Scheduling & Dispatch

September 2019

EIRGRID SONI

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Agenda

1. Introduction

2. Scheduling Process

3. Dispatch Process

4. WSAT

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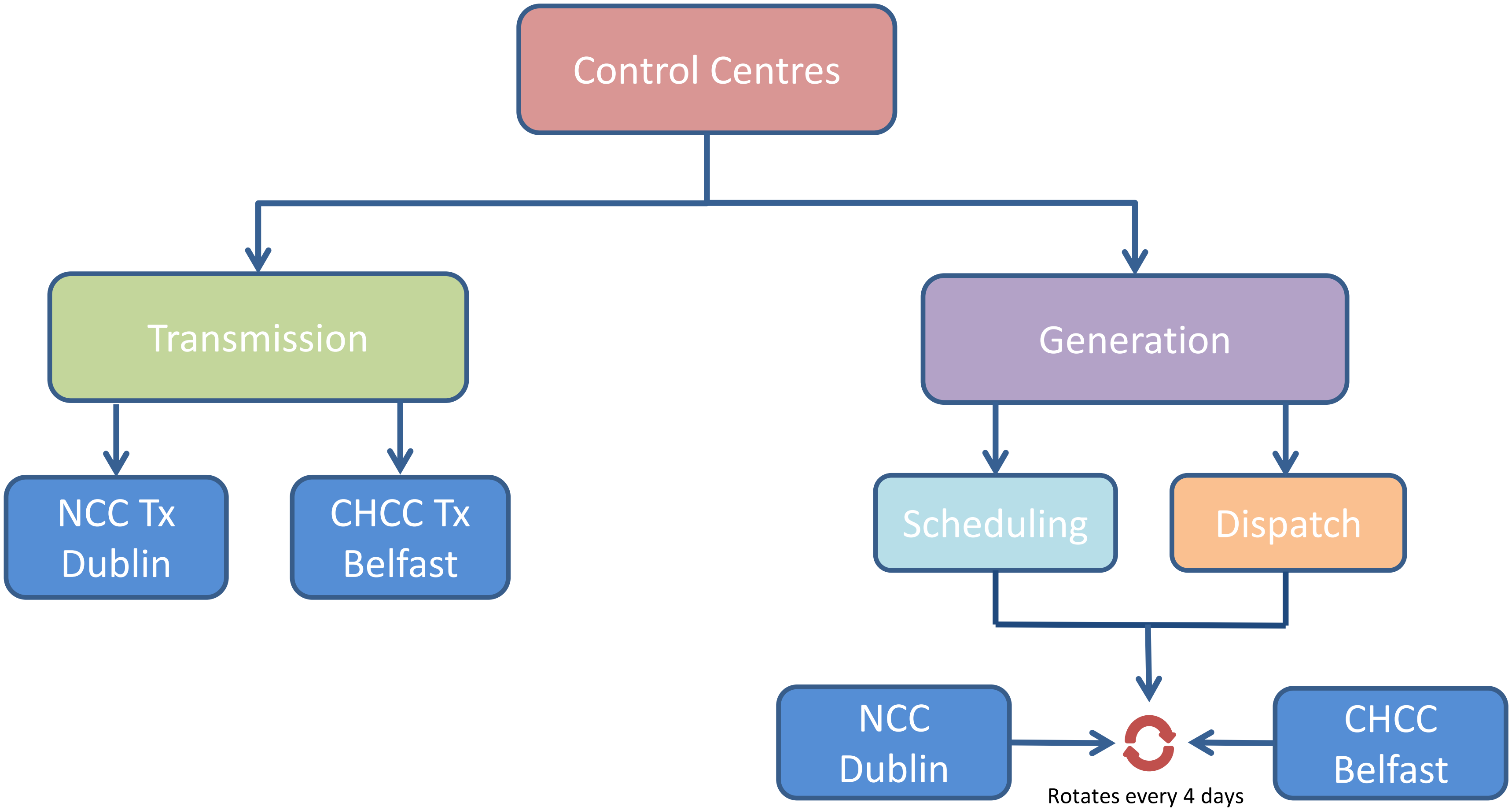
Control Centre



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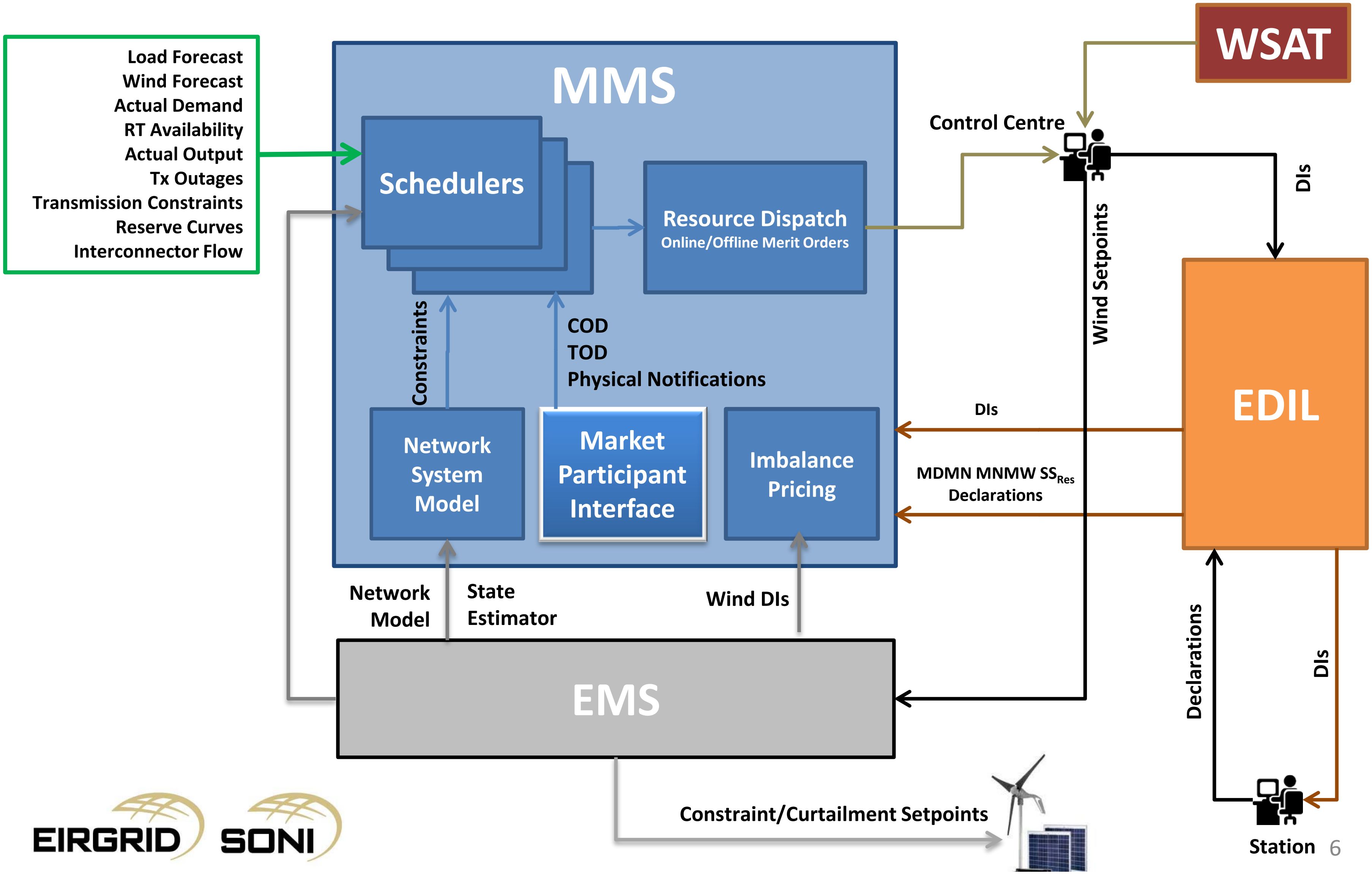
From SEM to I-SEM

	SEM	I-SEM
Gate closure	EA2 WD1 > 10 hr notice	Half-hourly 1 hr before real-time 08:40 11:54 18:10 ICRP updates
Unit Prices	Single curve Bidding Code of Practice 'BCoP'	Dual curve - Inc/Dec Simple and complex data Partly 'BCoP'd
Start point for scheduling	Market prices (fixed), Interconnector nominations Current dispatch	Market Physical Notifications (PNs), Varying prices (from PNs), Interconnector schedules Current dispatch
Cost optimisation objective	Minimise production cost	Minimise cost of deviating from PNs*
Scheduling process	Day Ahead, Inday 1, Inday 2 & Inday 3, and ad hoc as required	Continuous (100+) Economic dispatch (every 5 mins)
Energy Balance	Implicitly balanced	Market participants are balance responsible
Price	Ex-post unconstrained price	Real Time Imbalance Price

