DS3 Programme Status Update

19/03/13

Yvonne Coughlan

Relevant Industry Developments

- Publication of CER Decision on Tie Breaks (SEM-13-010)
  - Constraint Reports under development by EirGrid
  - Expected completion date: May – July 2013
  - Tie in with DS3 Control Centre Tools workstream

- European Commission Consultation on Generation Adequacy, Capacity Mechanisms and Internal Electricity Market
  - ENTSO-E and EirGrid response submitted

Background – DS3 Programme

Shaping the power system of the future

System Services
Performance Monitoring
Grid Code
Demand Side Management

Frequency Control
Voltage Control
Renewable data
Rate of Change of Frequency

Studies & Model Development
Control Centre Tools
Wind Security Assessment Tool

System Performance

DS3 System Services Review

3 public consultations completed

1. Initial Information Gathering [COMPLETE]
2. Detailed New System Services product proposals [COMPLETE]
3. Financial Arrangements - remuneration, contractual arrangements [COMPLETE]
4. Recommendations Paper to RAs [UNDERWAY – Q1 2013]
5. Draft Decision by RAs [Q2 2013]
6. Full High Level Decision [Q3 2013]

Grid Code

- All RoCoF Modifications submitted to RAs - Dec 2012
  - All island standard of 1 Hz/s averaged over 500 ms is proposed

- Wind Farm Modifications

	Ireland Grid Code	Northern Ireland Grid Code / Settings Schedule	Ireland Distribution Code	Northern Ireland Distribution Code
Reactive Power Control Modes	Approved by CER – Feb 2013	TSO input complete – with UREGNI for approval	Mods being drafted	T&D Settings Schedule with UREGNI. D-Code Mods required
Steady State Q Capability	Approved by CER – Feb 2013	TSO input complete – with UREGNI for approval	Mods being drafted	T&D Settings Schedule with UREGNI. D-Code Mods required
Fault Ride Through	Approved by CER – Feb 2013	TSO input complete – with UREGNI for approval	Mods being drafted	T&D Settings Schedule with UREGNI. D-Code Mods required

Grid Code – Next Steps

- Distribution Code Modifications need to be progressed
- DSU and Dynamic Model modifications in progress
- Review of Network Codes underway
- Testing Guidelines under development for wind farm modifications
- Need for further Joint Grid Code Working Group Meetings?

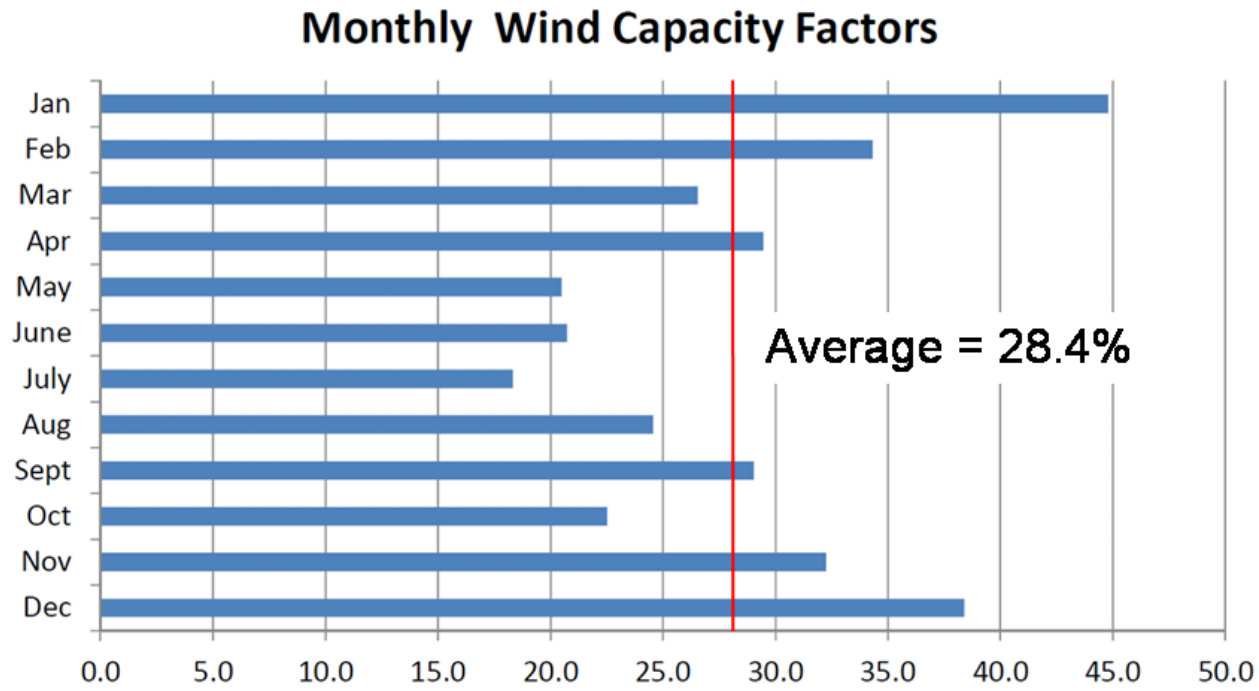
Demand Side Management

- Phase out of WPDRS complete
- 2 DSU operational (54 MW)
- Review of Grid Codes almost complete
  - Consultation planned for Northern Ireland in Q2 2013.
- Trialling of a new communications interface between Control Centres and DSU
- Issue with licensing for DSU in Northern Ireland (Remaining Barrier to Entry)
- Commenced DSM Demonstration project with Glen Dimplex

Renewable Data

- All-island Wind Record 18/12/12 – 1875 MW

- 2012 Curtailment Report
  - under development
  - Intend to issue invitation to renewable developers (hydro, CHP, wind etc.) to provide comments on curtailment reporting



System Tools

Control Centre Tools

- Wind Dispatch Tool Development
  - In line with SEM-13-010
  - Capability for Curtailment Reporting
- Publish new plan for workstream
- Managing Renewables in the Control Centres
- WSAT operational in both Control Centres
  - Further developments to investigate frequency stability planned

Modelling and Studies

- Minimum Generator Study underway
  - Maintaining standards for transient stability, voltage stability, transient voltage stability, sufficient voltage control reserve, frequency stability, transient voltage stability
  - Ensuring ramping capability of the power system
  - snapshots of daily minimum load selected from three summer months 2012 at periods with highest wind
- Distributed Voltage Control study underway
  - Investigation of operating modes for wind farm clusters
- Generic wind farm model development
  - To include Grid Code modifications (frequency response and fault ride through)

Modelling and Studies

- Further Facilitation of Renewables studies
  - Developing methodology for automation
  - Dependent on output of System Services, Grid Code workstreams
  - Will use new models developed

- Assumptions
  - Assumptions will be developed in Q2 2013
  - For discussion in Q3 2013 at Advisory Council Meeting

- Model Validation
  - Reviewing Actual Performance relative to model performance

System Policies

In the Control Centres….

- Largest Single In-Feed & RoCoF Policy
  - If the output from the largest in-feed is too high, losing the Largest In-feed could mean that the RoCoF is so high, that DSO windfarms could trip by ROCOF protection, causing the frequency to decrease even further.
  - The EMS will alert Control Centre operators when system inertia is below a threshold
  - Calculation of inertia by operators and reduction of size of largest in-feed if required

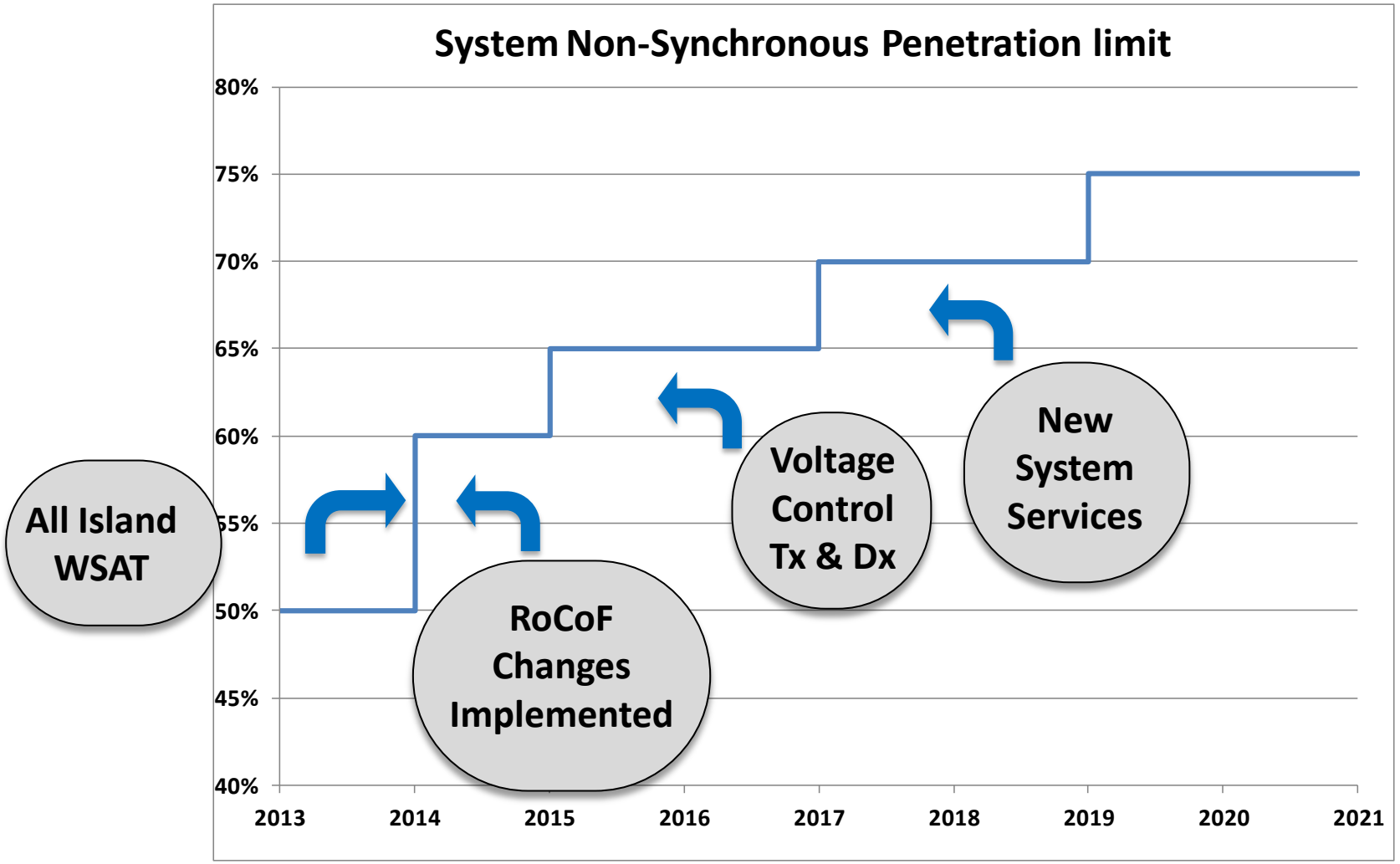
- SNSP Policy
  - Non-Synchronous Generation = Total wind generation on the all-island system, including embedded generation, and all additional non-synchronous generation

