoid UFLS for a single credible contingency.	Reserve MW headroom/footroom to respond to loss of generation/load to restore frequency to acceptable level
RoCoF Control	If frequency changes too quickly it can cause problems for electrical equipment connected to the power system, including generator and motor tripping, protection scheme mal-operation, and a potential for cascade faults which risks overall power system stability. Also supports in case of loss of generation/load. The RoCoF Control Service has two functions: • Ensure rate of change of frequency is restricted to below a certain maximum level • Ensure minimum frequency requirements are maintained, by potentially allowing trade-off between the amount of reserve required and the amount of inertia on the power system	Provide megawatt-seconds of synchronous inertia to provide instantaneous response that slows down rate of frequency change.

ESS Accreditation

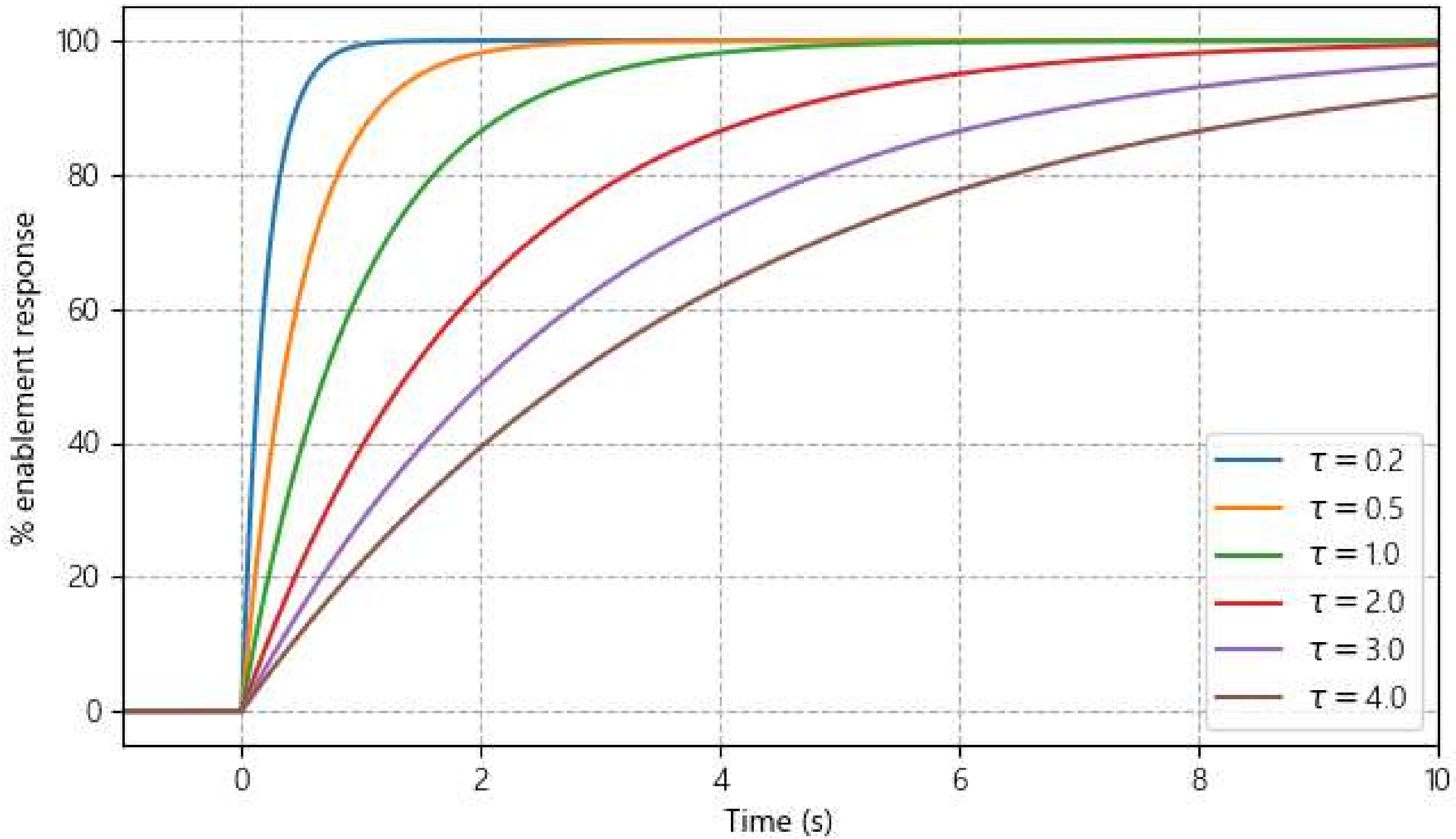
ESS ACCREDITATION – CONTINGENCY RESERVE

Contingency reserve accreditation will include:

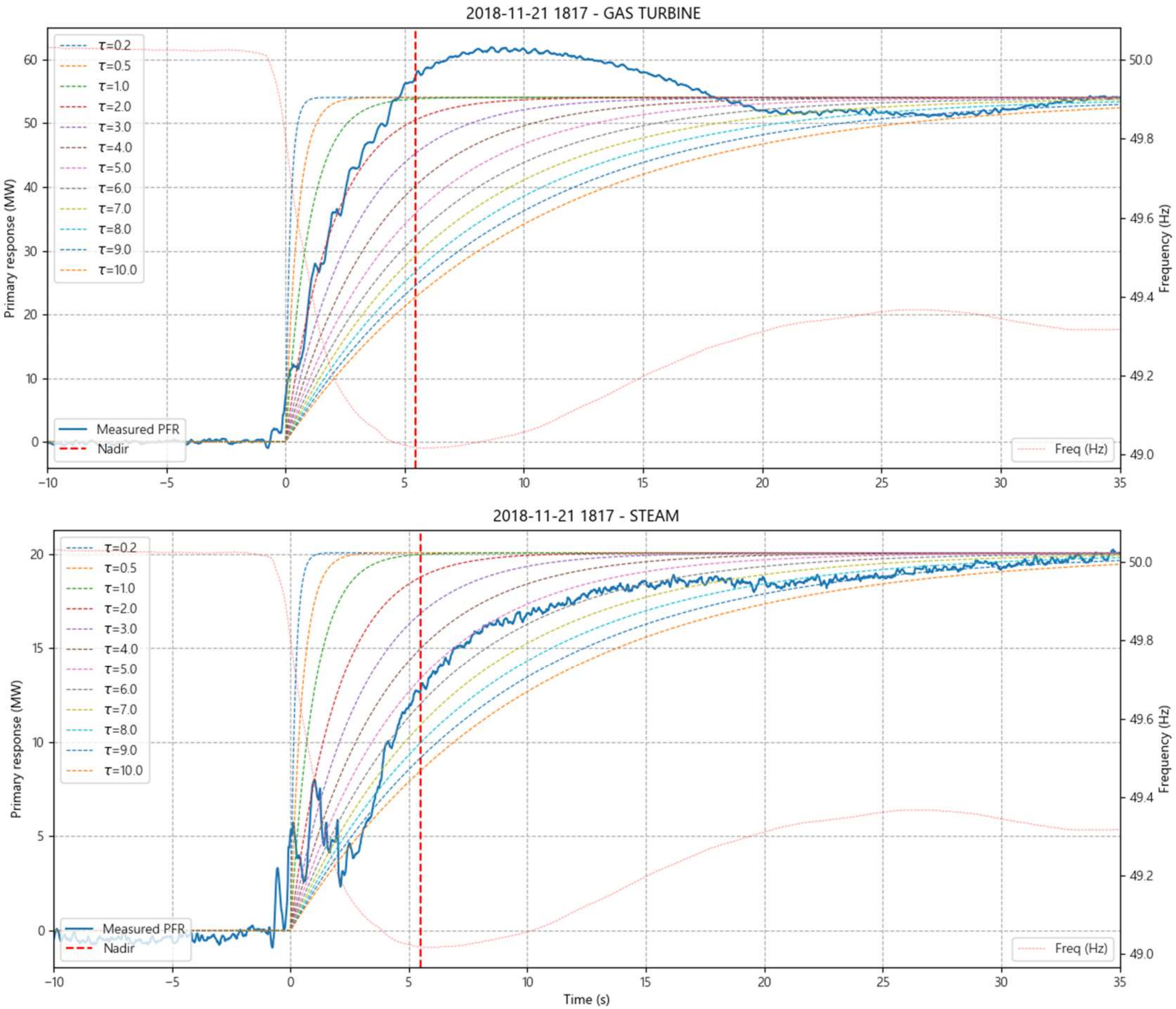
- Provision of standing enablement limits – energy dispatch levels between which services can be provided
- Identification of any detection delays required for response
- Ability to capture high speed event data
- Assessing a 'speed factor' reflecting the characteristics of facility response to frequency deviation. This will form part of standing data for the facility.
- Speed factor is constant across system conditions, but faster facilities can contribute more to frequency response under some system conditions. Speed factor combined with system conditions gives a 'performance factor' for the facility, to be used in dispatch process.

ACCREDITATION – FACILITY CAPABILITY

Example speed factor curves



FACILITY CAPABILITY EXAMPLES



ESS ACCREDITATION – REGULATION, ROCOF CONTROL

Regulation:

- Facilities must operate on AGC
- Performance factors not currently proposed for market start, but could be accommodated.

RoCoF control:

- Megawatt-second capability of each facility (based on engineering report or performance)
- Identification of any flexibility in provision (multiple units, synchronous condenser optionality)

Offering to provide ESS

OFFERING INTO REAL TIME ESS MARKETS

- Regulation and Contingency Reserve
  - Up to 10 price-quantity pairs for each five minute dispatch interval
  - $ per MW per hour
  - Monotonically increasing prices
  - Upper and lower enablement limits
  - Response breakpoints
- RoCoF Control
  - $ per MWs per hour
  - Lower enablement limit
  - Expect single price-quantity pair for most facilities

Offer change reason flag for all services.

Same gate closure as energy.

ENABLEMENT LIMITS AND THE ESS TRAPEZIUM

- Clearing engine will respect minimum and maximum enablement limits.
- ESS offers from facilities operating outside enablement limits will not be considered in real-time dispatch – 'stranded outside ESS zone'
- Facilities with ESS offers operating inside limits will not be dispatched off – 'trapped within ESS zone'.
- Pre-dispatch will include forecast with and without enablement limits.
- Participants will have to monitor forecast dispatch and adjust offers to ensure they are placed for the services they wish to provide