*plus a number of additional objectives

System Overview for Scheduling & Dispatch



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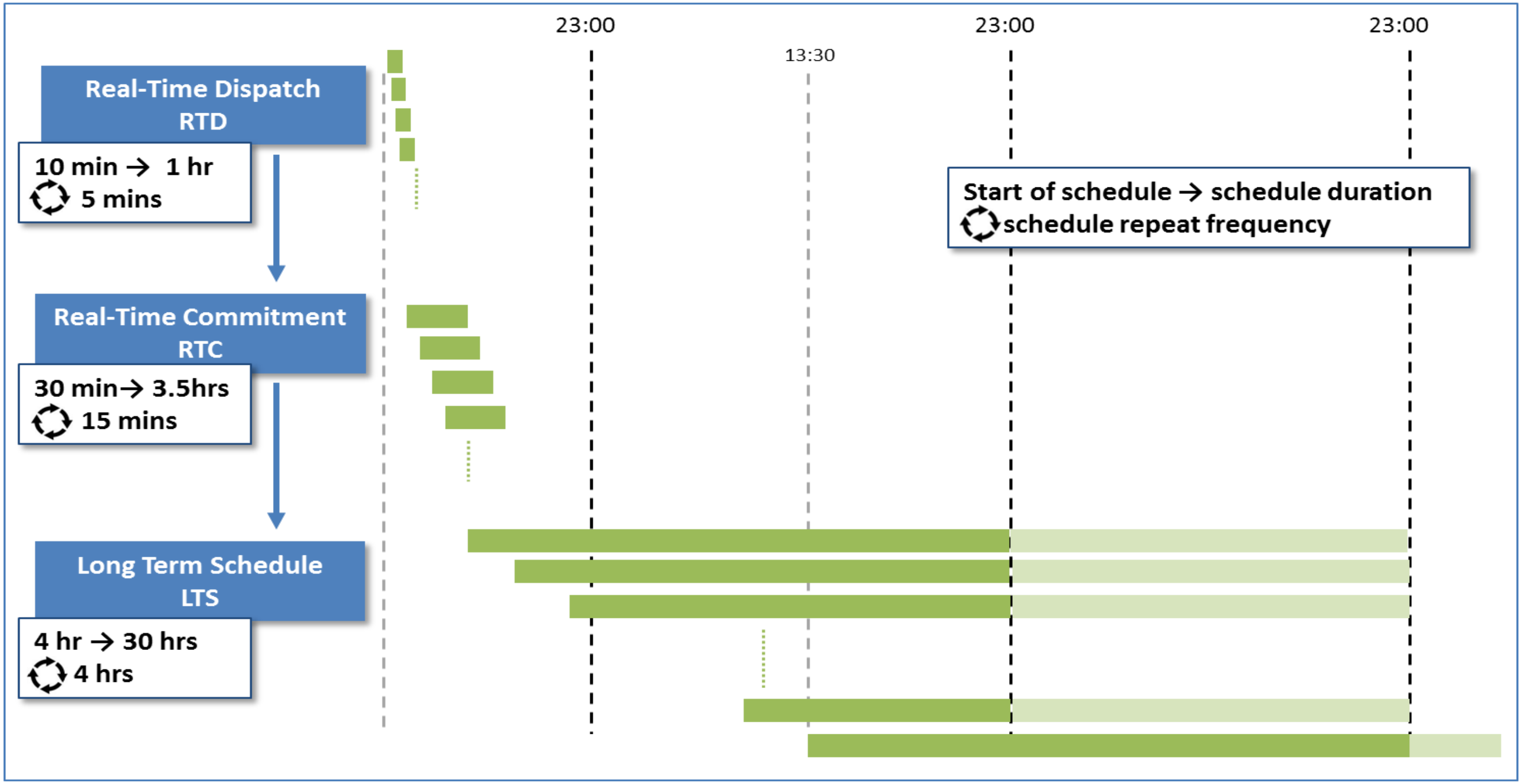
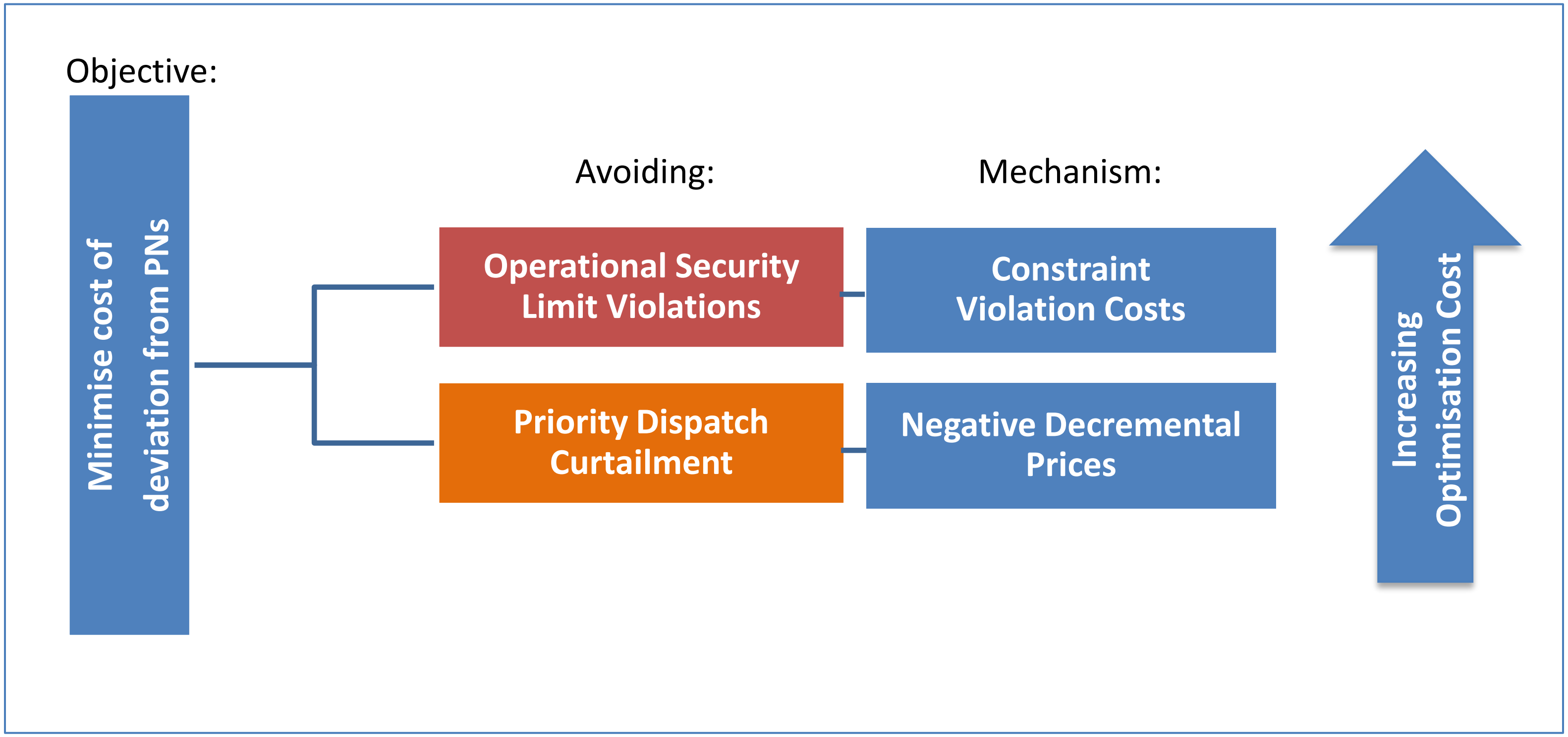
Scheduling