$$SNSP\ (\%) = \frac{Non\text{-}Synchronous\ Generation + Net\ Imports\ (Moyle + EWIC)}{Demand + Net\ Exports\ (Moyle + EWIC)} \times 100$$

The past 18 months…..

- Steady Progress on System Services
  - Independent Consultant review period
  - Extended Consultations
  - Industry Engagement
- RoCoF discussion and issues
  - Lengthy discussions
  - Cost issue still outstanding
  - Difficult to work toward a solution for all parties
- Grid Code Wind Farm Modifications
  - Great progress made
- Challenge of aligning all island position
  - Different Grid Codes
  - 2 Regulatory Authorities

Operational Limits on Renewable Generation

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All Island on-line Wind Security Assessment Tool **WSAT**

19 March 2013

Ivan Dudurych

System Services
Performance Monitoring
Grid Code
Demand Side Management

Frequency Control
Voltage Control
Renewable data
System inertia

Models Development
Control Centre Tools
AI Wind Security Assessment Tool

Overview

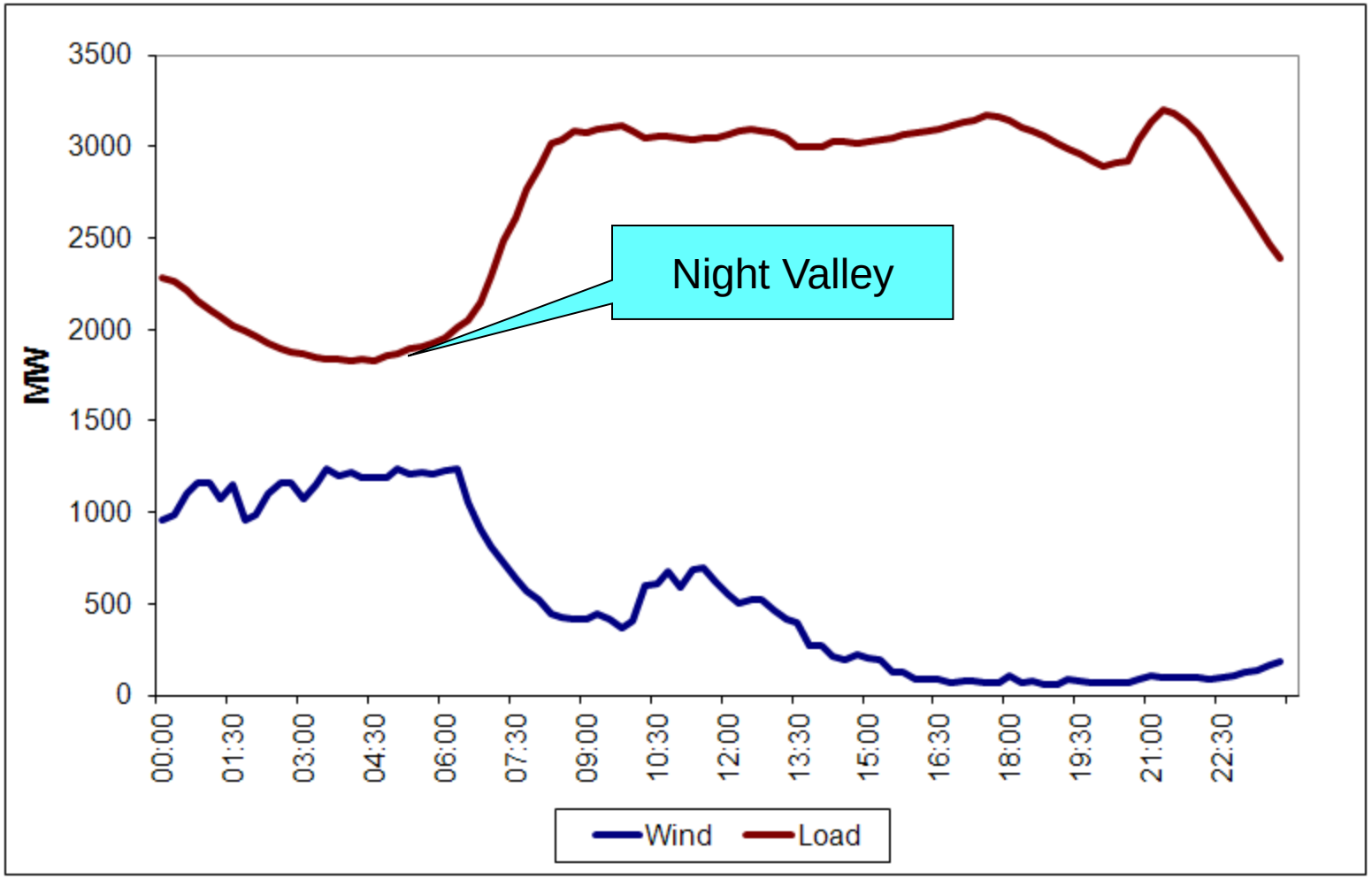
- Secure Wind Level Concept and WSAT
- On-line WSAT Characteristics
- Further WSAT Development

Secure Wind Generation Level (SWL)

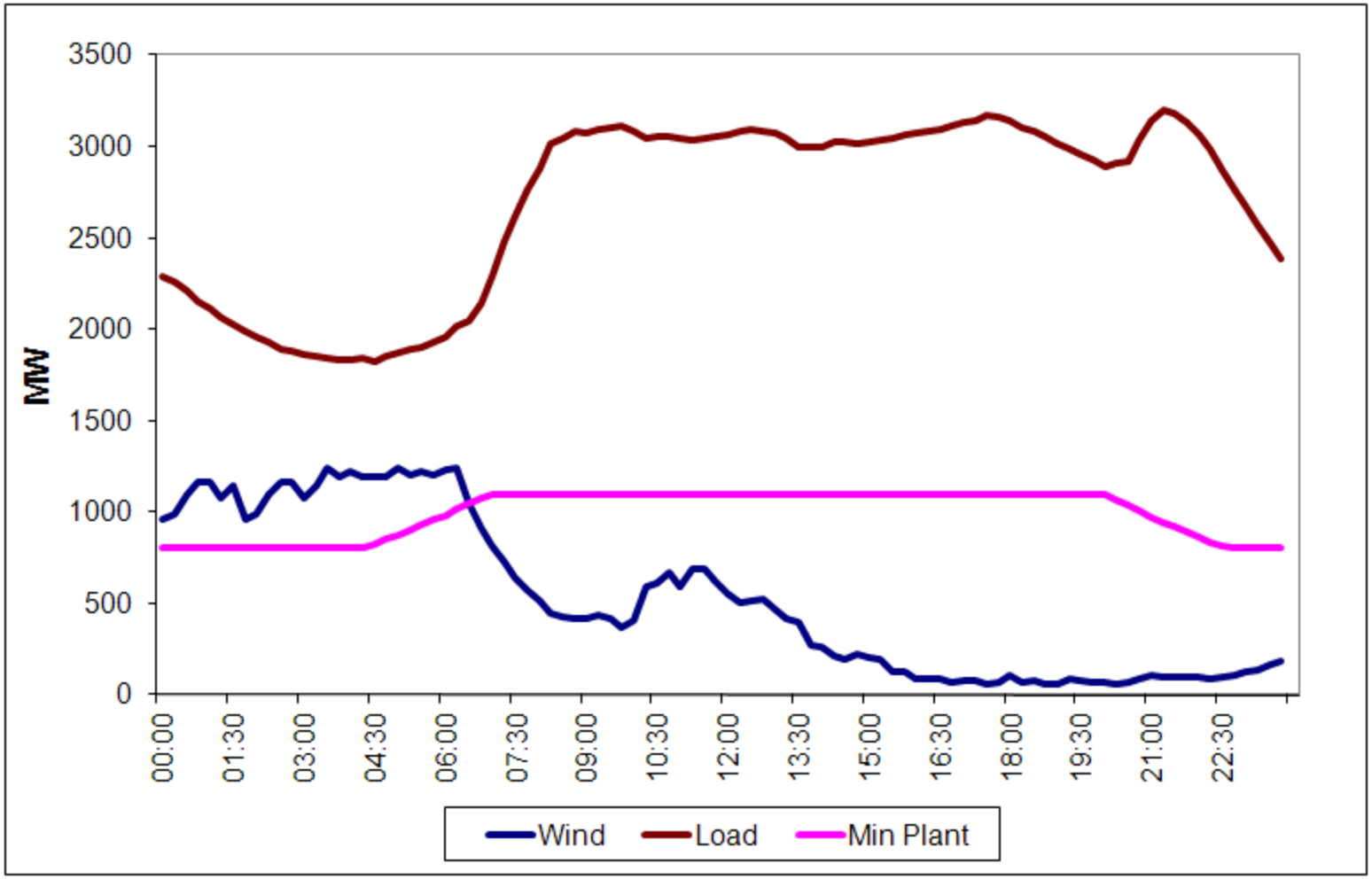
- It is the maximum amount of wind (with agreed margin) on the power system with which system security standards are maintained.
- These standards include but not limited to
  - frequency and voltage control
  - reserve requirements
  - adequate ‘ramping capability’ and
  - system stability
- **Min**imum **Contr**ollable **Gen**eration