ENABLEMENT LIMITS EXAMPLE: CONTINGENCY RAISE RESERVE

Max capacity: 90MW

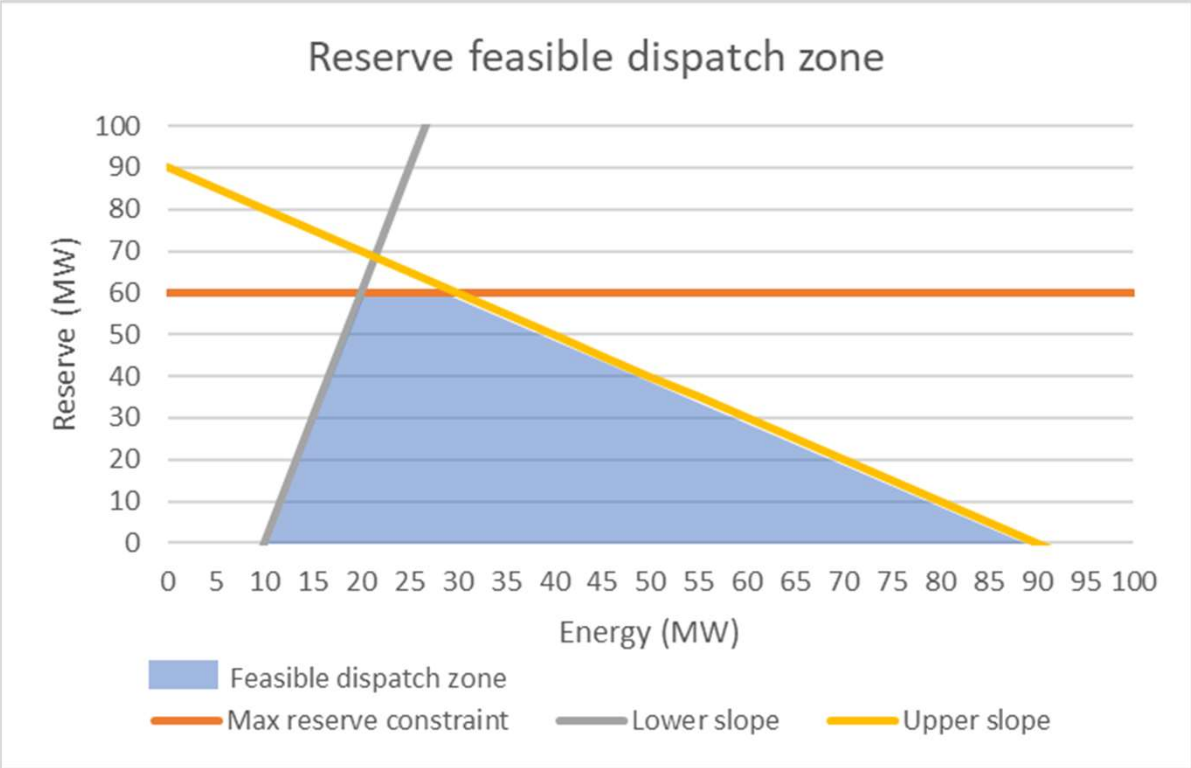
Max reserve: 60MW

Enablement min: 10MW

Lower breakpoint: 20MW

Upper breakpoint: 30MW

Enablement max: 90MW



ENABLEMENT LIMITS EXAMPLE: REGULATION LOWER

Max capacity: 90MW

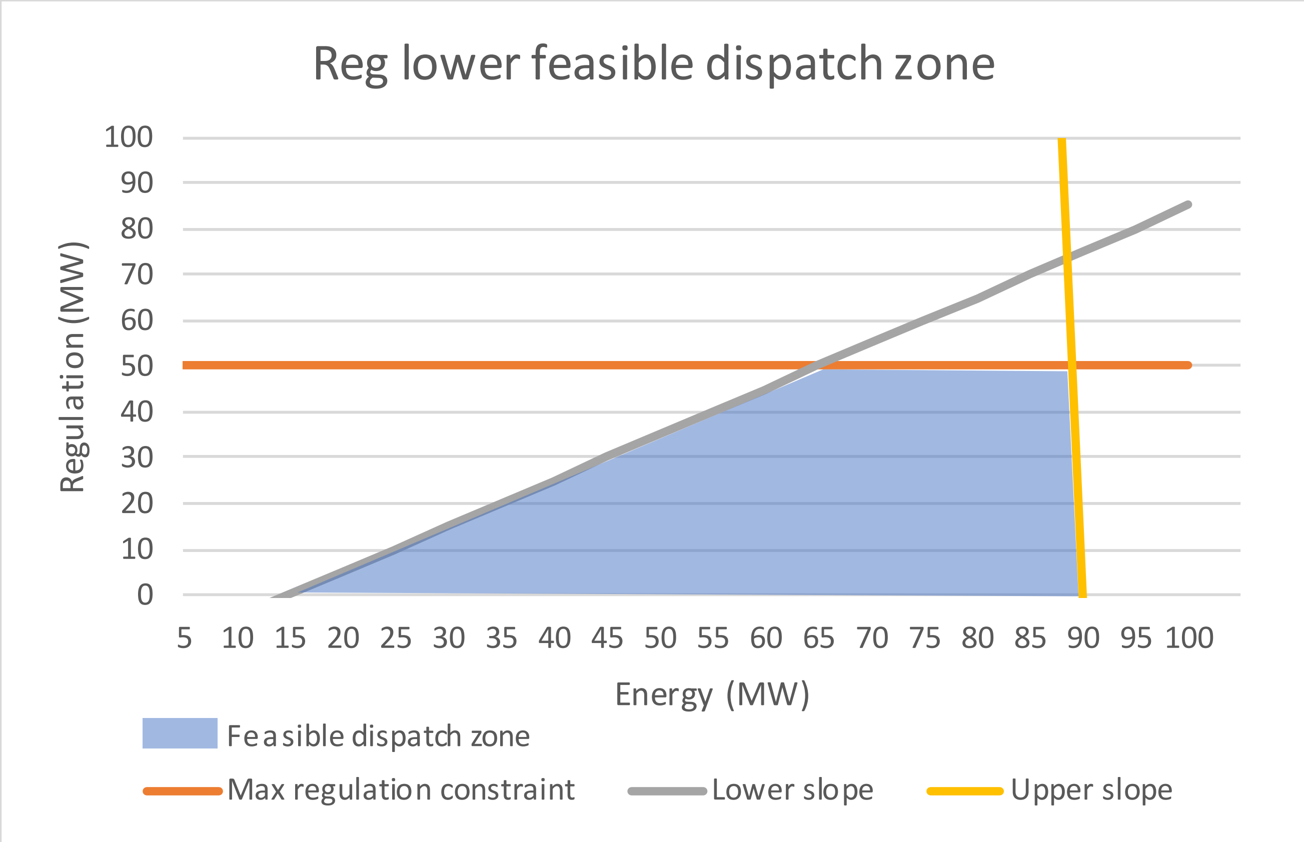
Max regulation: 50MW

Enablement min: 15MW

Lower breakpoint: 65MW

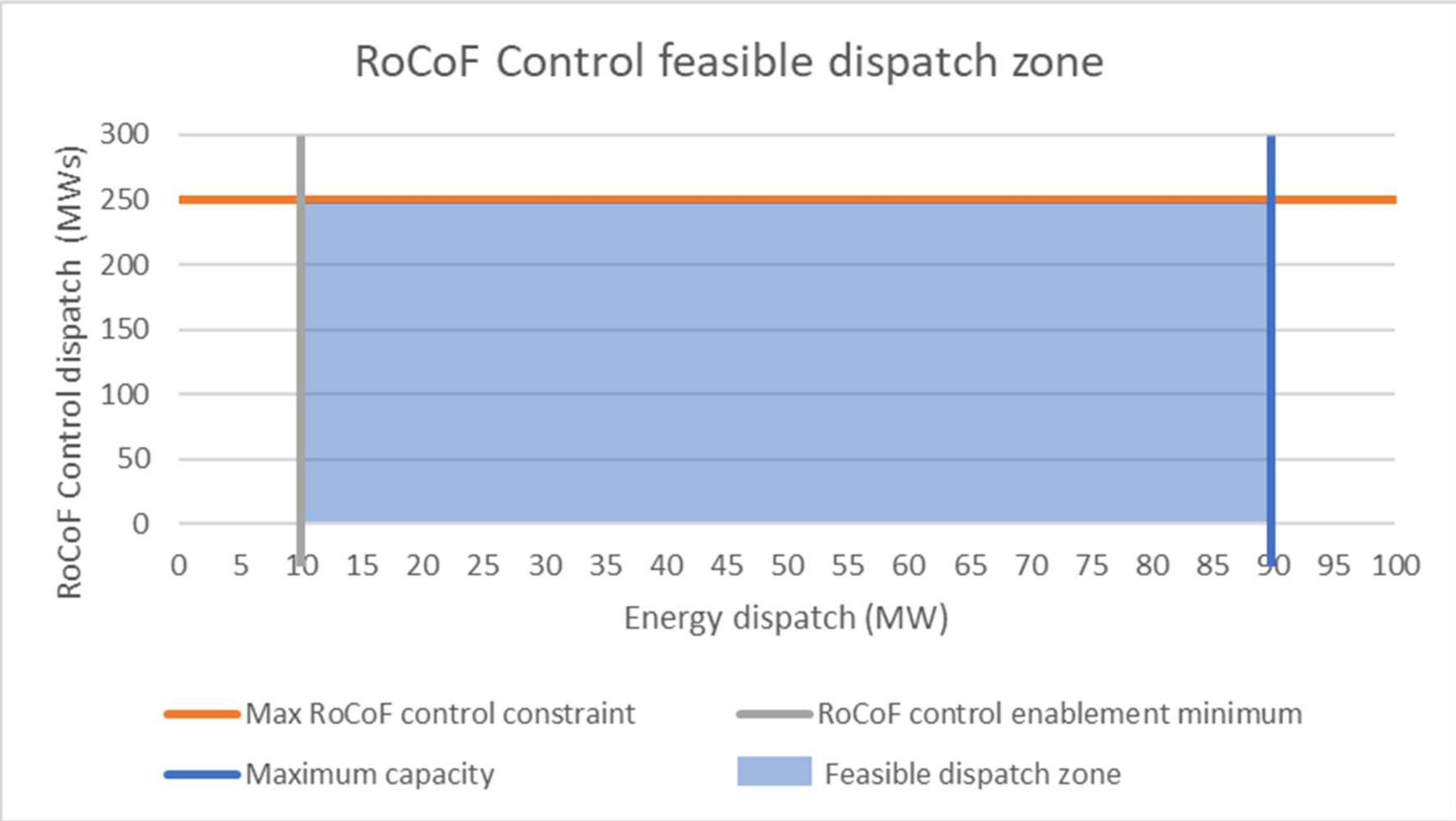
Upper breakpoint: 89MW

Enablement max: 90MW



ENABLEMENT LIMITS EXAMPLE: ROCOF CONTROL SERVICE