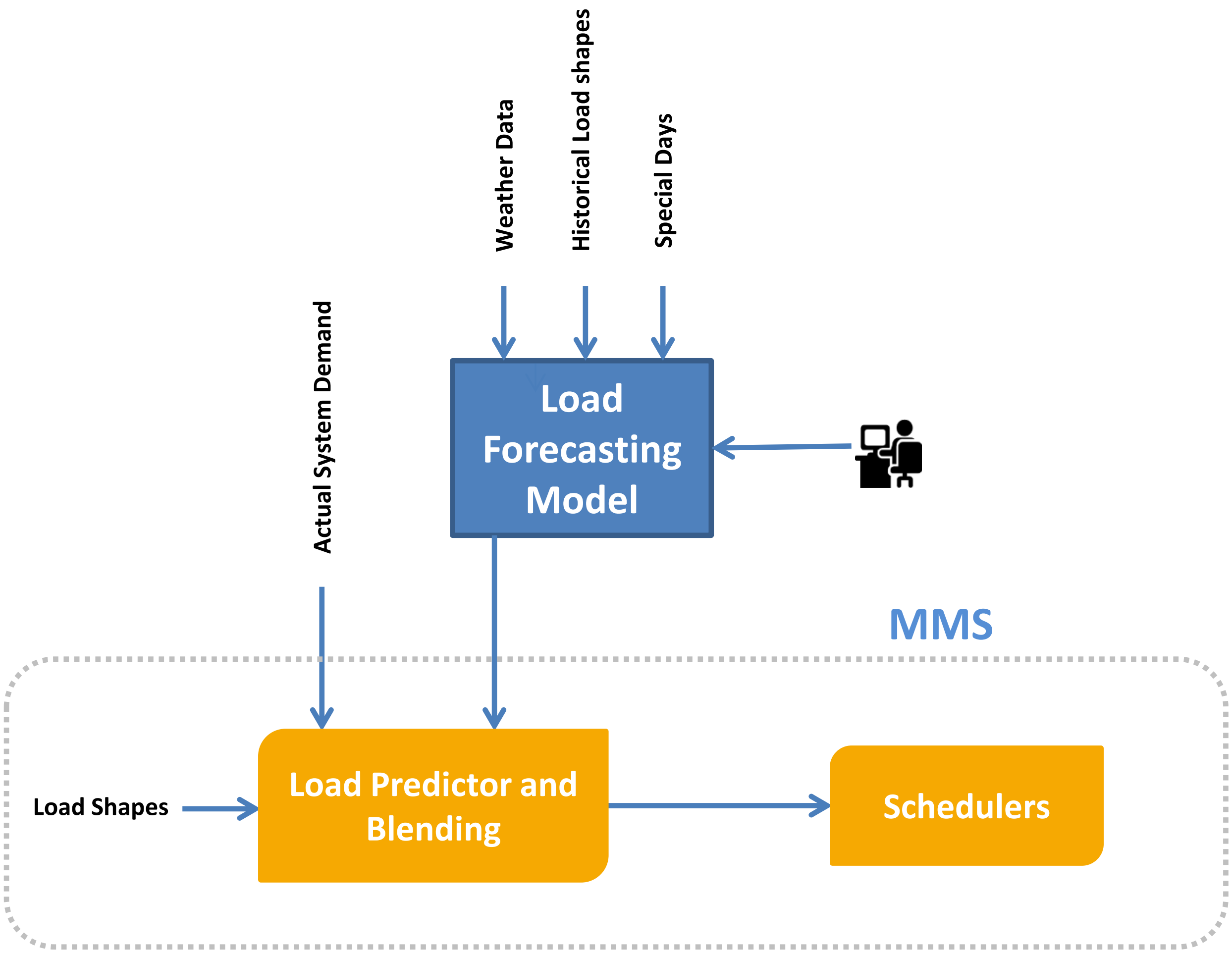
Scheduling Run Sequence



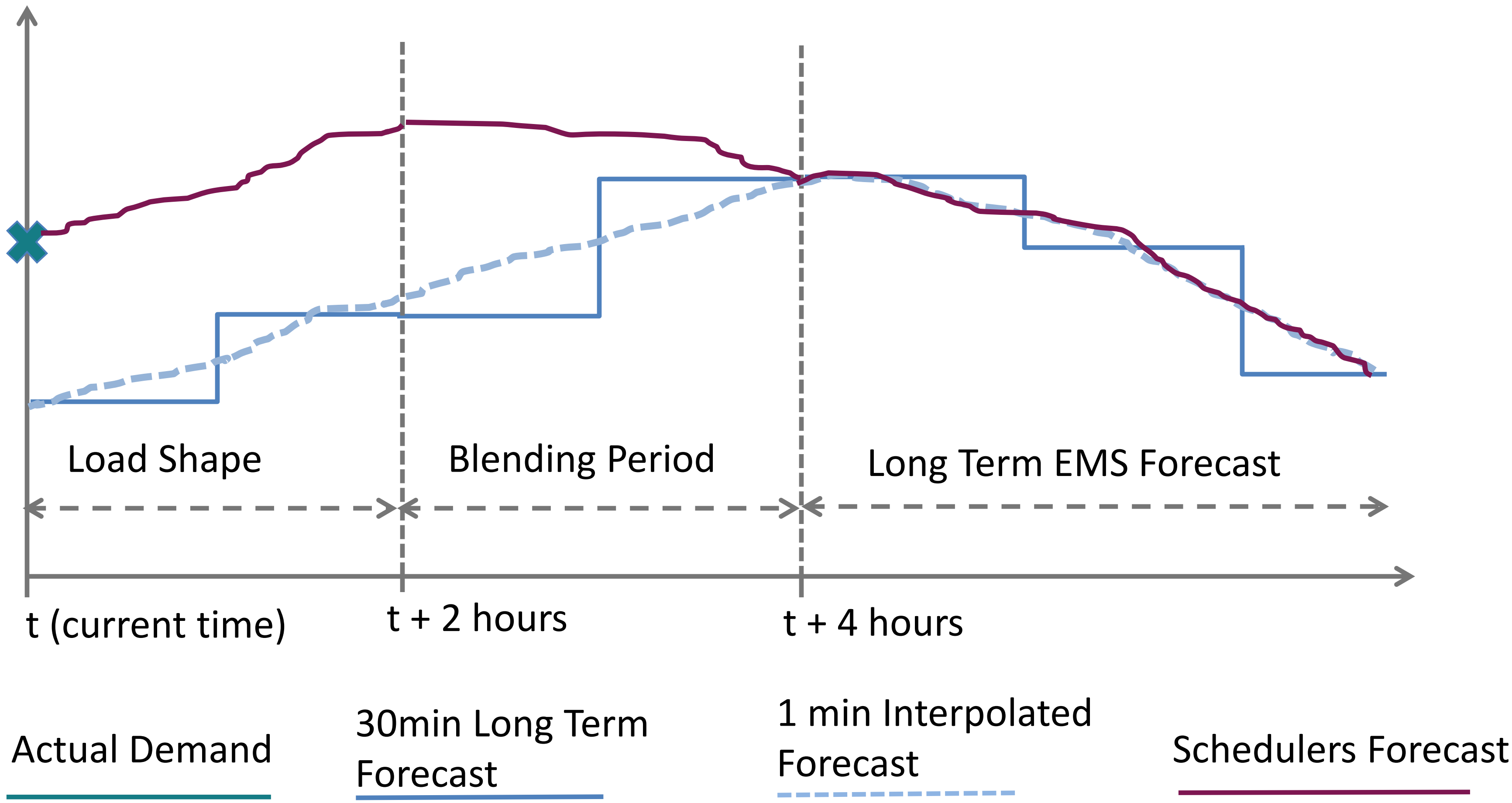
The Optimisation



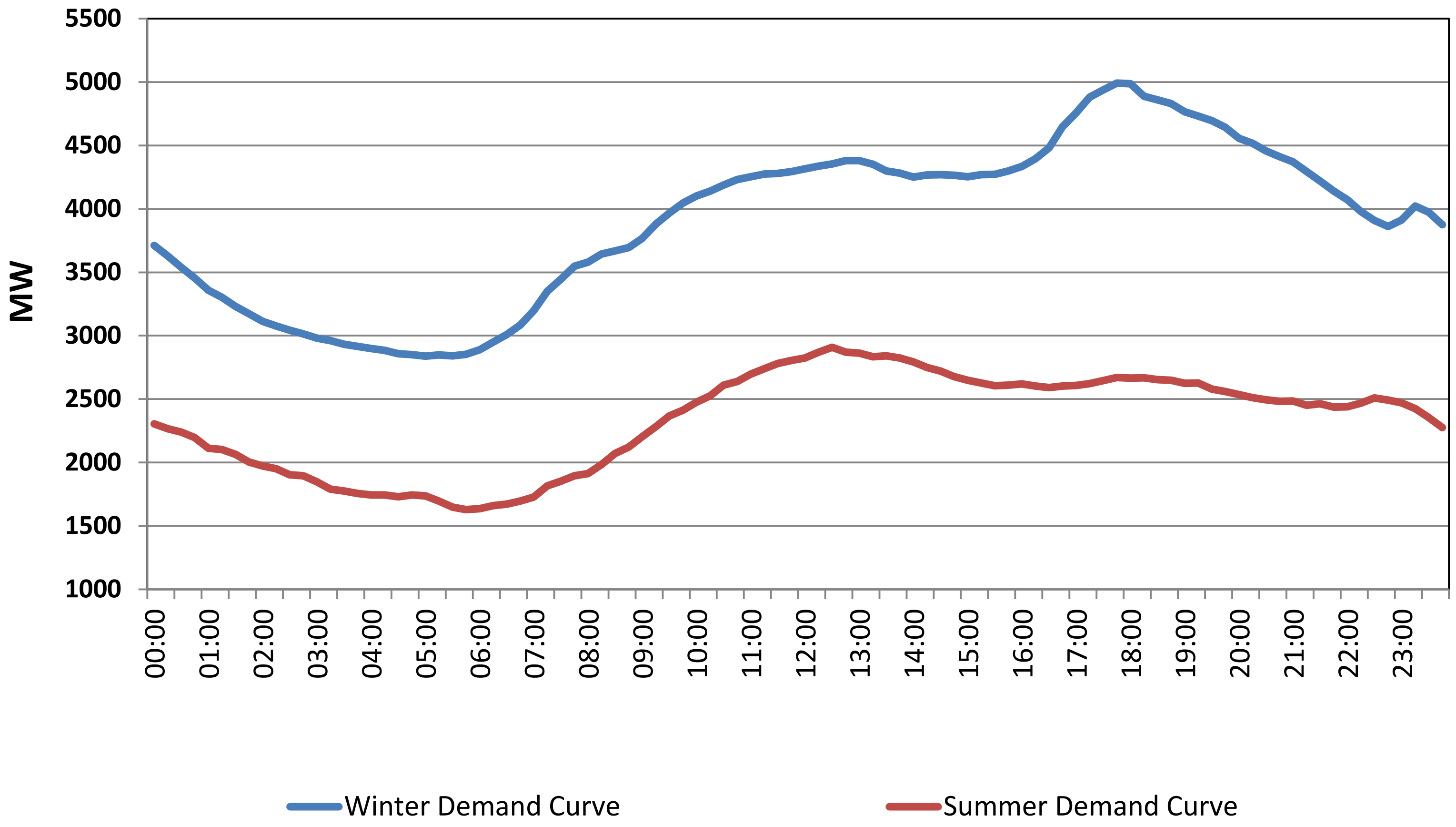
Load Forecasting



Load Prediction & Blending



Load shapes



5500
5000
4500
4000
3500
3000
2500
2000
1500
1000
MW
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01:00
02:00
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05:00
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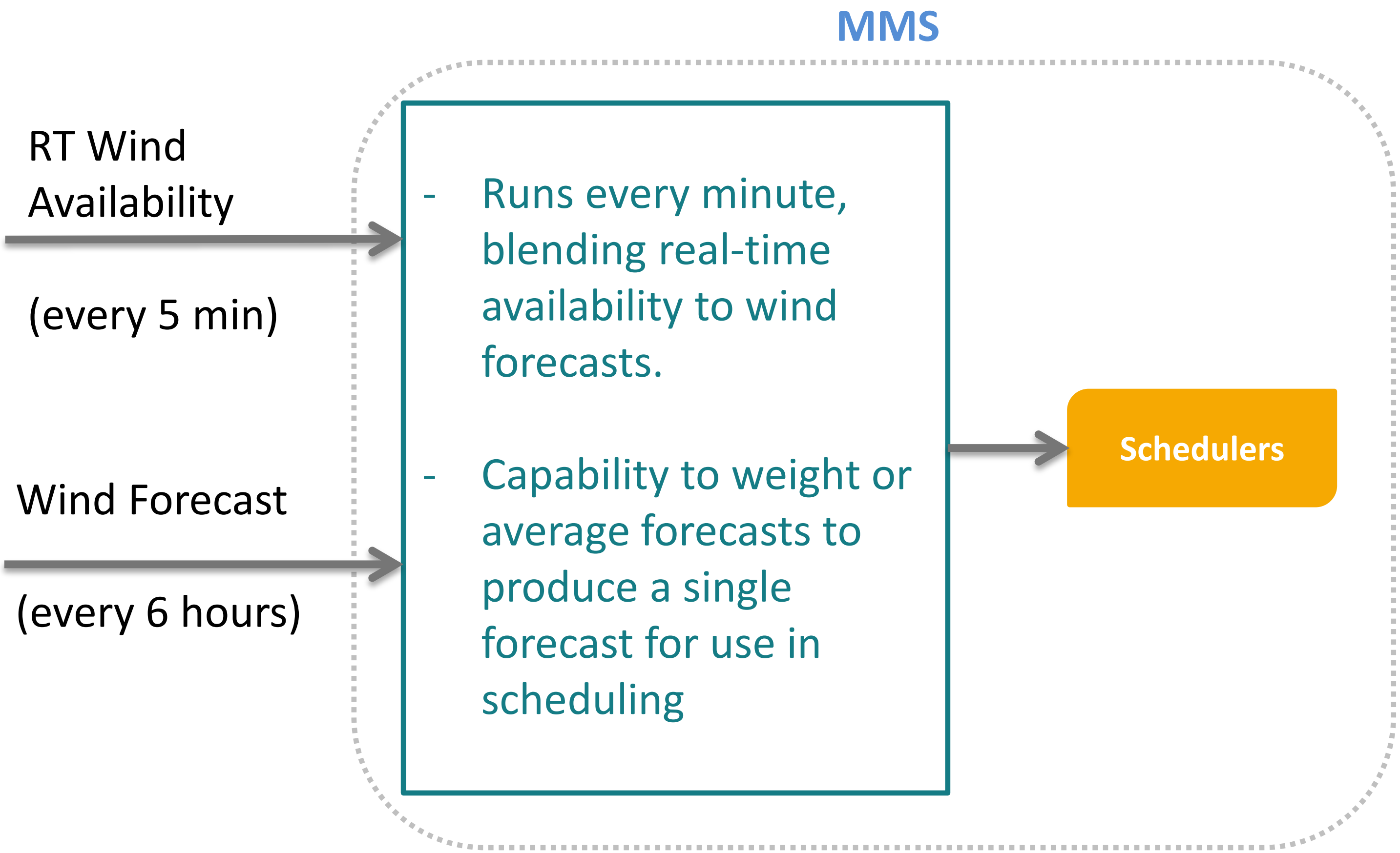
21:00
22:00
23:00
Winter Demand Curve
Summer Demand Curve