- **Secure Wind Level = Demand – Min. Contr. Gen.**

Secure Wind Generation Level (SWL)



Secure Wind Generation Level (SWL)



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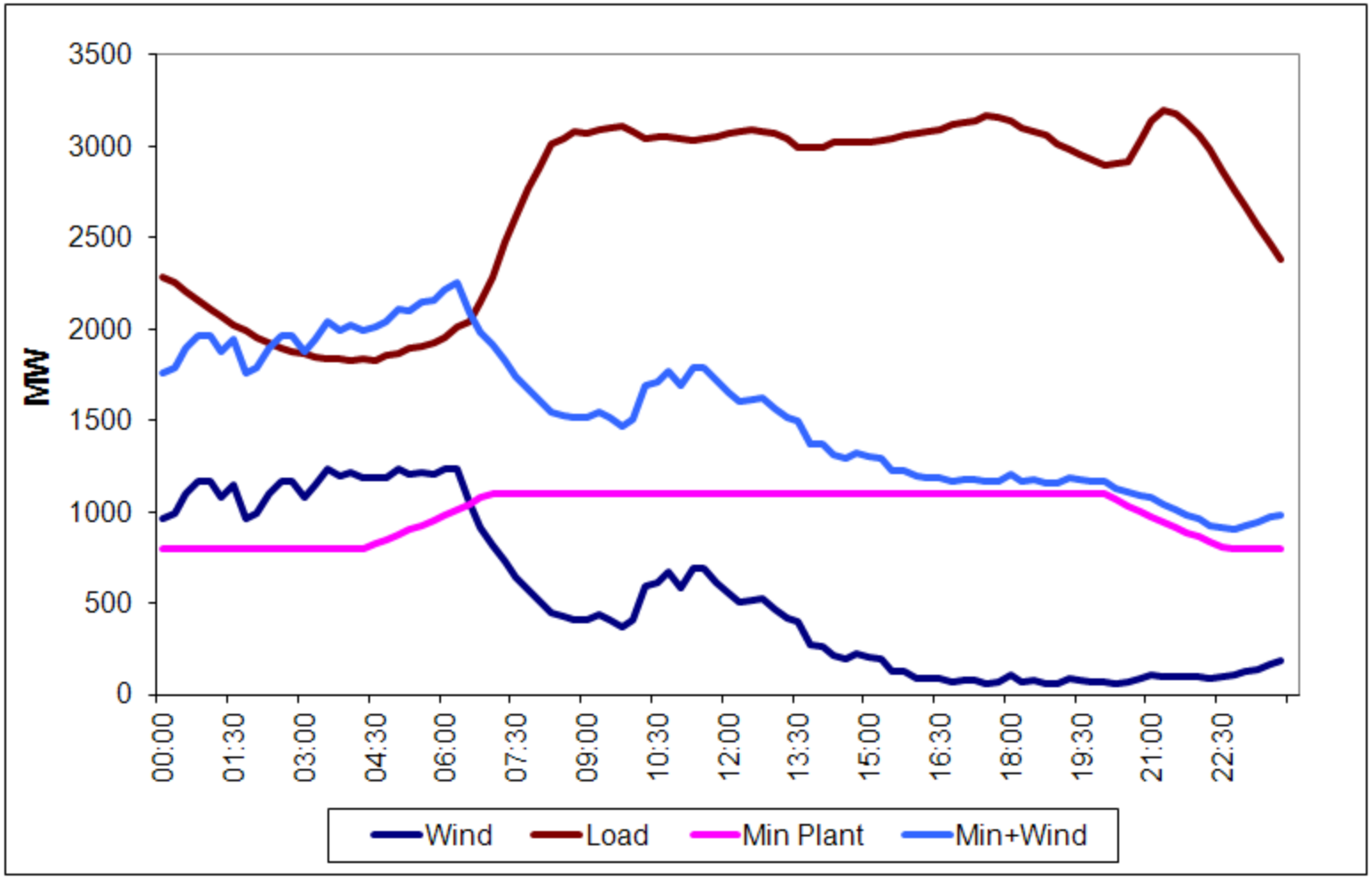

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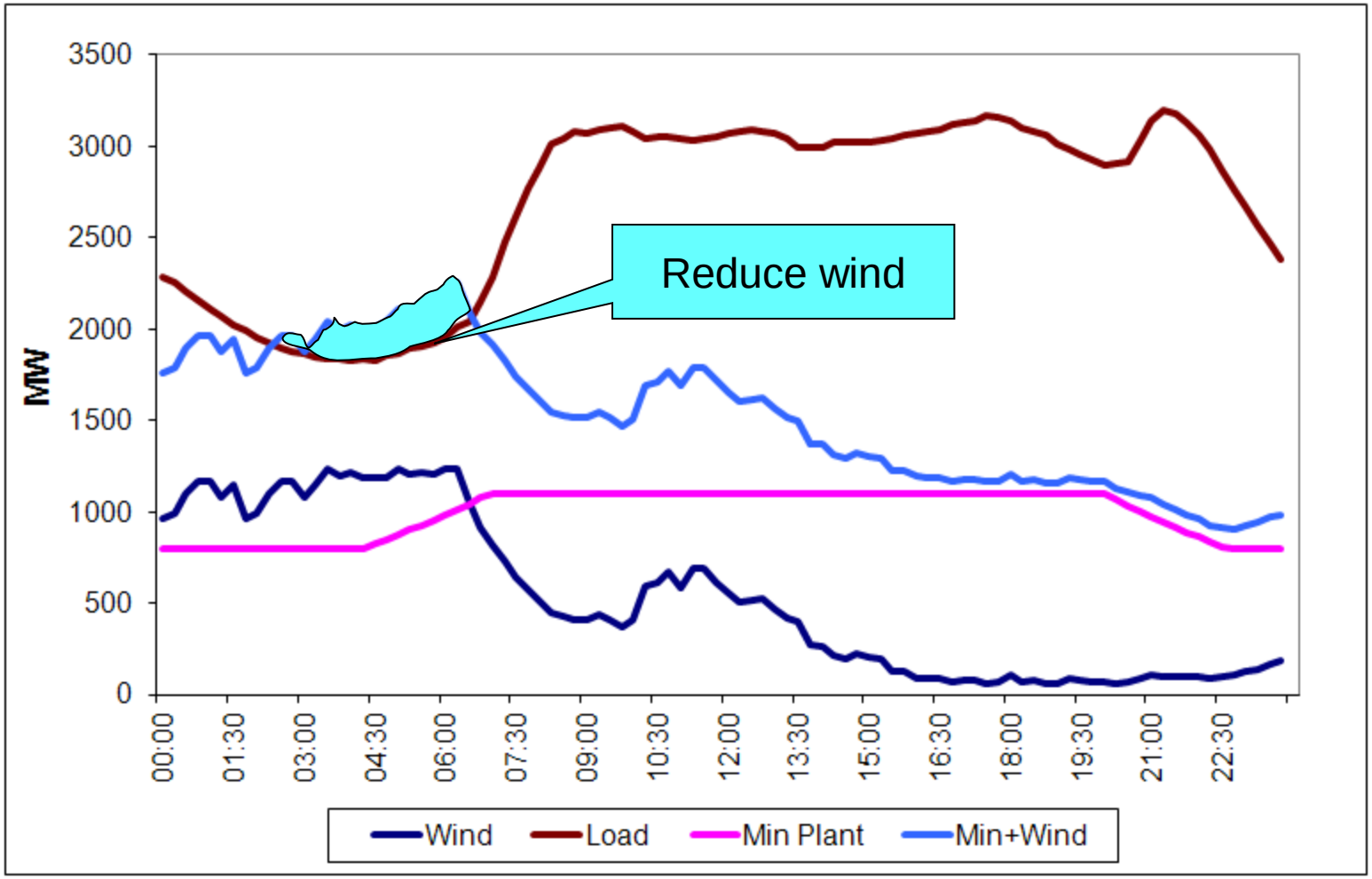
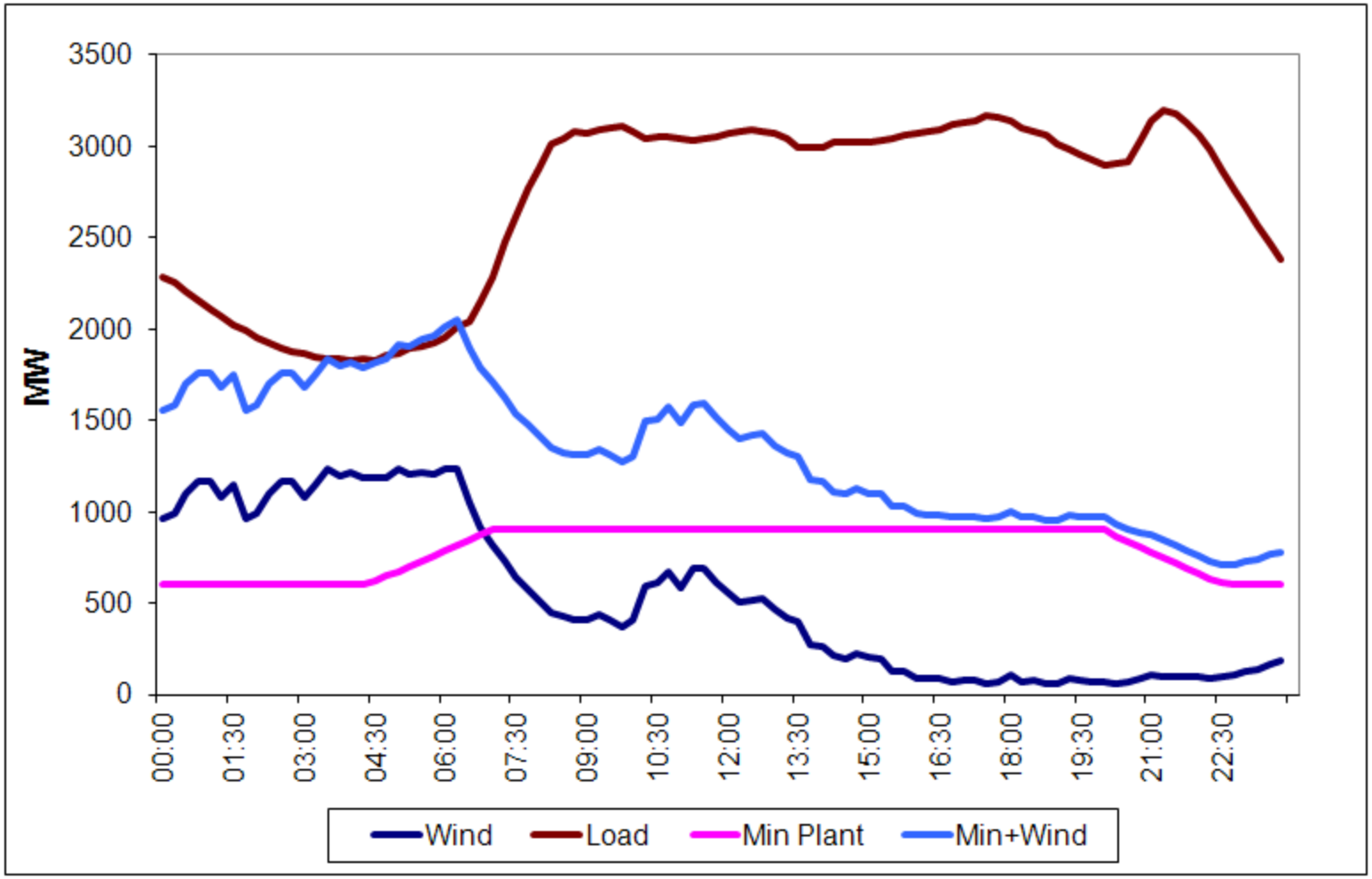