- Max capacity: 90MW
- Inertia offered: 250MWs
- Enablement minimum: 10MW



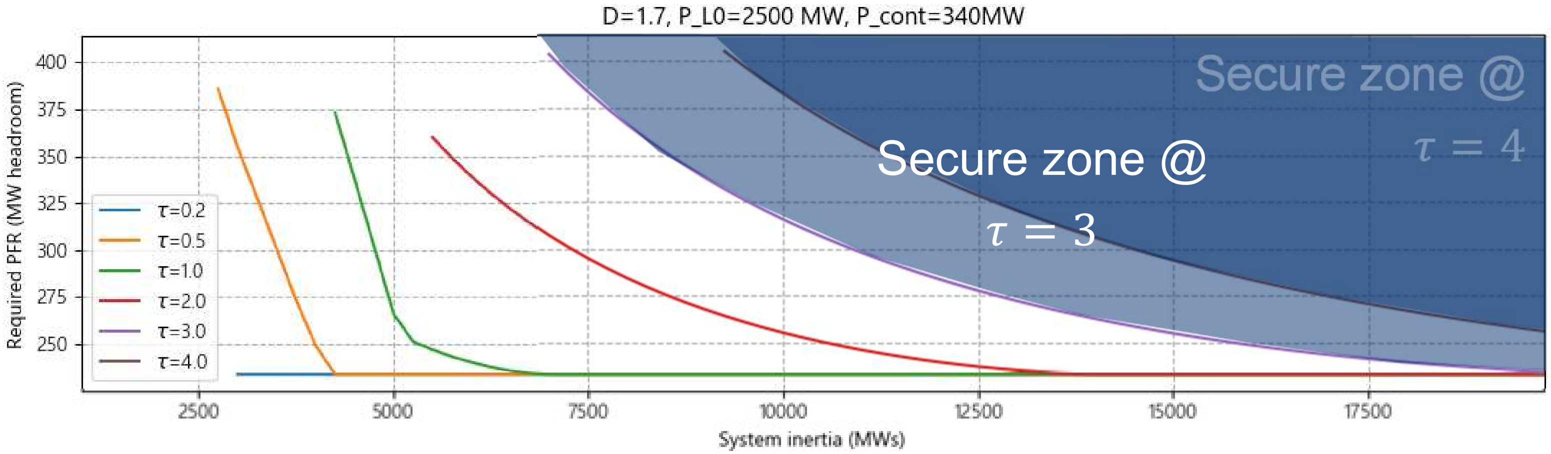
Dispatch process

DISPATCH PROCESS

- ESS performance factors for each facility will differ in each interval based on speed factors and system conditions.
- Dynamic frequency contingency model calculates:
  - Performance factors
  - Contingency factor (ratio of contingency size to Contingency Reserve requirement)
  - RoCoF Control service requirement
- Iterate with Market Clearing Engine to converge on secure and optimal dispatch