Wind Forecast



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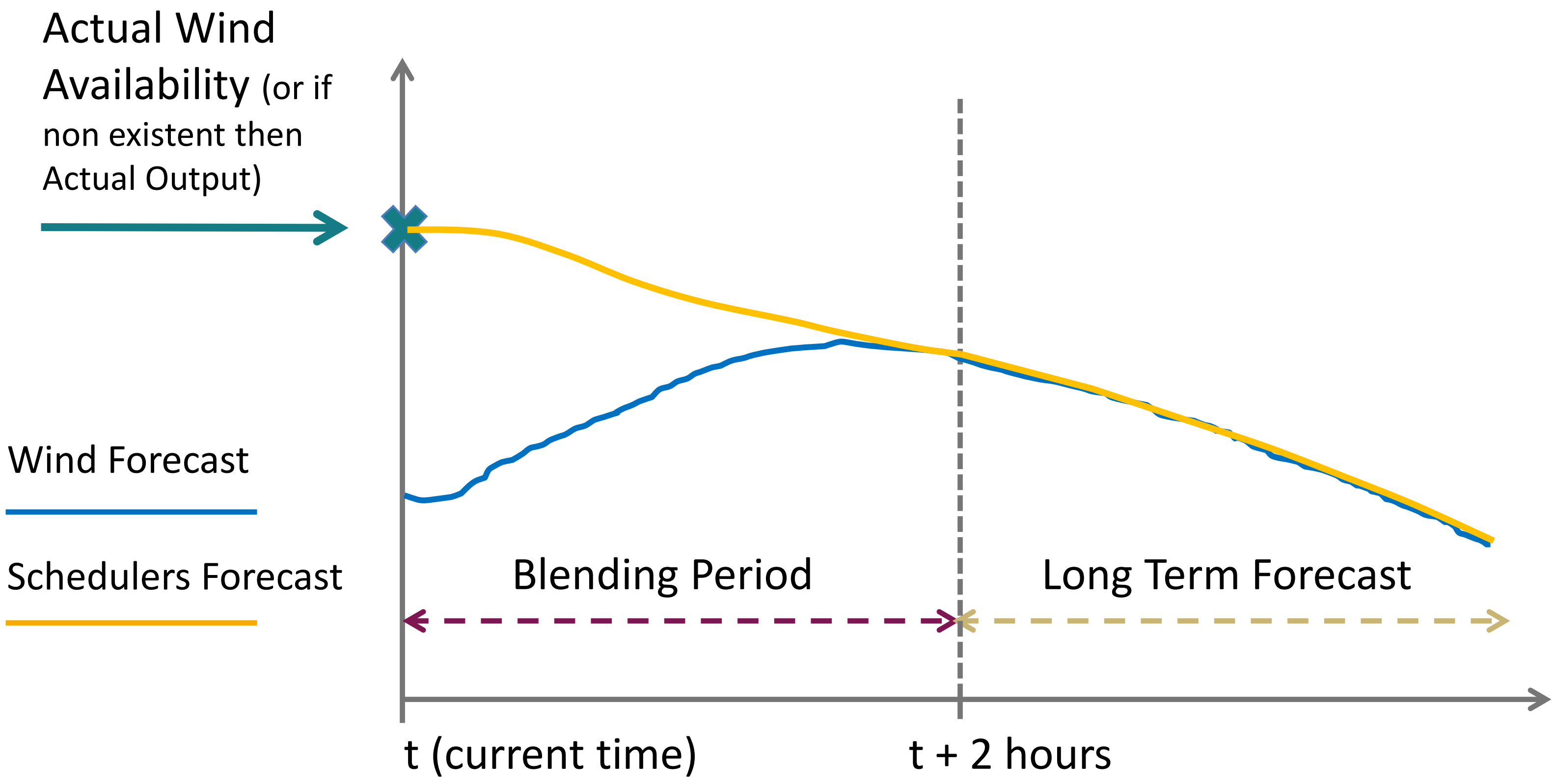
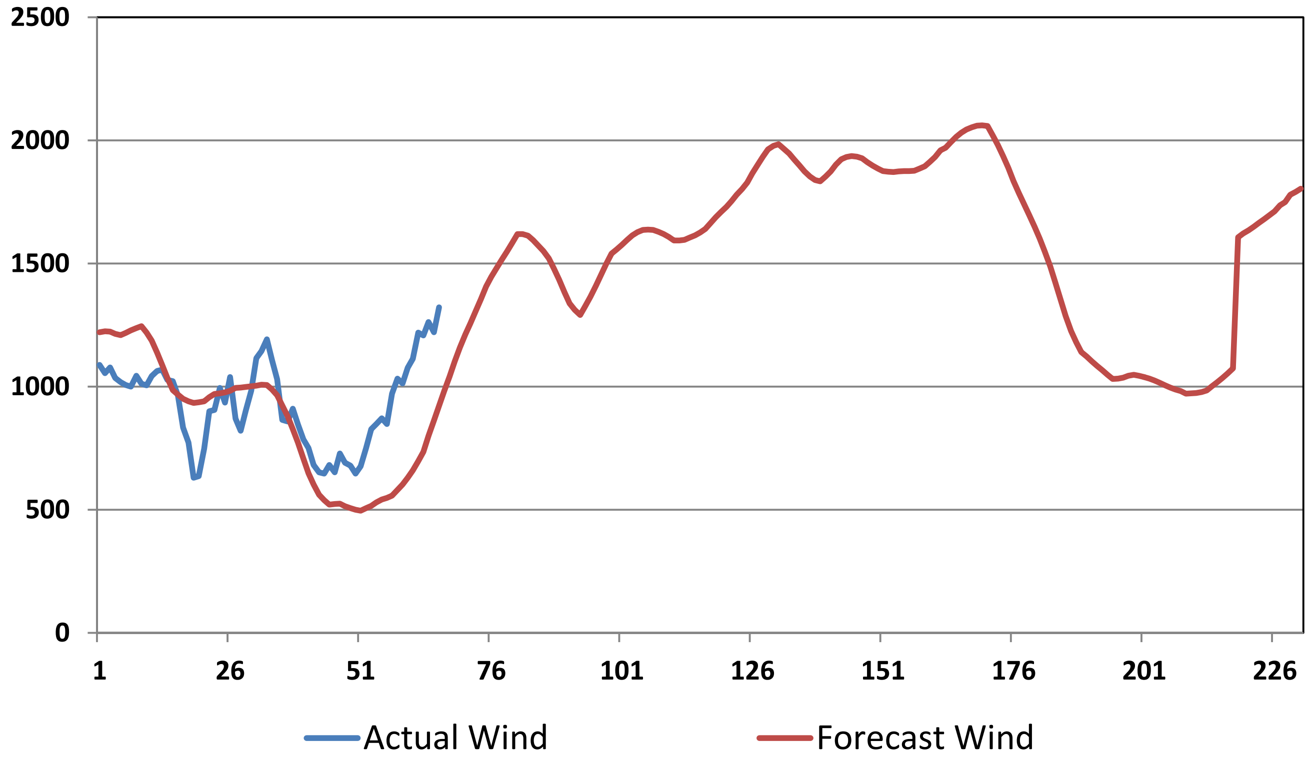
Wind Forecast Blending



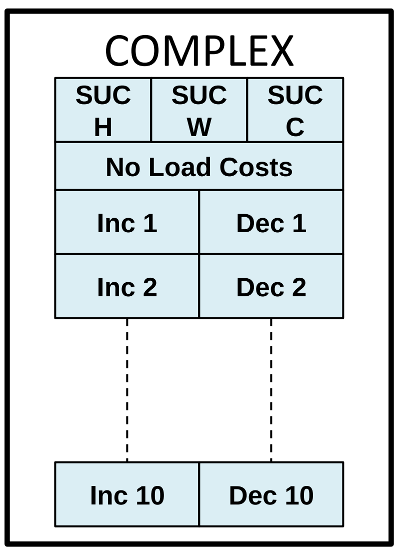
Actual Wind v's Forecast Wind

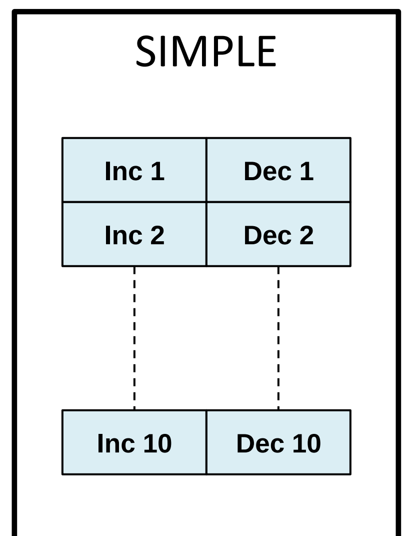


Commercial Offer Data (COD)

The following Bid Offer Data is used in each run type for scheduling decisions:

Scheduling/Dispatch Run	Source of Commercial Data		
	Primary	Back-Up 1	Back-Up 2
LTS – Long Term Schedule	Complex	Default	N/A
RTC – Real-Time Commitment	Complex	Default	N/A
RTD – Real-Time Dispatch	Simple	Complex	Default





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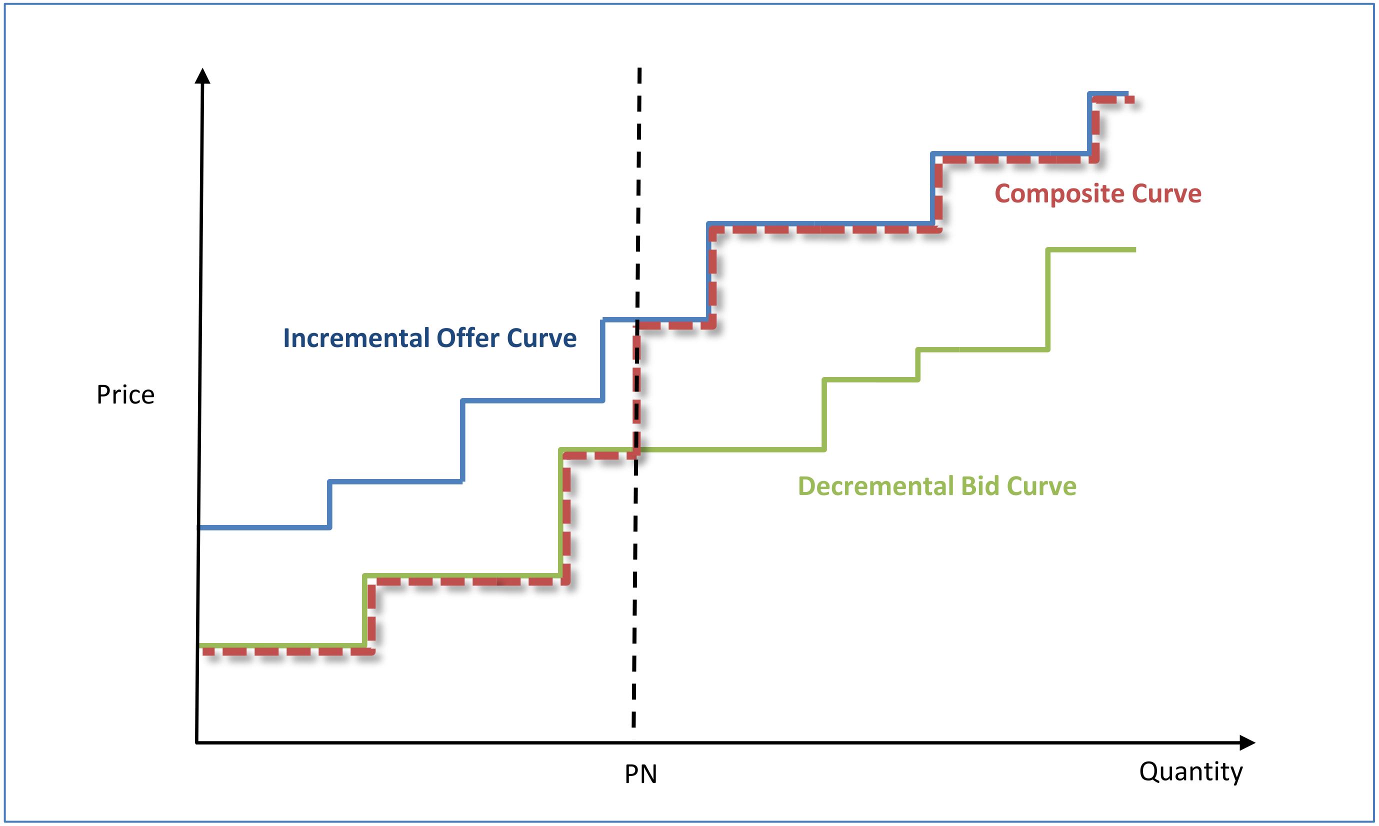
Cost Curve