Secure Wind Generation Level (SWL)

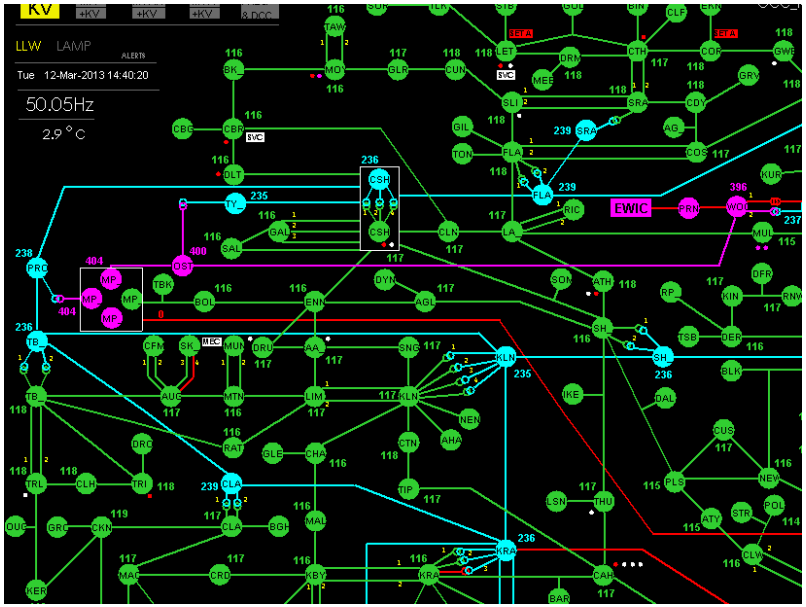


On-line WSAT Characteristics

- WSAT has been installed in NCC in Dublin in September 2010
- AI WSAT was officially launched simultaneously in both Control Centres in Dublin (NCC) and Belfast (CHCC) on 19 November 2012. This probably is one of the first multi-jurisdictional tools in the world
- WSAT runs every 15 minutes 24/7 and assesses the Transient and Voltage Security of the power system in near real time for the **Real** case, **Wind increase** cases, and **Load increase** cases.

On-line WSAT Characteristics

- **Real** case: Initial case (EMS SCADA snapshot) + Contingency cases



- **Increase** cases are also called ***Transfers***

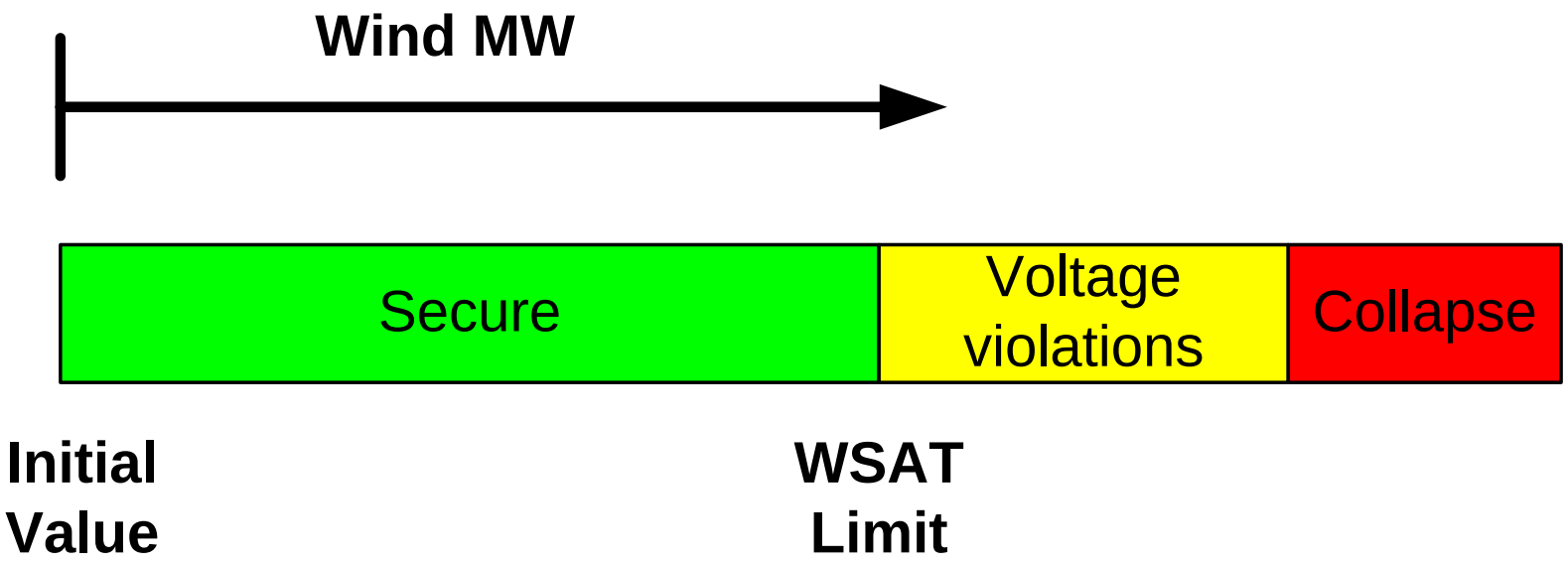
Wind - Conventional generation Power Transfer