- Clearing engine co-optimises energy, ESS, and largest risk using given performance factors and contingency factor.
- While each individual step appears feasible, now starting prototyping to confirm whole approach. Still potential to fall back to simpler approach (less dynamic/more conservative) to be confirmed during implementation.

DISPATCH PROCESS: PERFORMANCE FACTOR EXAMPLE

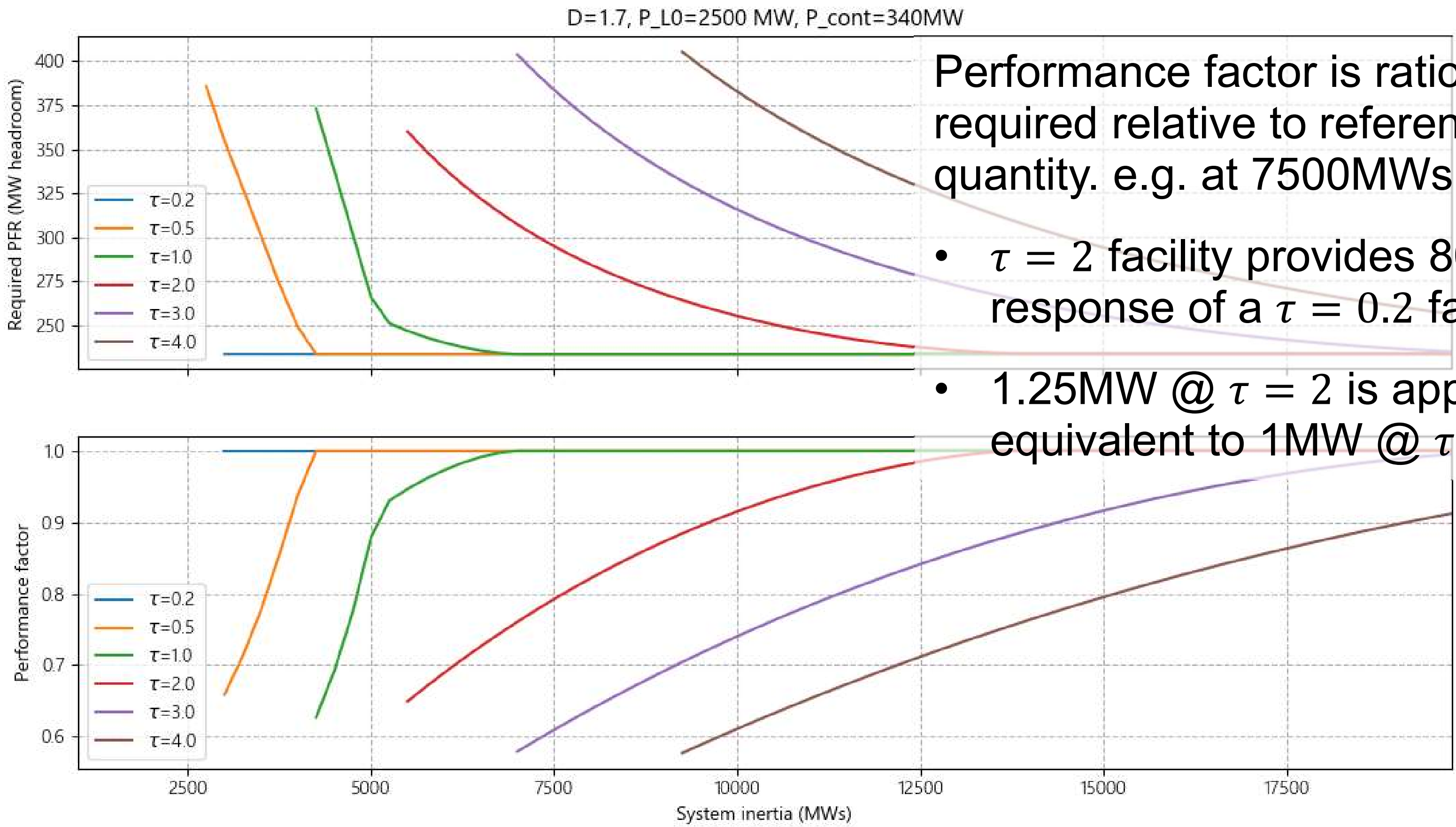
Response requirement at different speeds translates to performance factor (Illustration only)