Production of Composite Cost Curves:



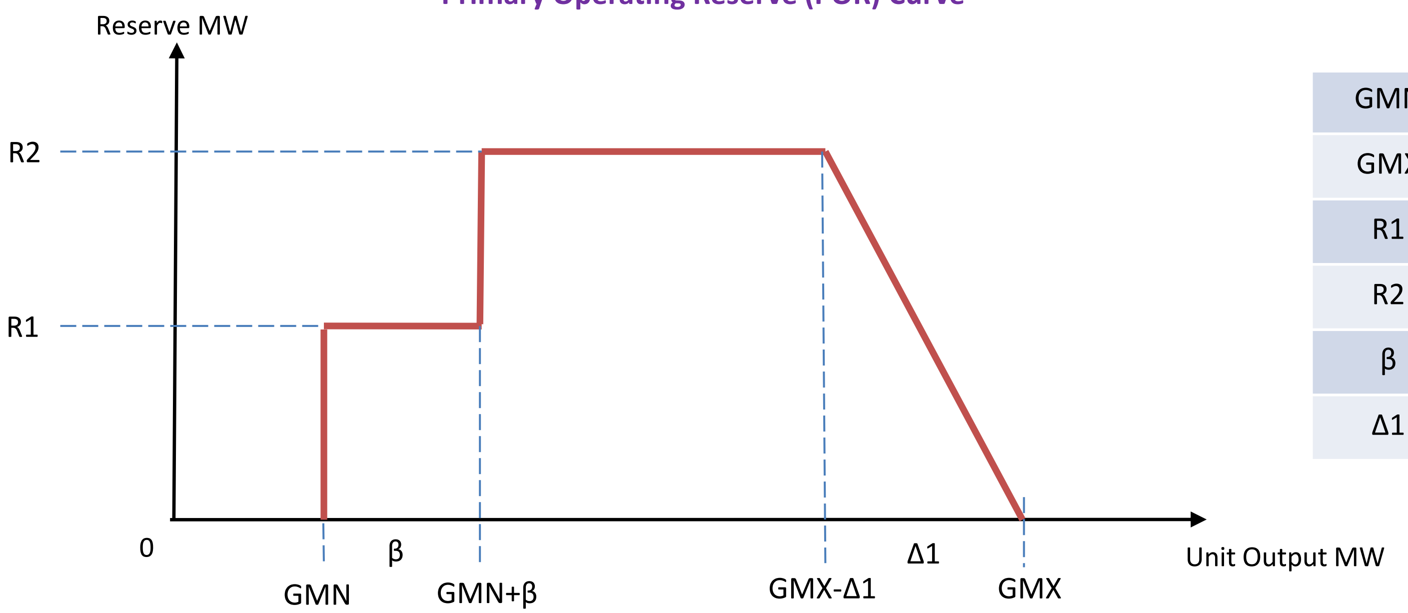
Technical Offer Data (TOD)

As detailed in Appendix I of Trading and Settlement Code, largely unchanged from SEM including:

- Block load
- Load up rate
- Soak up time
- Minimum Stable Generation level
- Ramp up rate
- Dwell up time
- Ramp down rate
- Dwell down time
- Maximum Availability
- Minimum On Times, Minimum Off Time
- Cooling Boundaries
- Forecast Profiles (Availability, Minimum Output, Minimum Stable Generation)
- Short-term Maximisation Capacity and Time
- Synchronous Start up times for three different heat states
- De-load rate

Reserve

Primary Operating Reserve (POR) Curve



GMN	140
GMX	400
R1	15
R2	25
β	60
Δ1	25

Primary Operating Reserve (POR) – 5 to 15 Seconds
Secondary Operating Reserve (SOR) – 15 to 90 Seconds

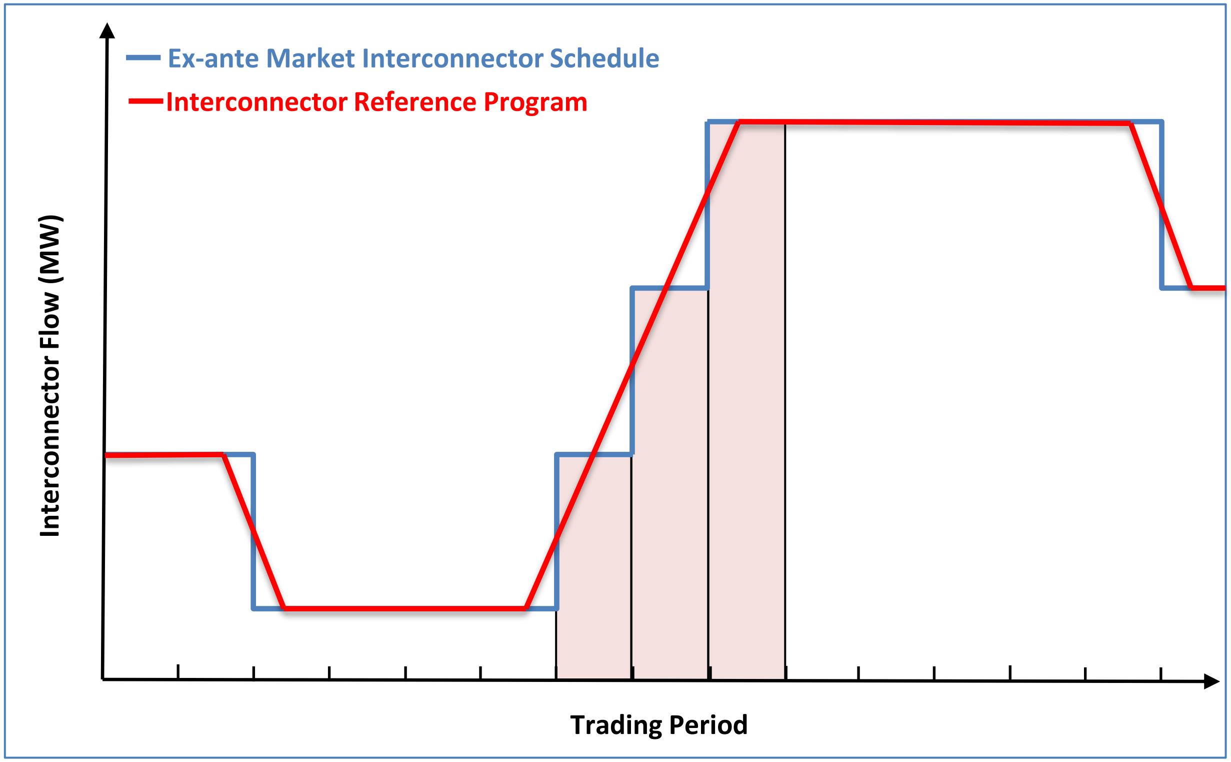
Required to carry 75% Largest Infeed

Tertiary Operating Reserve 1 (TOR1) – 90 to 5 Minutes
Tertiary Operating Reserve 2 (TOR2) – 5 to 20 Minutes

Required to carry 100% Largest Infeed

Interconnector Reference Program

Production of Interconnector Reference Programme:



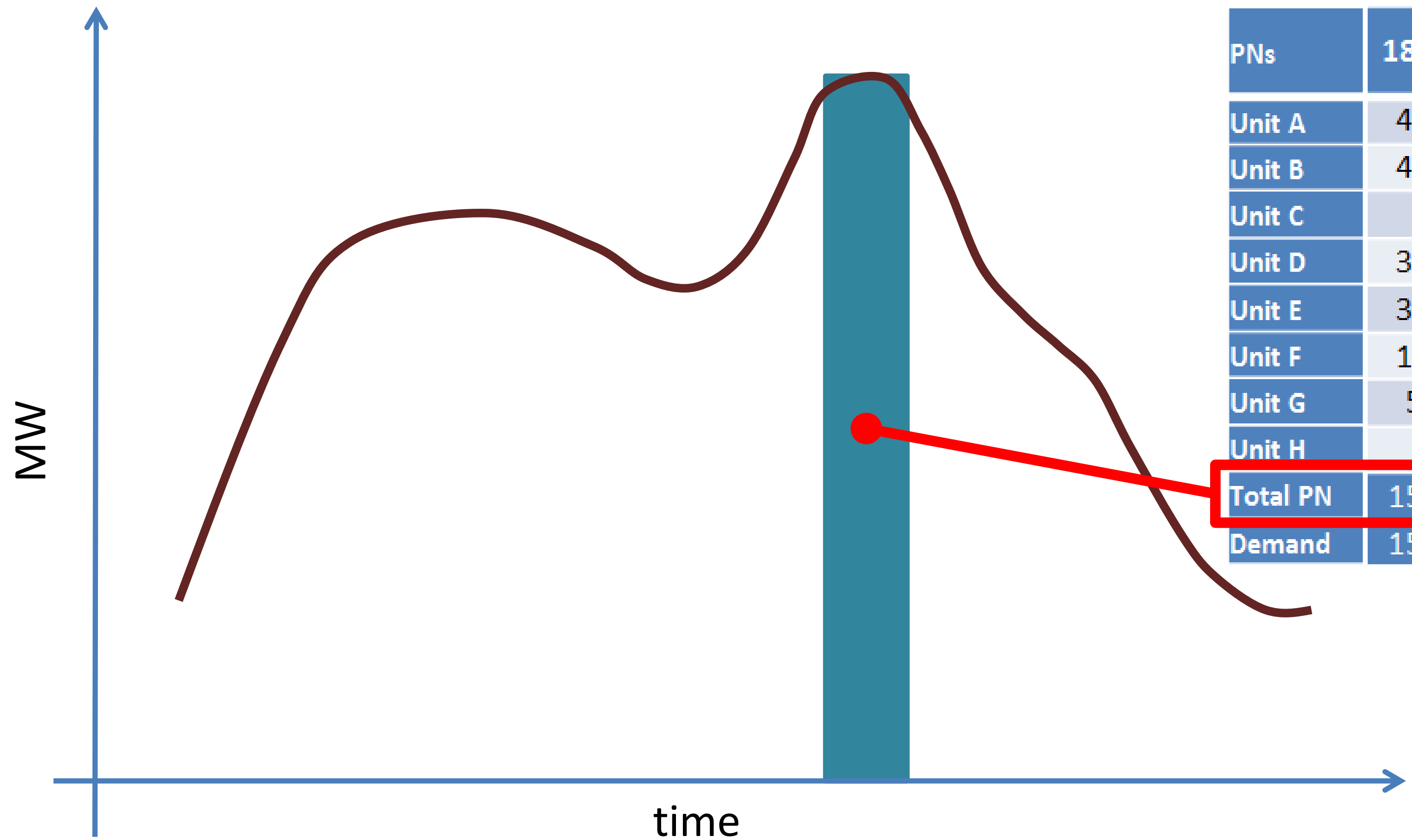
Example PN's

PNs	Availability Max / Min	08:00	09:00	10:00	11:00	12:00	13:00	14:00	15:00	16:00	17:00	18:00	19:00	20:00	21:00
Unit A	400 / 200	400	400	400	400	400	400	400	400	400	400	400	400	400	400
Unit B	400 / 200	300	350	400	400	400	400	400	400	400	400	400	400	300	200
Unit C	400 / 200	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Unit D	300 / 100	100	200	250	250	300	250	200	200	200	250	300	300	250	200
Unit E	300 / 100	100	200	200	200	200	200	200	200	200	250	300	200	100	100
Unit F	100 / 20	0	0	0	0	0	0	0	0	0	100	100	50	0	0
Unit G	100 / 20	0	0	0	0	0	0	0	0	0	0	50	0	0	0
Unit H	50 / 10	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total PN		900	1150	1250	1250	1300	1250	1200	1200	1200	1400	1550	1350	1050	900
Demand		900	1150	1250	1250	1300	1250	1200	1200	1200	1400	1550	1350	1050	900

Snapshot of PNs submitted for 08:00 to 21:00

For illustration purposes this data is presented at hourly resolution.