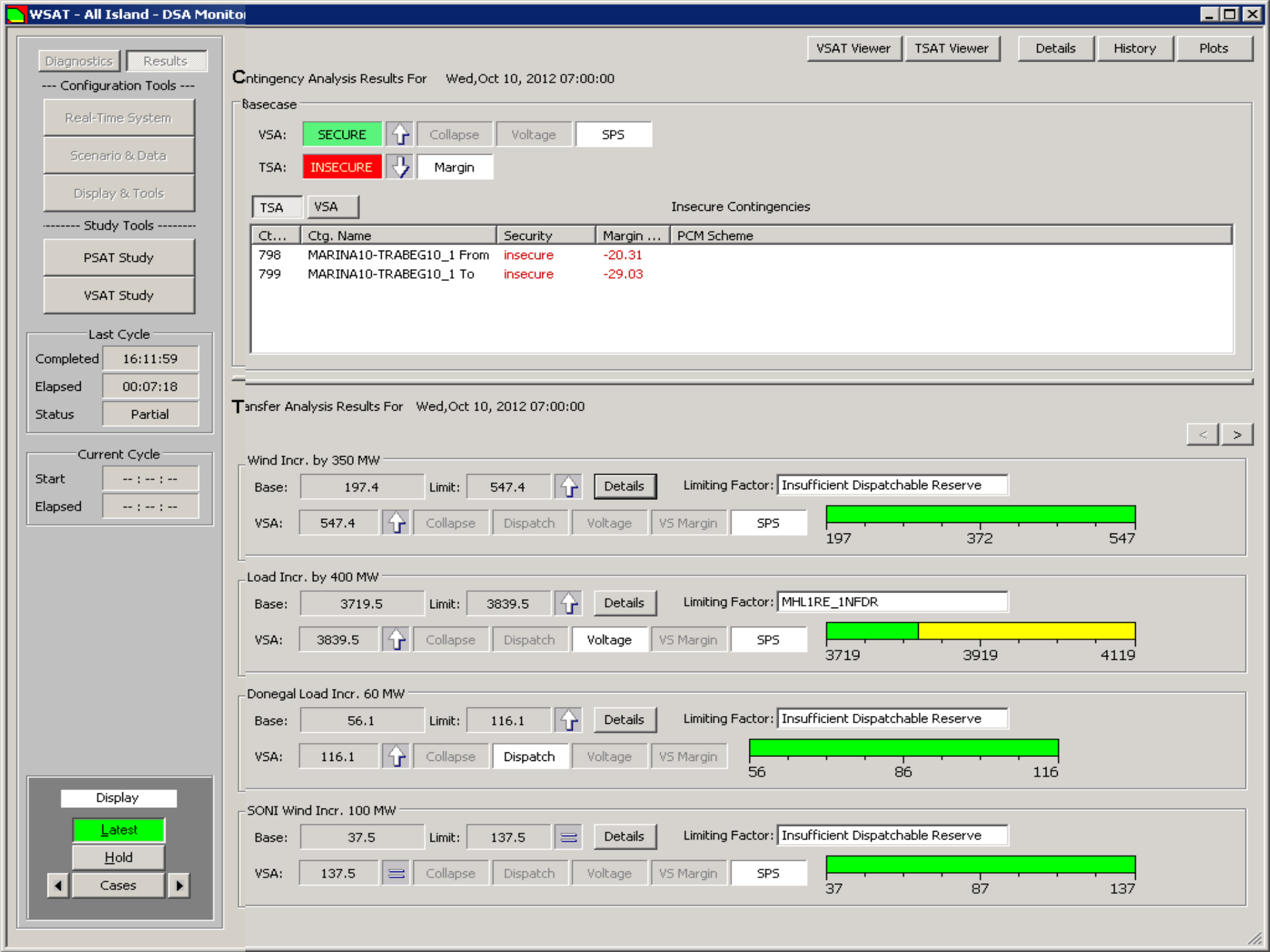
Total generation

Source

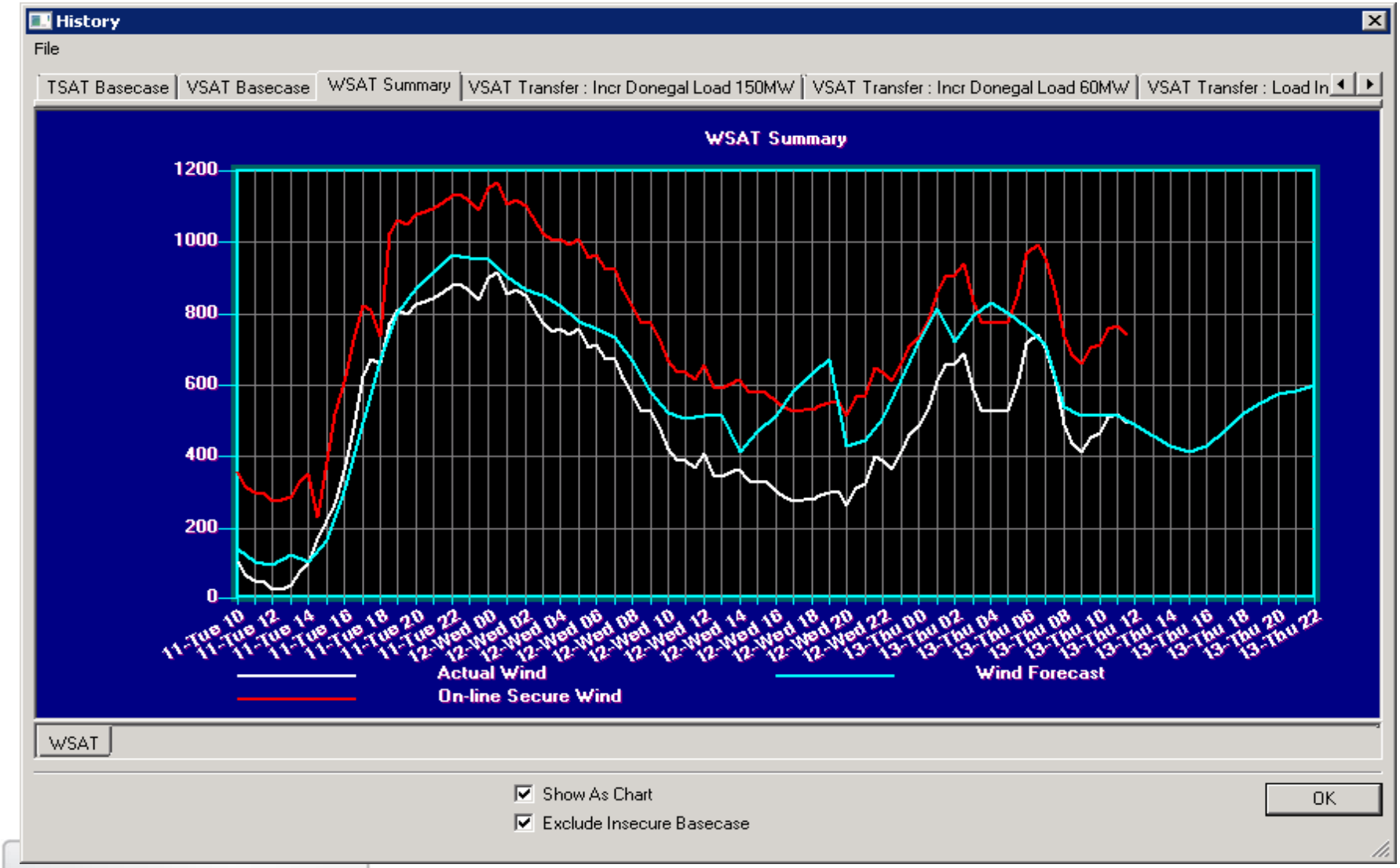
Sink

Wind Secure Limit Bar

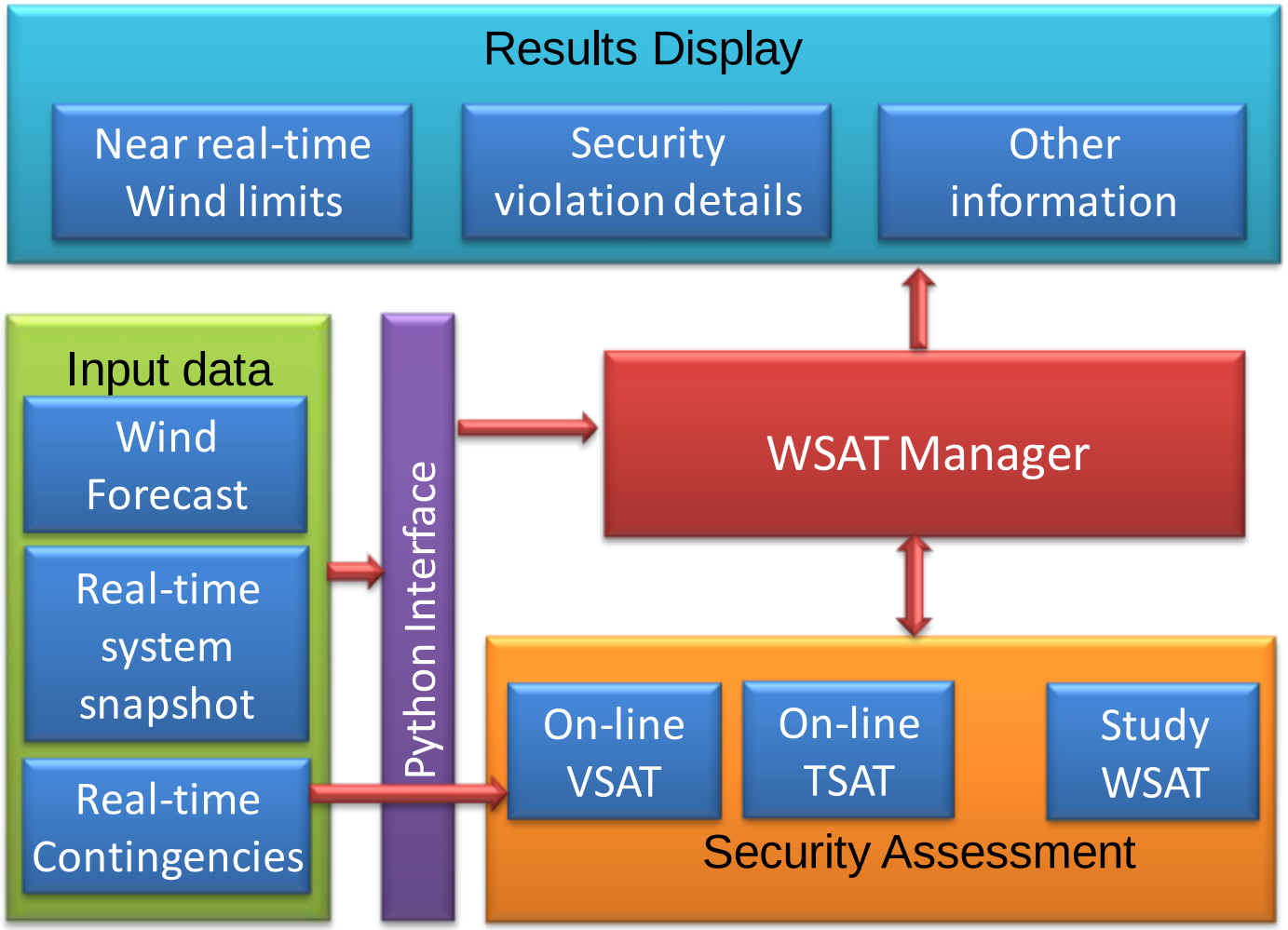



WSAT - All Island - DSA Monitor
Diagnostics
Results
--- Configuration Tools ---
Real-Time System
Scenario & Data
Display & Tools
-------- Study Tools --------
PSAT Study
VSAT Study
Last Cycle
Completed 16:11:59
Elapsed 00:07:18
Status Partial
Current Cycle
Start -- : -- : --
Elapsed -- : -- : --
Display
Latest
Hold
Cases
VSAT Viewer
TSAT Viewer
Details
History
Plots
Contingency Analysis Results For Wed,Oct 10, 2012 07:00:00
Basecase
VSA: SECURE Collapse Voltage SPS
TSA: INSECURE Margin
TSA
VSA
Insecure Contingencies
Ct... Ctg. Name Security Margin ... PCM Scheme
798 MARINA10-TRABEG10_1 From insecure -20.31
799 MARINA10-TRABEG10_1 To insecure -29.03
Transfer Analysis Results For Wed,Oct 10, 2012 07:00:00
Wind Incr. by 350 MW
Base: 197.4 Limit: 547.4 Details Limiting Factor: Insufficient Dispatchable Reserve
VSA: 547.4 Collapse Dispatch Voltage VS Margin SPS
197 372 547
Load Incr. by 400 MW
Base: 3719.5 Limit: 3839.5 Details Limiting Factor: MHL1RE_1NFDR
VSA: 3839.5 Collapse Dispatch Voltage VS Margin SPS