- Traditionally, SWIS operated with assumption of approx. $\tau = 2$ (red curve). Very fast response (e.g. battery) would be 0.2 or 0.5.
- If response is faster, secure zone is larger: system is secure with less PFR and at lower inertia.
- At high inertia, speed of response becomes less significant

DISPATCH PROCESS: PERFORMANCE FACTOR EXAMPLE

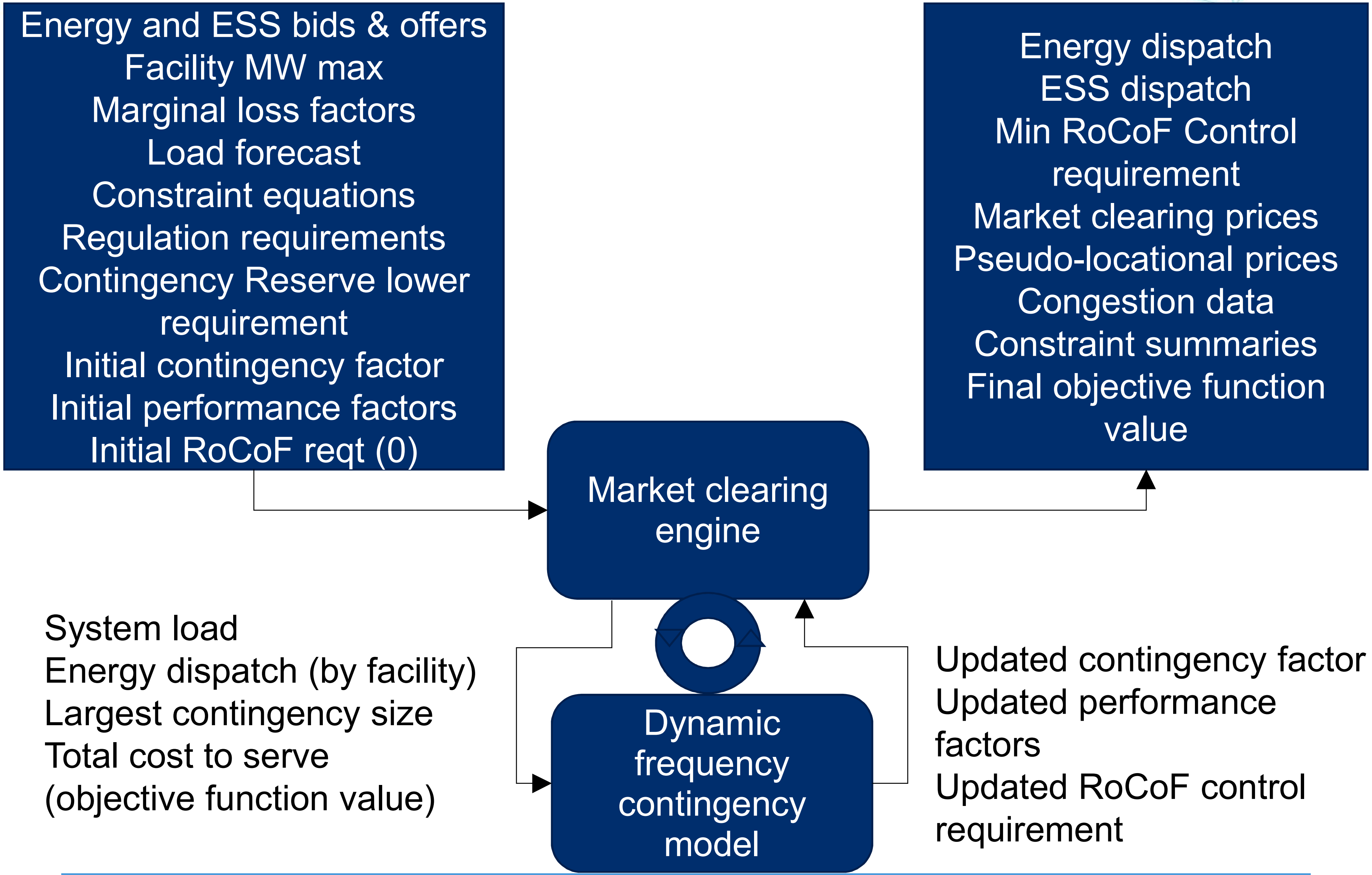
Response requirement at different speeds translates to performance factor (Illustration only)