Example PN's



PNs	18:00
Unit A	400
Unit B	400
Unit C	0
Unit D	300
Unit E	300
Unit F	100
Unit G	50
Unit H	0
Total PN	1550
Demand	1550

System Security

Reserve (Frequency)	Thermal	Voltage	Dynamic Stability	Short Circuit
All Island OR Requirement	North-South Tie-Line Limit	NI North West Generation	Inertia	Operational Switching
NI/ROI Min OR Requirement	Cork Generation Export Limit	Dublin Generation	RoCoF	
NI/ROI Replacement Reserve ("GTs")		South West Must Run	SNSP	
NI/ROI Negative Ramping Reserve		400kV network Generation	NI 3 Units Must Run	
Ramping (1hr 3hr 8hr)			ROI 5 Units Must Run	

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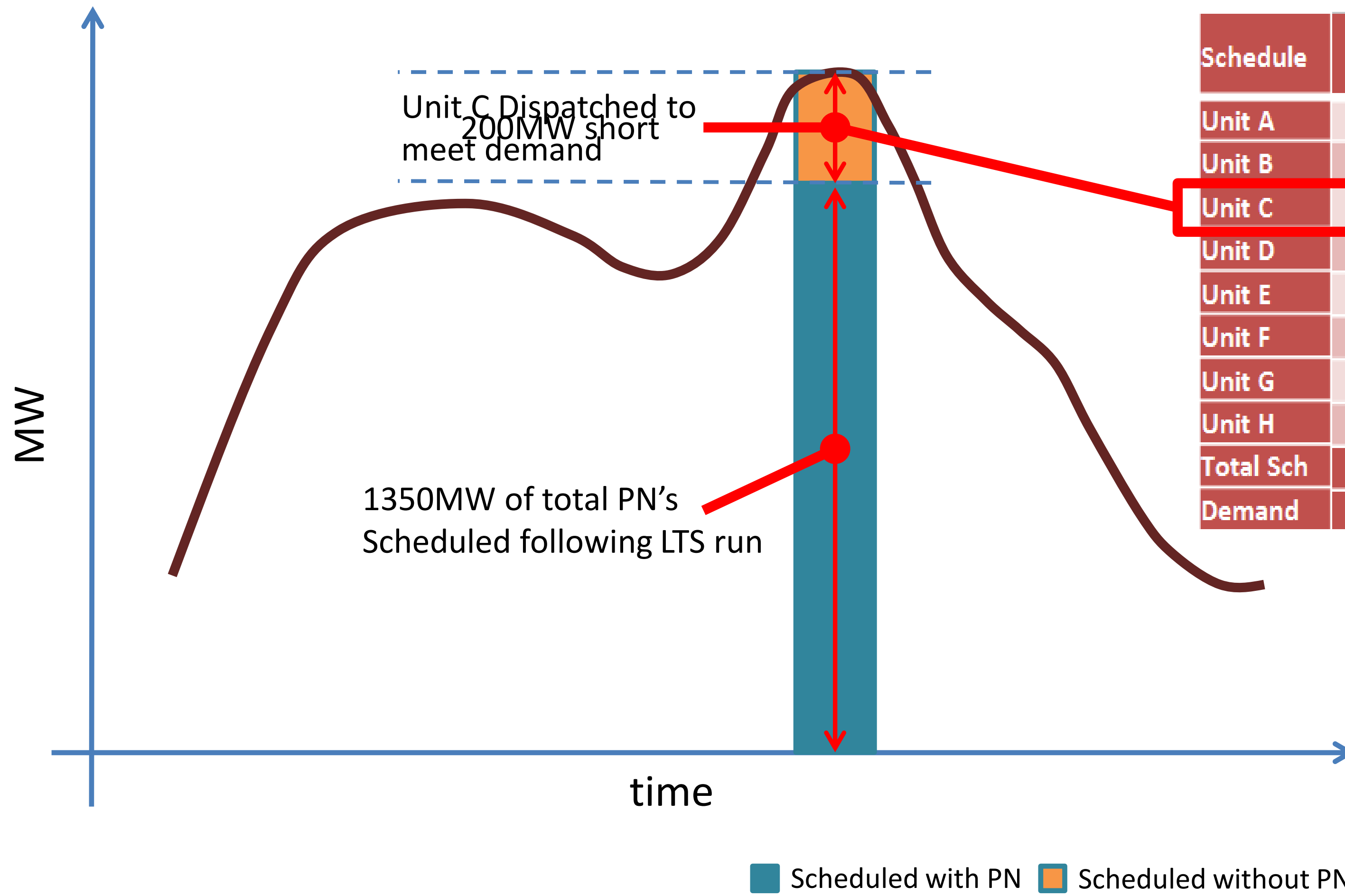
LTS Example

PNs	Availability Max / Min	08:00	09:00	10:00	11:00	12:00	13:00	14:00	15:00	16:00	17:00	18:00	19:00	20:00	21:00
Unit A	400 / 200	400	400	400	400	400	400	400	400	400	400	400	400	400	400
Unit B	400 / 200	300	350	400	400	400	400	400	400	400	400	400	400	300	200
Unit C	400 / 200	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Unit D	300 / 100	100	200	250	250	300	250	200	200	200	250	300	300	250	200
Unit E	300 / 100	100	200	200	200	200	200	200	200	200	250	300	200	100	100
Unit F	100 / 20	0	0	0	0	0	0	0	0	0	100	100	50	0	0
Unit G	100 / 20	0	0	0	0	0	0	0	0	0	0	50	0	0	0
Unit H	50 / 10	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total PN		900	1150	1250	1250	1300	1250	1200	1200	1200	1400	1550	1350	1050	900
Demand		900	1150	1250	1250	1300	1250	[illegible]	1200	1200	1400	1550	1350	1050	900

LTS Run

Schedule	Availability Max / Min	08:00	09:00	10:00	11:00	12:00	13:00	14:00	15:00	16:00	17:00	18:00	19:00	20:00	21:00
Unit A	400 / 200	370	370	370	370	370	370	370	370	370	370	370	370	370	370
Unit B	400 / 200	330	350	370	370	370	370	370	370	370	370	370	370	280	230
Unit C	400 / 200	0	200	200	200	200	200	200	200	200	200	200	200	200	0
Unit D	300 / 100	100	130	210	210	260	210	160	160	160	250	270	270	100	200
Unit E	300 / 100	100	100	100	100	100	100	100	100	100	190	270	120	100	100
Unit F	100 / 20	0	0	0	0	0	0	0	0	0	20	20	20	0	0
Unit G	100 / 20	0	0	0	0	0	0	0	0	0	0	50	0	0	0
Unit H	50 / 10	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total Sch		900	1150	1250	1250	1300	1250	1200	1200	1200	1400	1550	1350	1050	900
Demand		900	1150	1250	1250	1300	1250	1200	1200	1200	1400	1550	1350	1050	900

LTS Example Cont'd



Schedule	18:00
Unit A	370
Unit B	370
Unit C	200
Unit D	270
Unit E	270
Unit F	20
Unit G	50
Unit H	0
Total Sch	1550
Demand	1550

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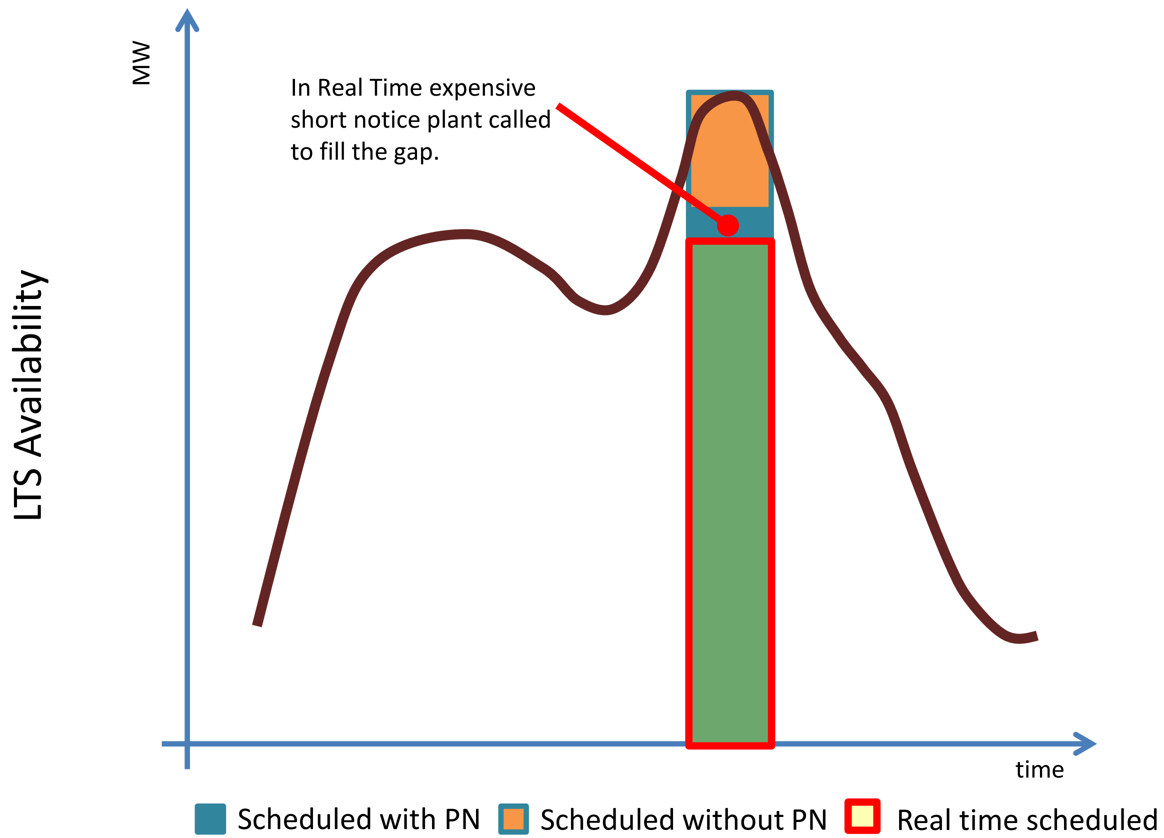
Forecast Availability v Declared

	Declared Max [MW]	Forecast Avail Max [MW]
Unit A	400	425
Unit B	400	408
Unit C	400	435
Unit D	300	310
Unit E	300	308
Unit F	100	105
Unit G	100	110
Unit H	50	59
	2050	**2160**

110MW Difference



LTS uses forecast availability, when it comes to real time the declared availability can be much lower, this leaves the real time schedules short, causing expensive short notice plant to be called, affecting imbalance pricing.