3719 3919 4119
Donegal Load Incr. 60 MW
Base: 56.1 Limit: 116.1 Details Limiting Factor: Insufficient Dispatchable Reserve
VSA: 116.1 Collapse Dispatch Voltage VS Margin
56 86 116
SONI Wind Incr. 100 MW
Base: 37.5 Limit: 137.5 Details Limiting Factor: Insufficient Dispatchable Reserve
VSA: 137.5 Collapse Dispatch Voltage VS Margin SPS
37 87 137

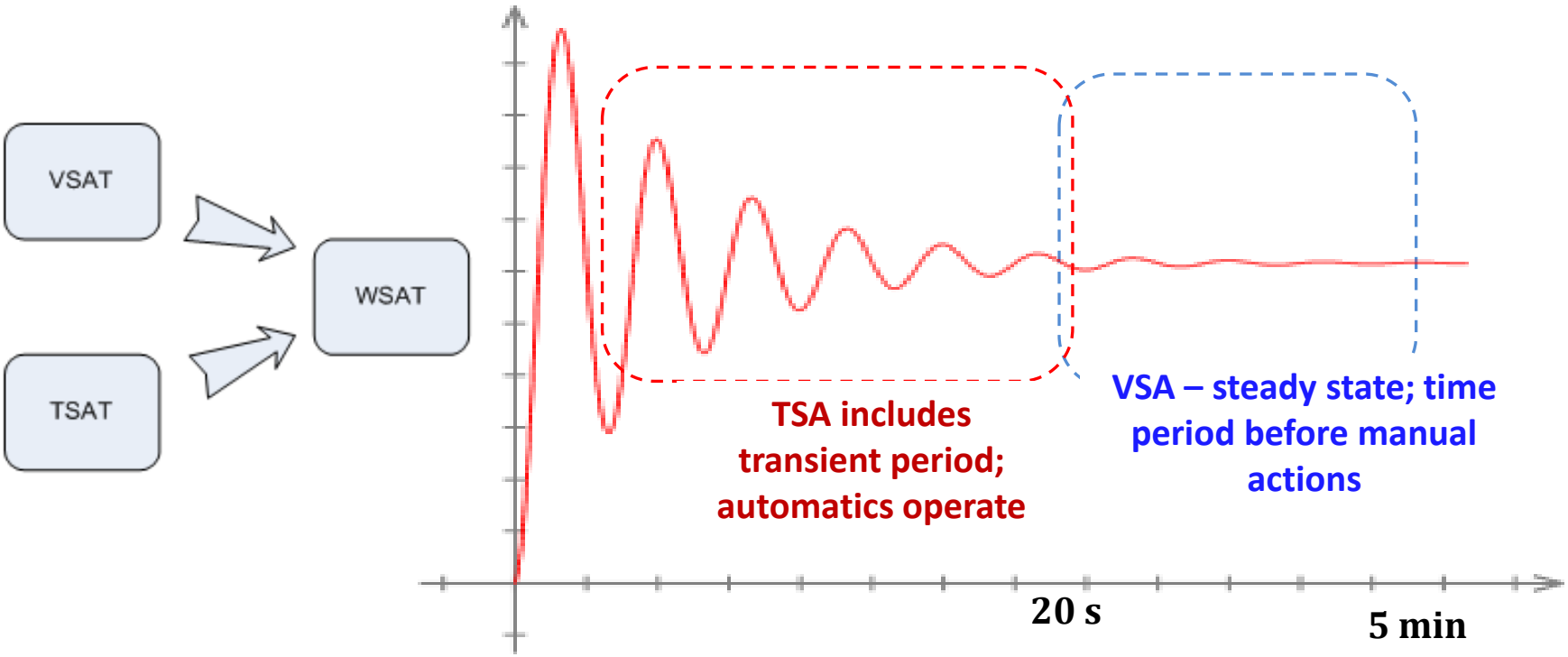
WSAT History Window



WSAT – Software Structure

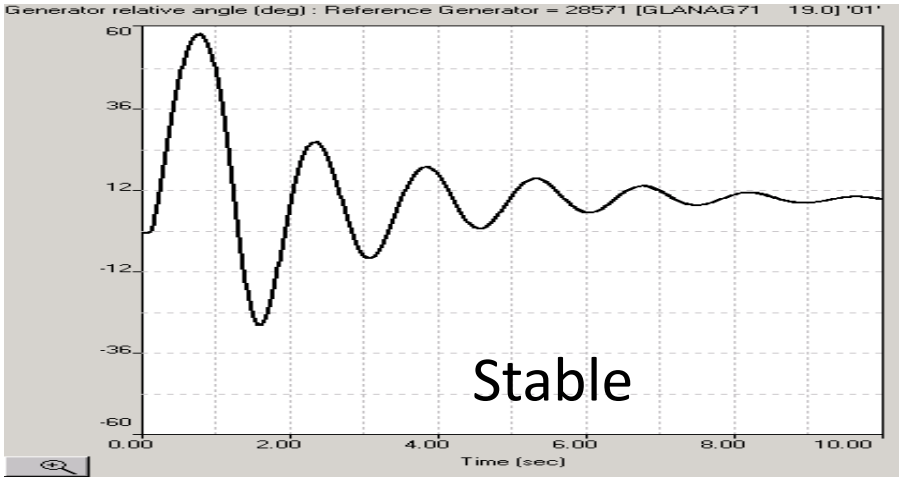


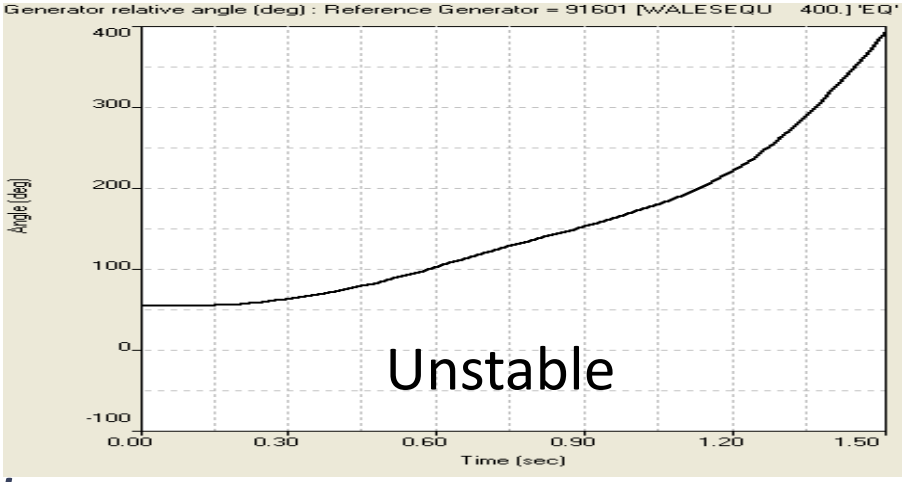
WSAT Calculations



Transient Security

- Transient Security of the power system involves checking to see if all conventional generators maintain transient or angular stability (do not slip poles) after contingency events and that non-synchronous plant returns to its normal op. range



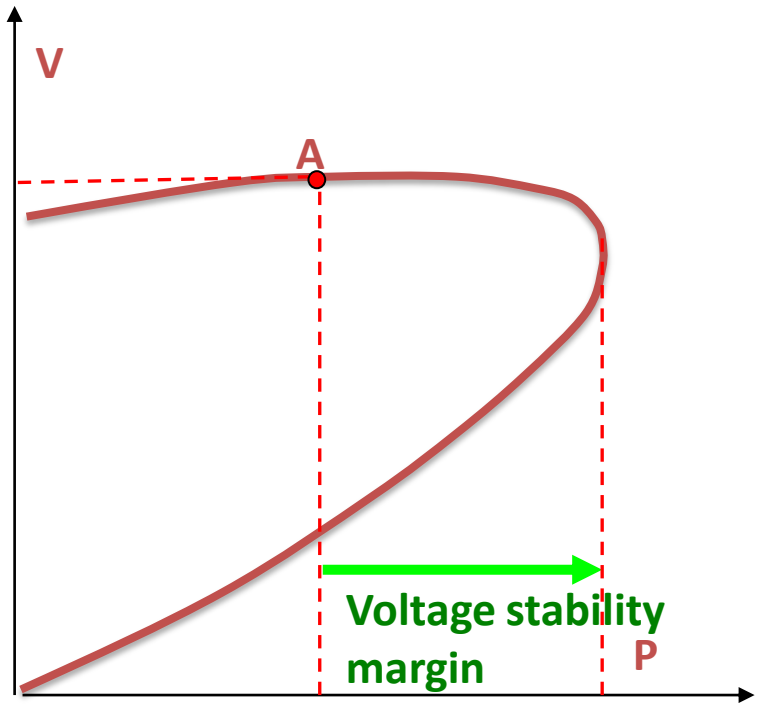


Rotor angle responses

Voltage Security

- Voltage Security of the power system involves checking to see if voltages around the transmission network stay within agreed limits for all credible N-1 and highly probable N-2 conditions and system is voltage stable (there is agreed margin to voltage collapse).