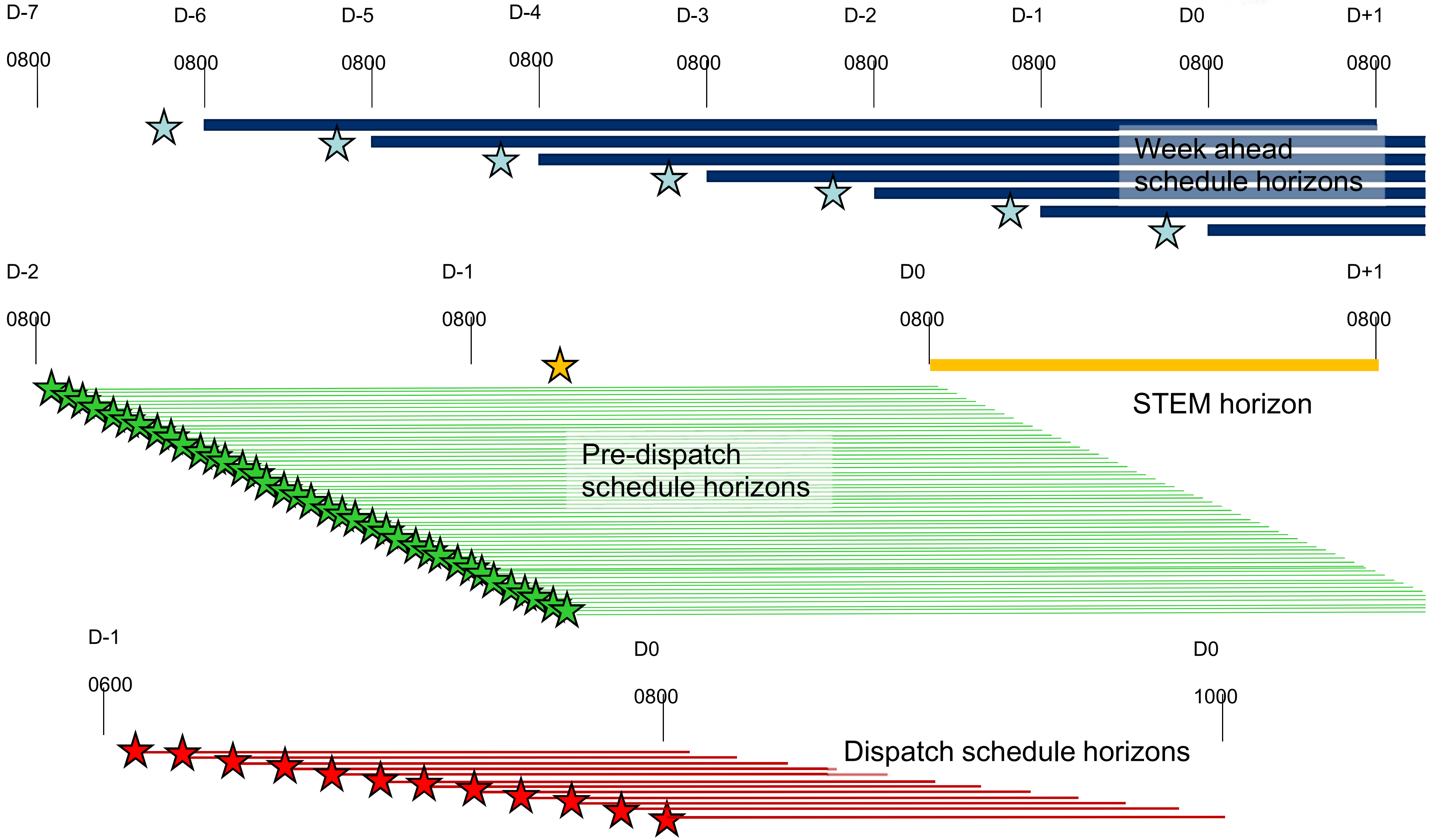
Performance factor is ratio of MW required relative to reference quantity. e.g. at 7500MWs:

- $\tau = 2$ facility provides 80% of response of a $\tau = 0.2$ facility.
- 1.25MW @ $\tau = 2$ is approx. equivalent to 1MW @ $\tau = 0.2$

MARKET CLEARING PROCESS



MARKET SCHEDULE TIMELINES



DISPATCH TIEBREAKING

If contribution of two facilities to provision of a particular service is identical, and both are marginal, the market clearing process is indifferent to which facility is dispatched.

The many additional factors incorporated into SCED dispatch means a true tie is much less likely than today, but it could still occur for facilities at the same network location.

The dispatch process will allocate evenly between any tied energy offer bands, but allocation between tied ESS offer bands may use a different process to the equal split used to apportion tied energy offer bands.

MONITORING AND DISPATCH COMPLIANCE

AEMO will continue to monitor performance of facilities accredited and enabled for ESS in real time and ex-post. Participants will be required to self-report performance following major contingencies, and regular accreditation retests if events do not occur.

In case of real-time non-performance (failure to respond, reasonable expectation of non-response) AEMO will:

- identify the facility as non-compliant with dispatch
- request a reason for the non-compliance
- request participant updates offers to reflect actual capability (which may include ceasing to offer ESS)
- implement manual overrides (including constraint equations) to ensure facility capability is accurately reflected in dispatch
- calculate and issue a new market dispatch reflecting the updated facility capability

For all products, if performance does not match accreditation settings, settings will be adjusted.

Dealing with shortfall

DEALING WITH REAL-TIME SHORTFALL

AEMO currently has broad discretion to dispatch facilities as required in case of system emergency, and discretion to relax AS requirements:

- Slightly, for short periods
- Completely to avoid load shedding
- Completely following a contingency

AEMO will retain discretion to shed load and direct participants in case of emergency. Under SCED, real-time shortfalls will be partly handled through market clearing processes:

- Where there is insufficient capacity to meet energy and ESS requirements, MCE will schedule:
  - Energy in preference to ESS
  - Regulation in preference to Contingency Reserve
- Following a contingency, next dispatch run will schedule as much of the ESS requirement as possible after energy requirements are satisfied.