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Dispatch

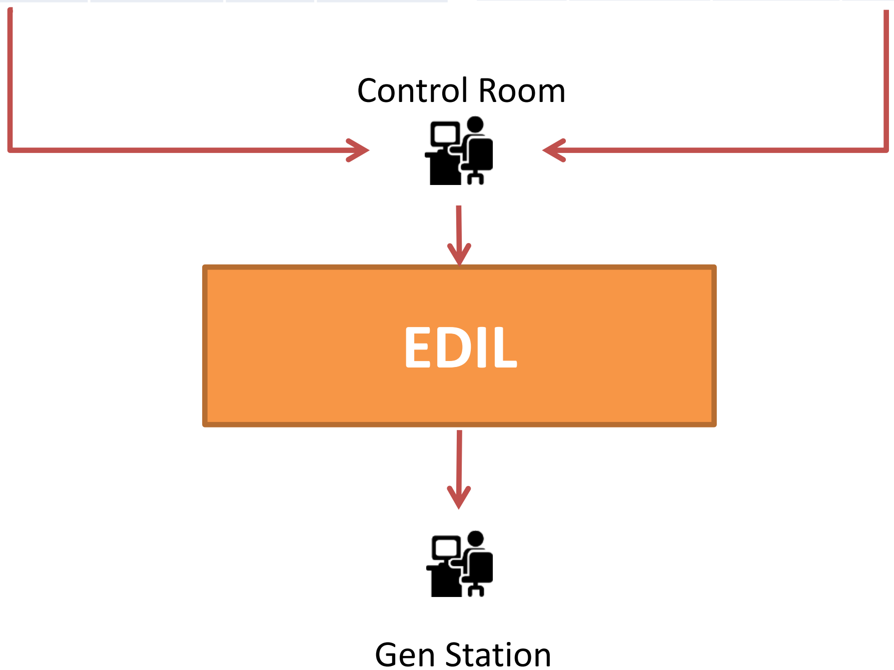
Dispatch

INC/DEC Merit Order

Unit	Current DI	Min Gen	Max Gen	Actual Output	PN	Price € MWh
A	396	150	431	398	431	20
B	335	130	390	332	380	25
C	375	100	400	374	400	26
D	60	20	120	60	100	30

OFFLINE Merit Order

Unit	PN	Min Gen	Max Gen	Cost € MWh	Notification Time [hr]
E	0	10	55	80	0.17
F	0	10	50	120	0.33
G	0	20	90	125	0.33
H	0	60	250	20,000	6



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Wind Dispatch

Reason for Wind dispatch

- **Curtailment** required for high wind output at low loads and minimum generation.
- **Constraint** required if there is insufficient transmission capacity to transport wind generation from weakly connected regions.

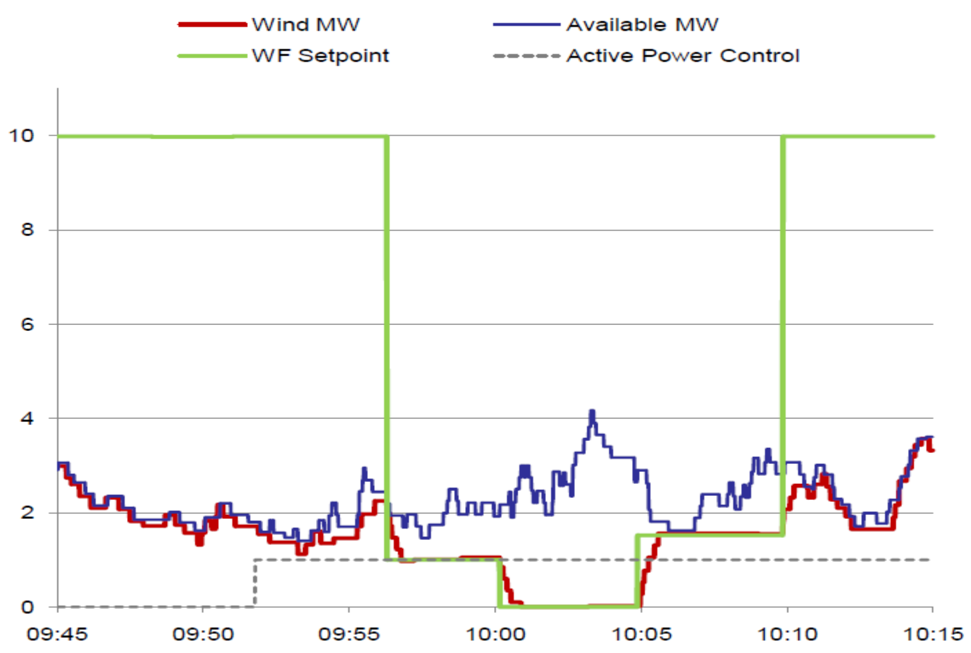
Curtailment/Constraint setpoints are issued to windfarms via the wind dispatch tool in the EMS

Active Power Control Status
Transfers control of active power setpoint to TSO control centre

Available MW
Calculated value provided by the wind farm

Wind MW
Present wind farm output

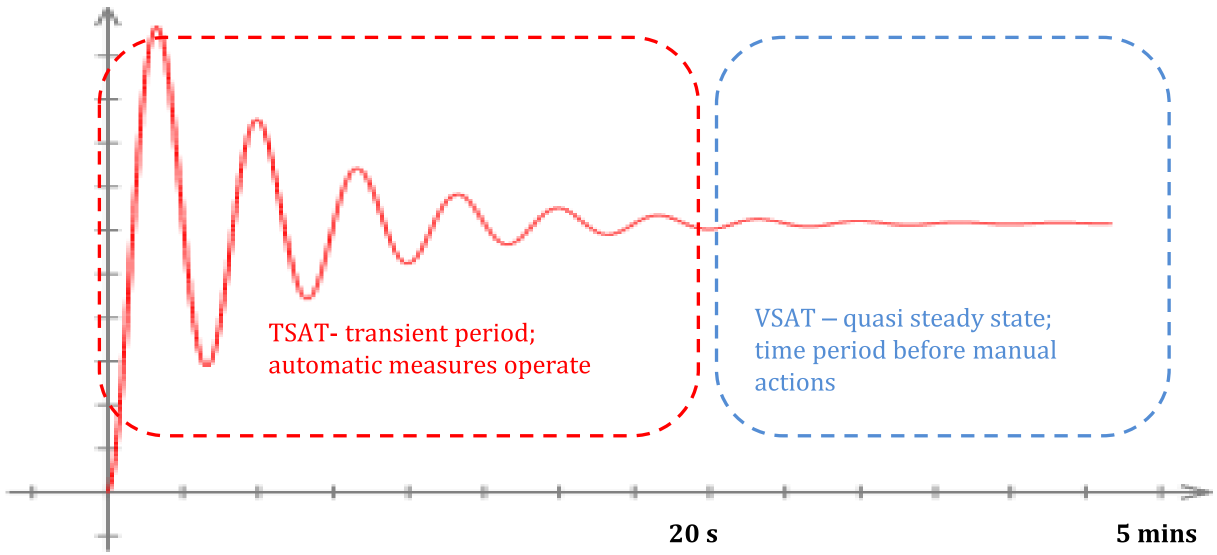
WF Setpoint
Active MW setpoint wind farm controller



WSAT

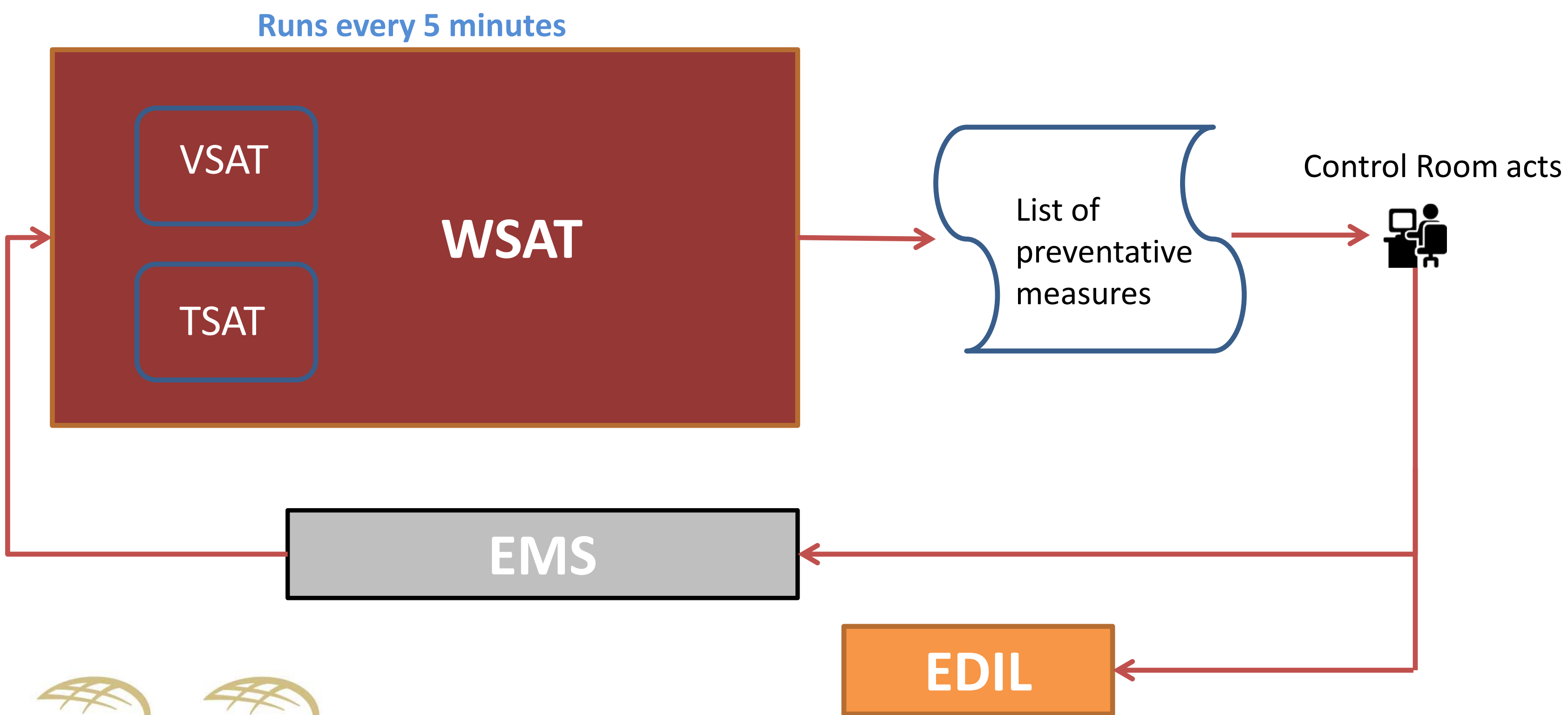
Power System Stability

Transient stability: the ability of the power system and individual generators to maintain synchronism after an operational disturbance. The system is within the **stability limit** when, after some given fault situations, it is able to return to an acceptable steady state situation.