Voltage Level kV	Pre-Contingency Voltage	Post-Contingency Voltage
110	105-121kV	99-123kV
220	210-242kV	200-245kV
275	260-300kV	250-303kV
400	370-412kV	360-420kV



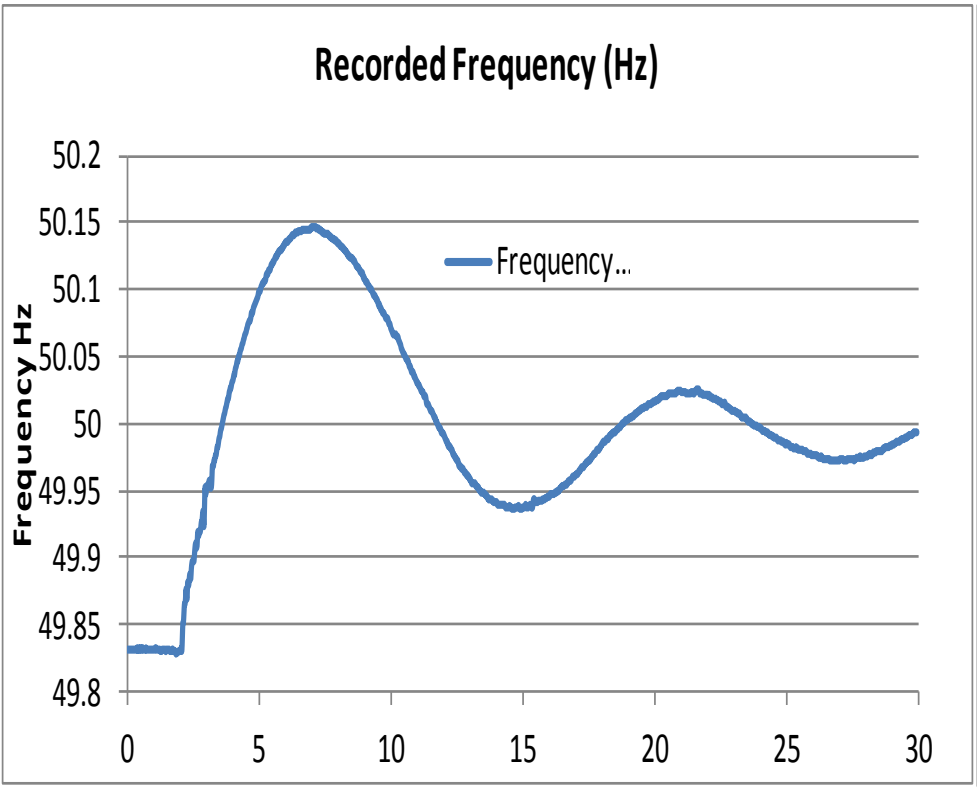
WSAT Results

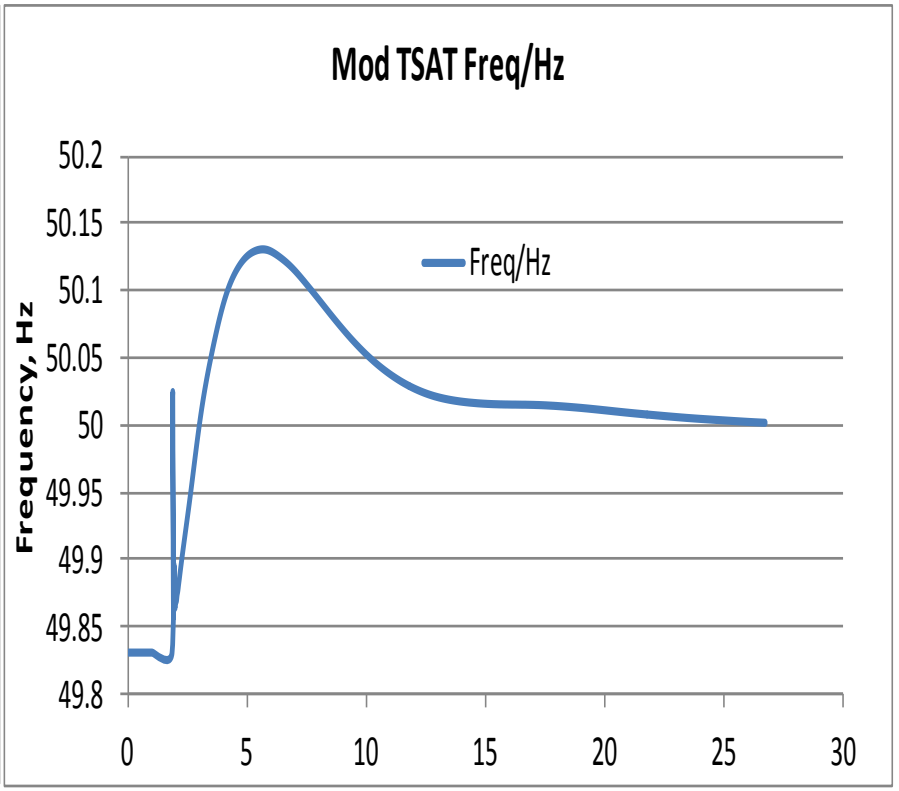
- With current levels of wind to date no wind-related issues with Transient and Voltage Stability were identified.
- If a problem is reported the Grid Controller will decide on an appropriate response based on a *Scenario – Consequence – Other Factors – Action* relationship.
- The action will be taken by a Control Room in which jurisdiction a problem is flagged
- WSAT as set at present is the last line of defence against Transient and Voltage instability. How the system is broadly operated is determined in offline studies
- Note: WSAT as set at present does not account for insufficient plant flexibility: specifically for active and reactive power ramping requirements.

Building Confidence in the WSAT Tool

- Off-line studies are performed at times of high wind events
- 42 High Wind events analysed in 2012
  - To date WSAT does not demonstrate any wind-related voltage or transient stability issues at current levels of wind, but frequency stability issues (high RoCoFs) have been identified
- Off-line WSAT studies have been used to estimate the minimum number of conventional generators on the EirGrid system
  - 98% of time 5 conventional units are sufficient to maintain the system operational security in terms of transient, voltage and frequency security
  - 50% of the time 4 conventional units are sufficient
  - Only 10% of the time 3 conventional units are sufficient
- New minimum all-island generation study is underway
- WSAT has been used for assessment of impacts of EWIC high- and low-frequency tests and demonstrated high accuracy of predicted system responses

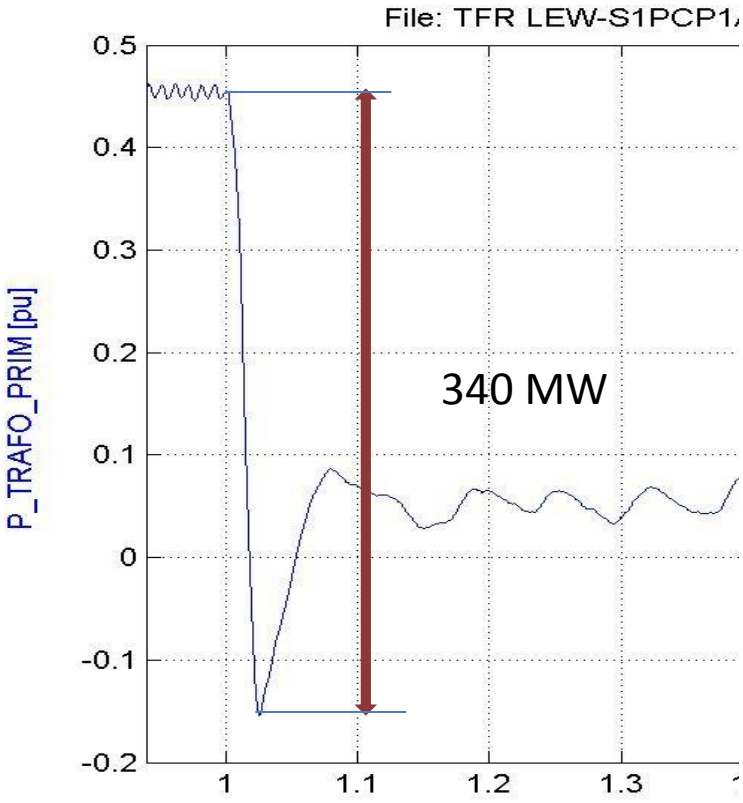
EWIC 255 MW Export trip on 22 August 2012: Frequency