DEALING WITH FORECAST SHORTFALL (1)

Pre-dispatch schedules and PASA will forecast potential ESS and energy shortfall. Detail to be confirmed in PASA work, but expect to use market notices with different levels of severity e.g.:

1. Available capacity insufficient to meet demand if two largest contingencies were to occur
2. Available capacity sufficient to meet demand and ESS requirements in largest contingency, but insufficient ESS capable facilities offering
3. Available capacity sufficient to meet energy demand but not ESS requirements if largest contingency occurs
4. Energy shortfall occurring or forecast within short-term PASA horizon

AEMO powers of intervention will be tied to specified levels

DEALING WITH FORECAST SHORTFALL (2)

The WEM design has a number of features designed to minimise the likelihood of a shortfall situation occurring:

- The RCM, which ensures that there is sufficient capacity available to meet energy and ESS requirements at 10% POE peak demand
- The supplementary ESS procurement mechanism, for which one of the triggers will be the balance between long-term forecast ESS requirement and long-term forecast ESS facility capability

In addition, the market design has a number of elements that can support resolution before real-time. These intervention powers will be available to AEMO when a shortfall situation is forecast or is occurring:

- Dispatch of DSP facilities (2 hours ahead of real-time)
- Requiring ESS-accredited facilities to offer non-zero ESS quantities if directed
- Outage cancellation, recall, or approval on condition of fast-recall capability
- Requiring facilities holding capacity credits to synchronise

Storage participation

STORAGE ACCREDITATION

There are currently no storage facilities registered and participating in the WEM.

Storage facilities will have slightly different standing data requirements from generators, including:

- Storage capacity (MWh)
- Maximum charge capability (MW)
- Maximum discharge capability (MW)
- Round trip efficiency (%)

Accreditation requirements will include:

- Real-time indication of current storage level
- Identification of limitations on transition from charge to discharge and vice versa
- Identification of changes in response capability at different levels of charge

STORAGE OFFERS AND DISPATCH

Storage facilities will still be able to offer their maximum capability in energy and all ESS products, with the clearing engine dispatching to optimise use across the various services.

As for generators, total dispatch is constrained by total capacity. For storage, dispatch is also constrained by current energy stored. This will be accounted for in:

- Offers – will be required to be at or below the lower of:
  - MW injection/withdrawal capacity
  - Available storage/headroom divided by response timeframe (15 mins (0.25h) for Contingency Reserve, 5 mins (0.8333h) for energy and regulation)
- Market clearing engine will include constraints to limit facility dispatch across all products to current stored energy levels.

STORAGE ENERGY CONSTRAINT EXAMPLE

Example facility characteristics:

- Injection capability: 100MW
- Storage capacity: 100MWh
- Current charge: 10MWh

Offer quantities must be limited by both MW and MWh:

- Energy ≤ 100MW (inject 6.6MWh)
- Energy ≥ -100MW (store 6.6MWh)
- Regulation lower ≤ 100MW (store 6.6MWh)
- Regulation raise ≤ 100MW (inject 6.6MWh)
- Contingency reserve lower ≤ 100MW (store 25MWh)
- Contingency reserve raise ≤ 40MW (inject 10MWh)

MCE constraint:

$$\frac{5}{60} \times energy_f + \frac{5}{60} \times regulationRaise_f + \frac{15}{60} \times contingencyReserveRaise_f \leq storedEnergy_f$$

Intermittent generation participation

INTERMITTENT GENERATOR PARTICIPATION

Intermittent generators are capable of providing ESS, but cannot currently participate in WEM ESS provision.

Intermittent generation will be able to provide ESS in the new WEM:

- likely to be a useful source of lower contingency reserve
- Would need to maintain headroom in order to provide raise services, based on forecast output

Accreditation will include:

- Existence of a facility generation forecast updated at least every 5 minutes
- Analysis of forecast accuracy to set headroom requirements. Providing 1MW of regulation or contingency reserve will require more than 1MW of headroom reserved from forecast.

INTERMITTENT + STORAGE PARTICIPATION

Colocation of storage with new or existing intermittent facilities is likely.

Dispatch model will support any of the three different possible registration scenarios:

1. Separate: one intermittent generator, one storage facility
2. Combined: intermittent generator only
3. Combined: scheduled generator (if can meet controllability requirements)

All storage capacity to be associated with a single facility.

If registered as intermittent generator only, can offer:

- Energy only
  - using own assumptions about storage use
  - can offer negative MW
  - Storage must be operated to support meeting energy forecast
- Energy and ESS, with:
  - energy component purely intermittent
  - storage capability counted towards ESS headroom requirements

DER / Demand Side participation

DISTRIBUTED/DEMAND SIDE RESOURCE PARTICIPATION

A single demand side resource provides ESS in the current WEM – one interruptible load providing spinning reserve. The DSP construct is not capable of providing ESS, as it does not respond in the required timeframes.

Multiple paths to provide ESS under SCED:

- Scheduled loads can be accredited for all ESS
- Interruptible loads can be accredited for Contingency Reserve (raise only).
    - May still be part of DSP
    - All-or-nothing dispatch option subject to maximum tranche sizes
    - No enablement limits
    - Periodic data required ex-post (incl post-event), not real-time telemetry
- Aggregated distributed schedulable resources (storage or load) can be accredited for Contingency Reserve and Regulation in both directions as either a storage facility or a scheduled load with zero energy offer.

Next steps

NEXT STEPS

- Non-cooptimised ESS
- ESS settlement
- Detailed design aspects of other workstreams:
  - Compliance and monitoring
  - Market power mitigation
  - PASA
- Worked examples of ESS pricing in a range of circumstances

MEETING CLOSE

- Questions or feedback can be emailed to tdowg@energy.wa.gov.au
- The next meeting will be on 25 November (morning). An invite and agenda will be sent later this week.