WSAT (Wind Security Assessment Tool)

- Developed by EirGrid and external company to monitor the stability of the Irish power system with increasing levels of wind generation.
- Determines the voltage and transient stability of the system calculated for fault and no-fault conditions.



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What affects Transient Stability?

Machine MW Output

- Within an operational range the higher the MW, the less stable a machine

Machine MVAr Output

- Absorbing MVArs BAD, Producing MVArs GOOD
- To do with strength of the field between stator and rotor

Network Short-Circuit Level

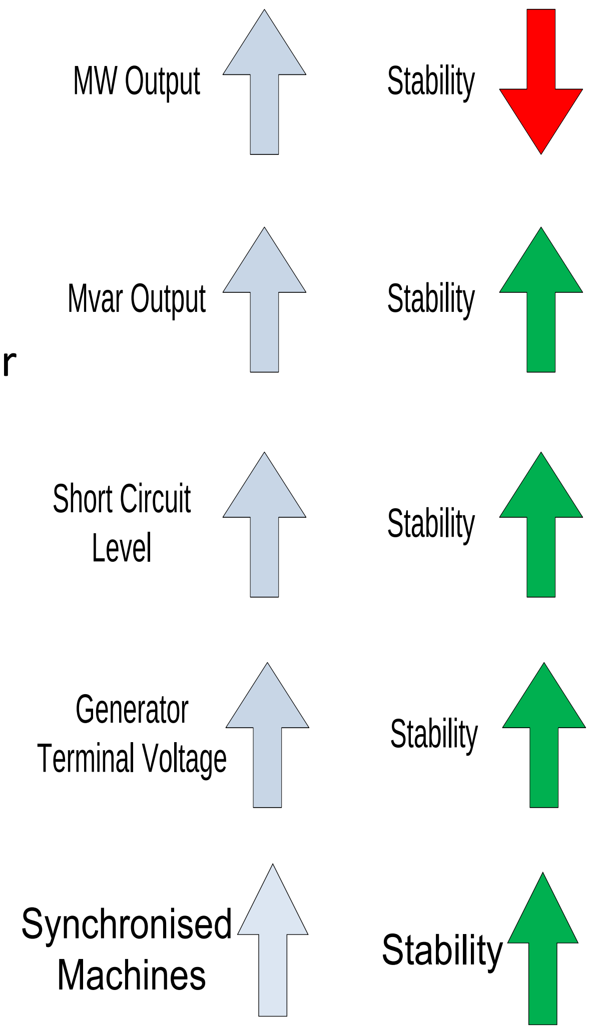
- The higher the SCMVA, the more stable a machine
- SCMVA related to how many machines in vicinity and the state of the network how many outages

Machine Terminal Voltage

- Higher is better

Number of Synchronised Machines

- # of machines is better



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WSAT Example (Loss of North – South Tie Line)

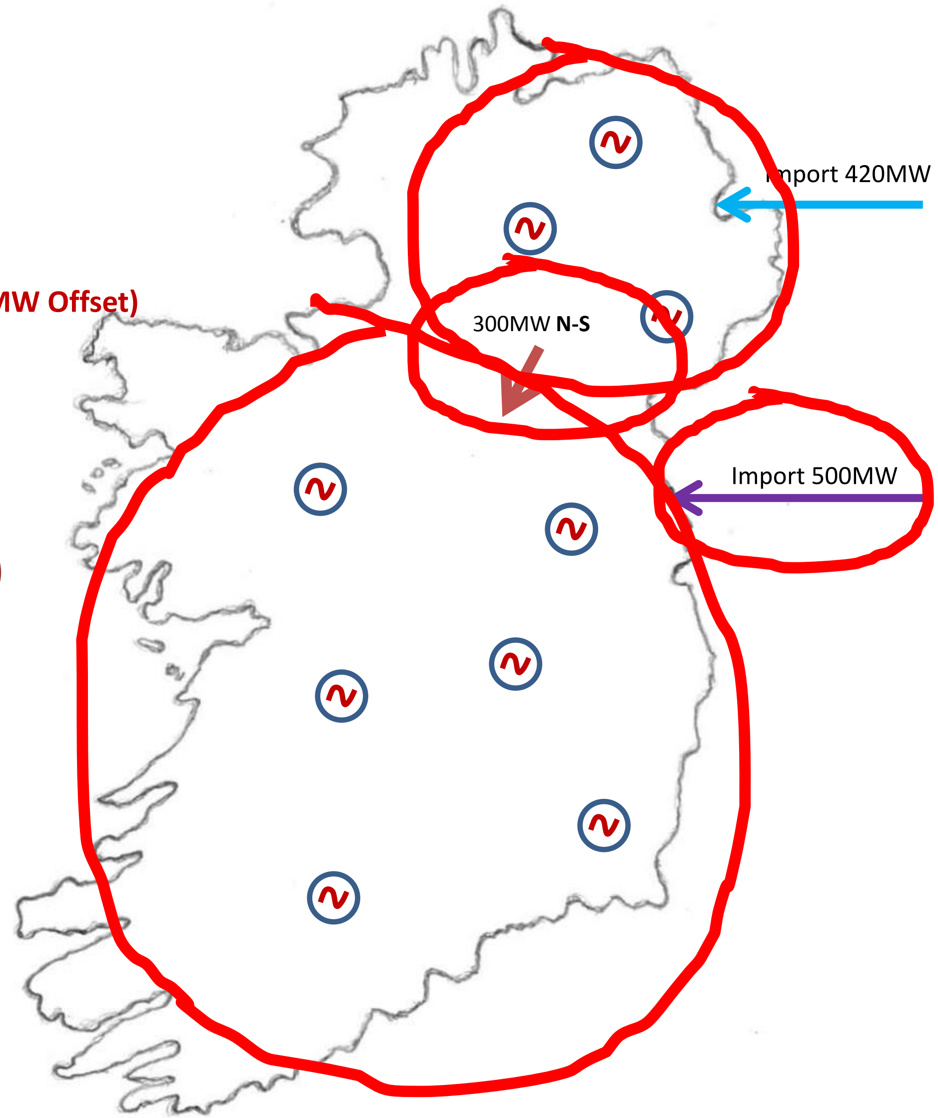
Largest Single Infeed 500MW

POR Required 75% of 500MW = 375MW

North – South flow = 300MW, **(Limit 450MW – 20MW Offset)**

NI POR = 130MW

ROI POR = 250MW



N-S Net Flow (Scheduled flow + Reserve)

$$T_{N-S} + Min(POR_{NI}, LSI_{IE} - 25\%\ POR_{IE}) \leq S\_MWR\_NI$$

300+Min(130, 500 - 0.25*250) ≤ 430

430 = S_MWR_NI = Max Flow

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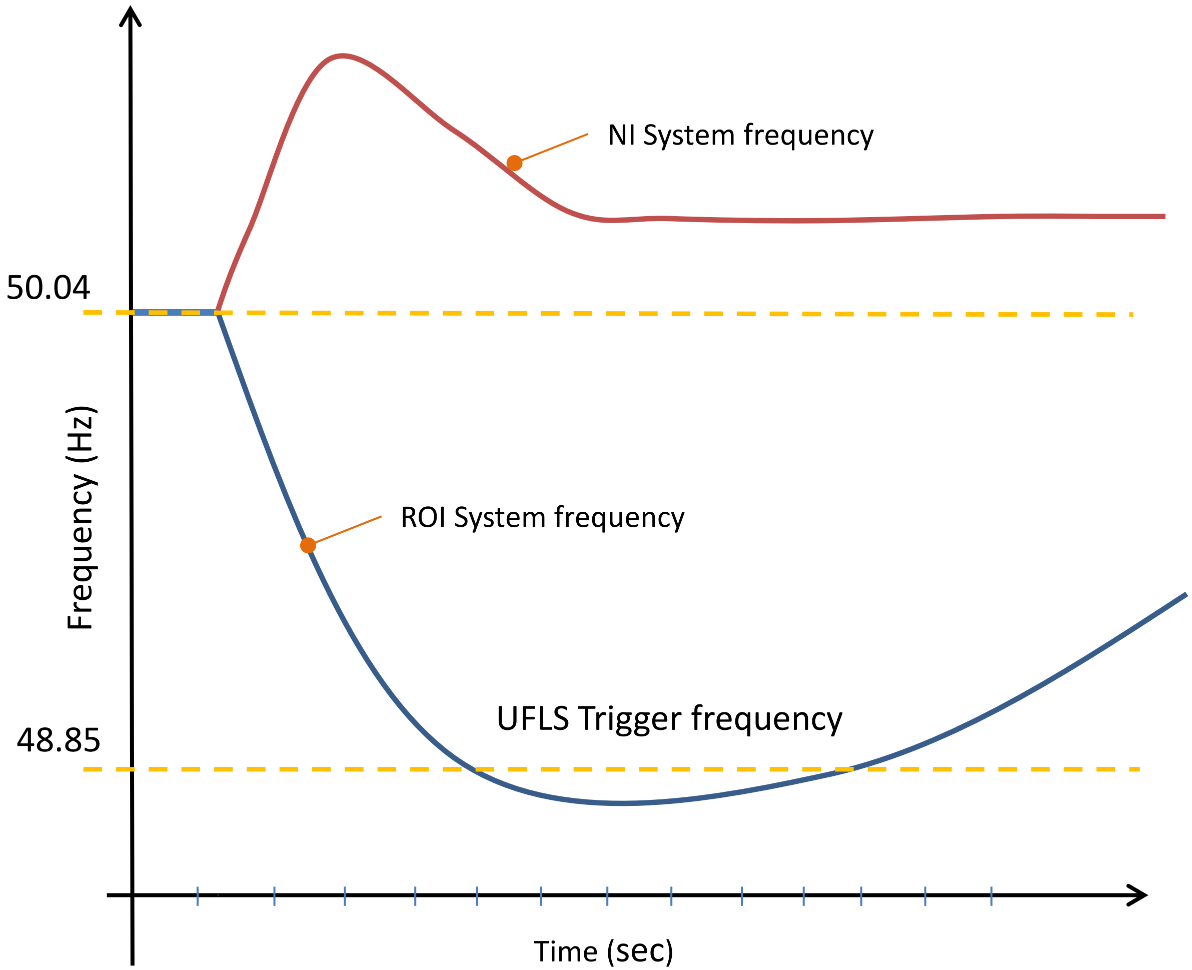
WSAT Example (Loss of North – South Tie Line)



For loss of Tie Line

- System Separation
- Low Frequency in ROI, UFLS triggered.
- ROI system low inertia, only 5 big generators ON.
- Frequency slow to recover.
- High Frequency in NI.
- Interconnector runback activated and recovers NI frequency to within limits.

Preventative Control Measures

- Reduce the Tie Line flow by decreasing Generation in NI (reduce generation, reduce Moyle import or Constrain wind)
- Increase reserve provision in ROI, re-dispatch out of merit generation.
- Sync additional generation.

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System Overview for Scheduling & Dispatch