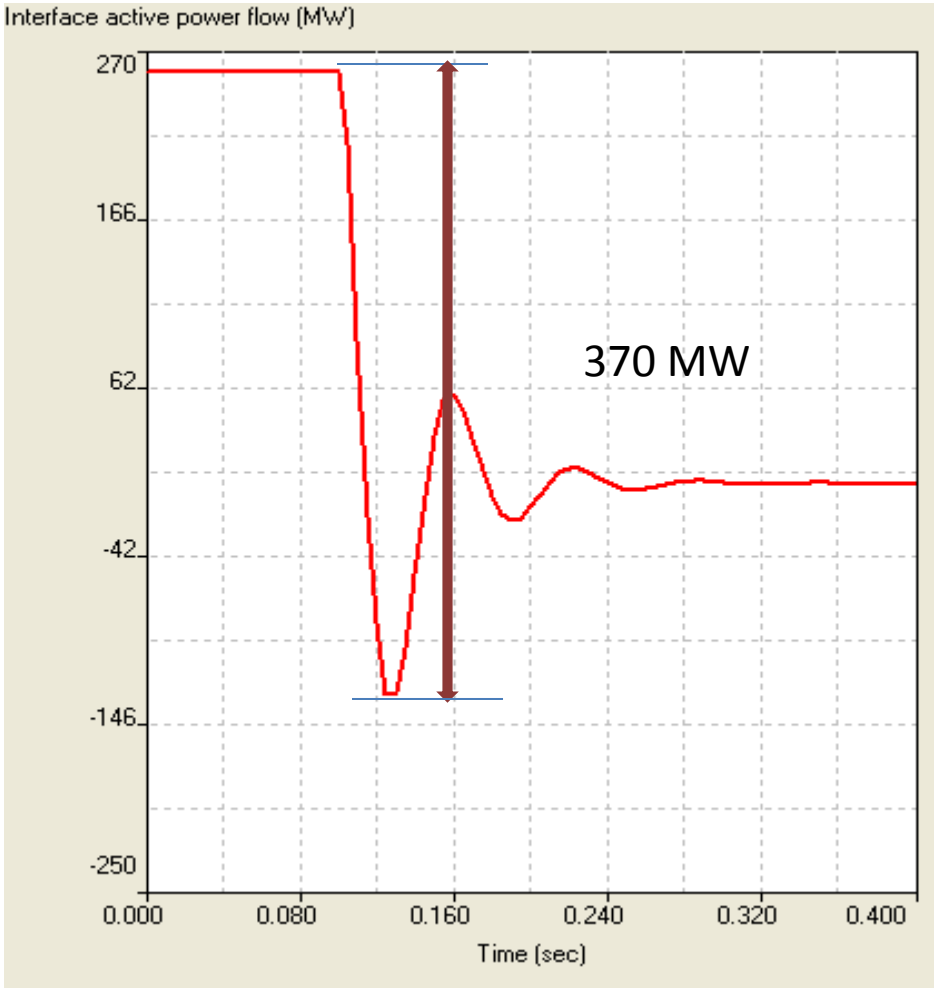




Frequency nadir difference 0.02 Hz

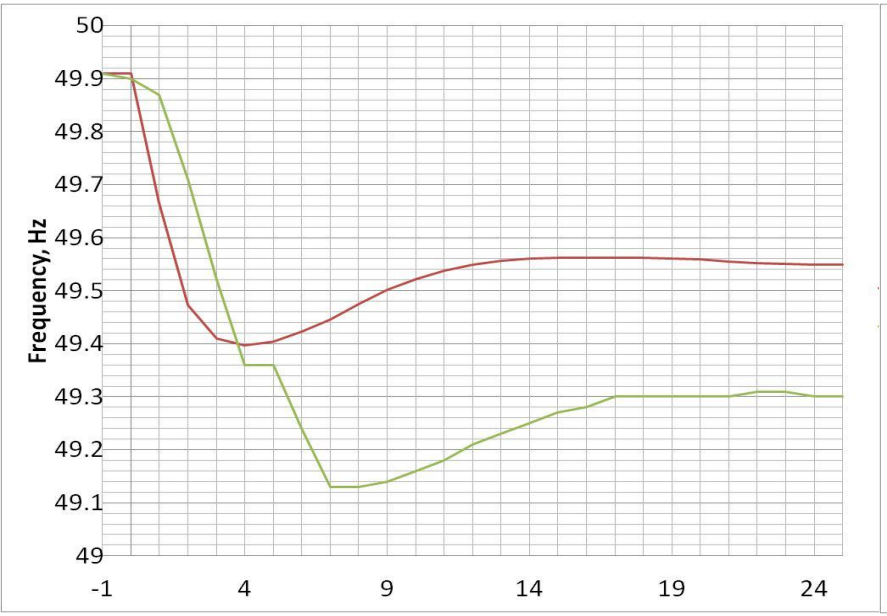
EWIC 255 MW Export trip on 22 August 2012: Power Reversal

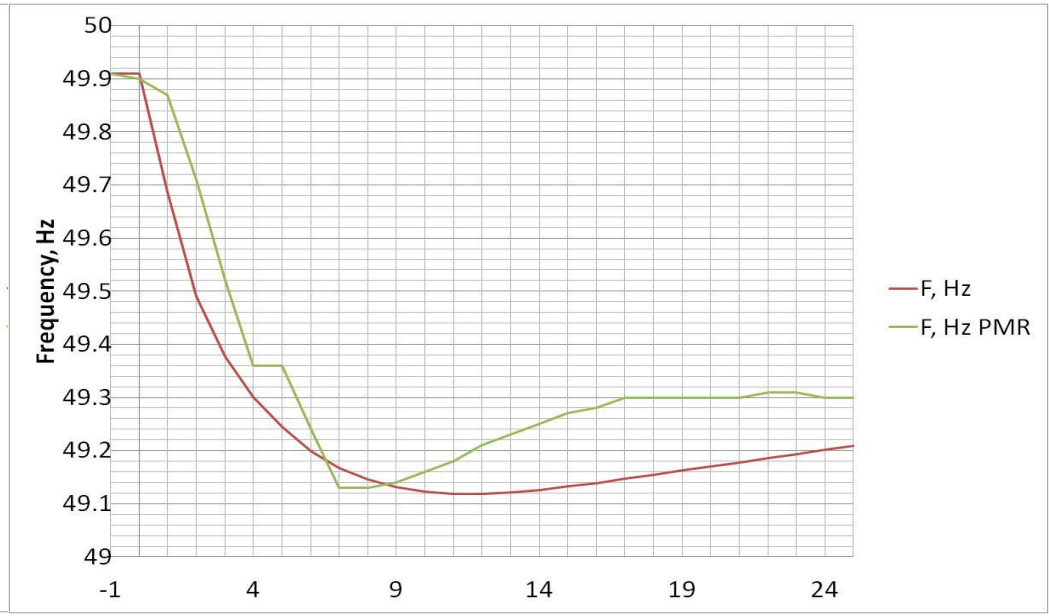




Next Steps

- On-going model Validation
- Improving Governor and Load models through comparison WSAT results with actual data and tuning these models



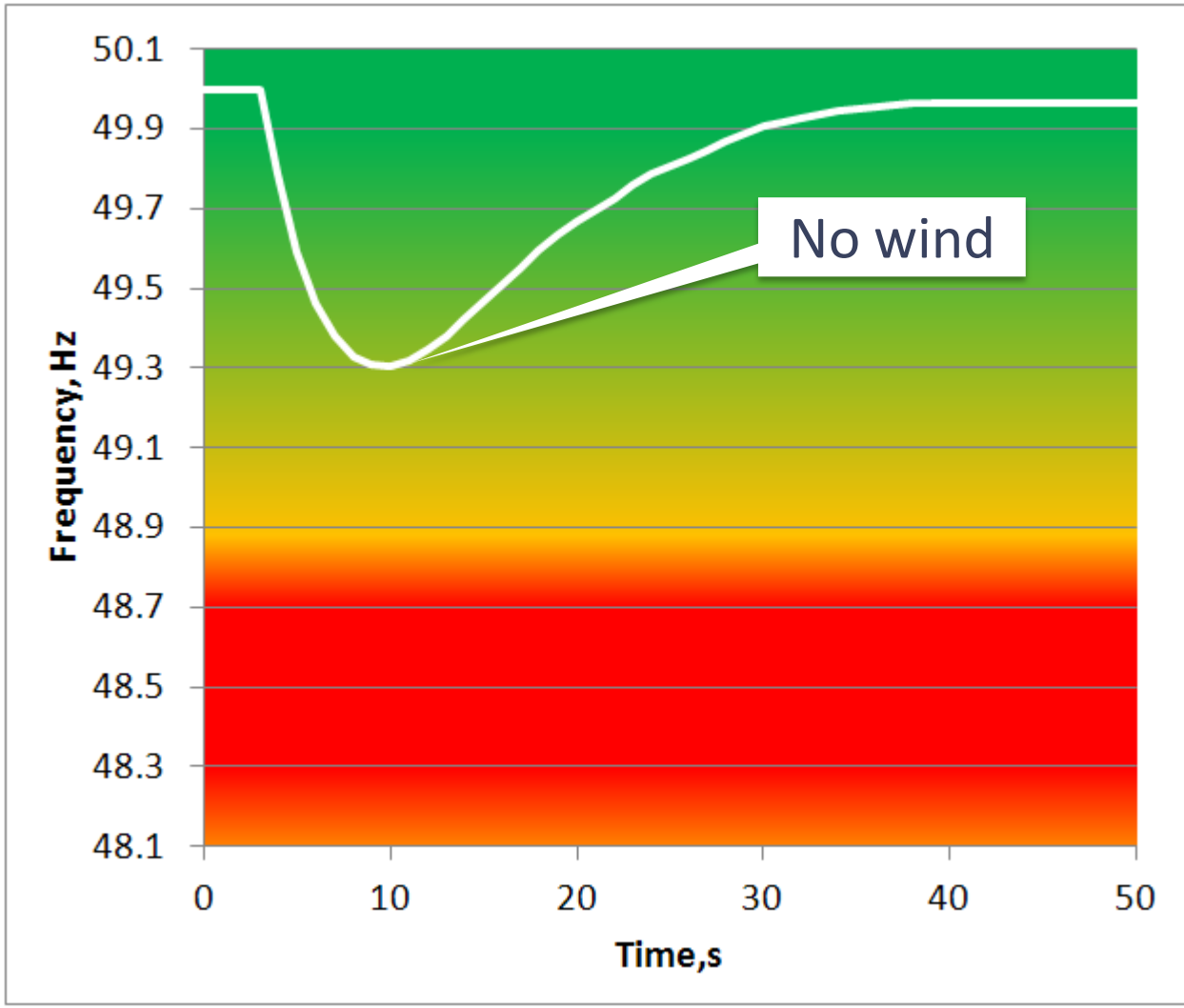


- This will allow to include **frequency security** criterion in WSAT

Frequency Stability

$$J\frac{d\omega_m}{dt} = T_m - T_e$$

$$E = \frac{1}{2}J\omega_{0m}^2$$



Ivan Dudurych. *Operational Security of Power Transmission System*

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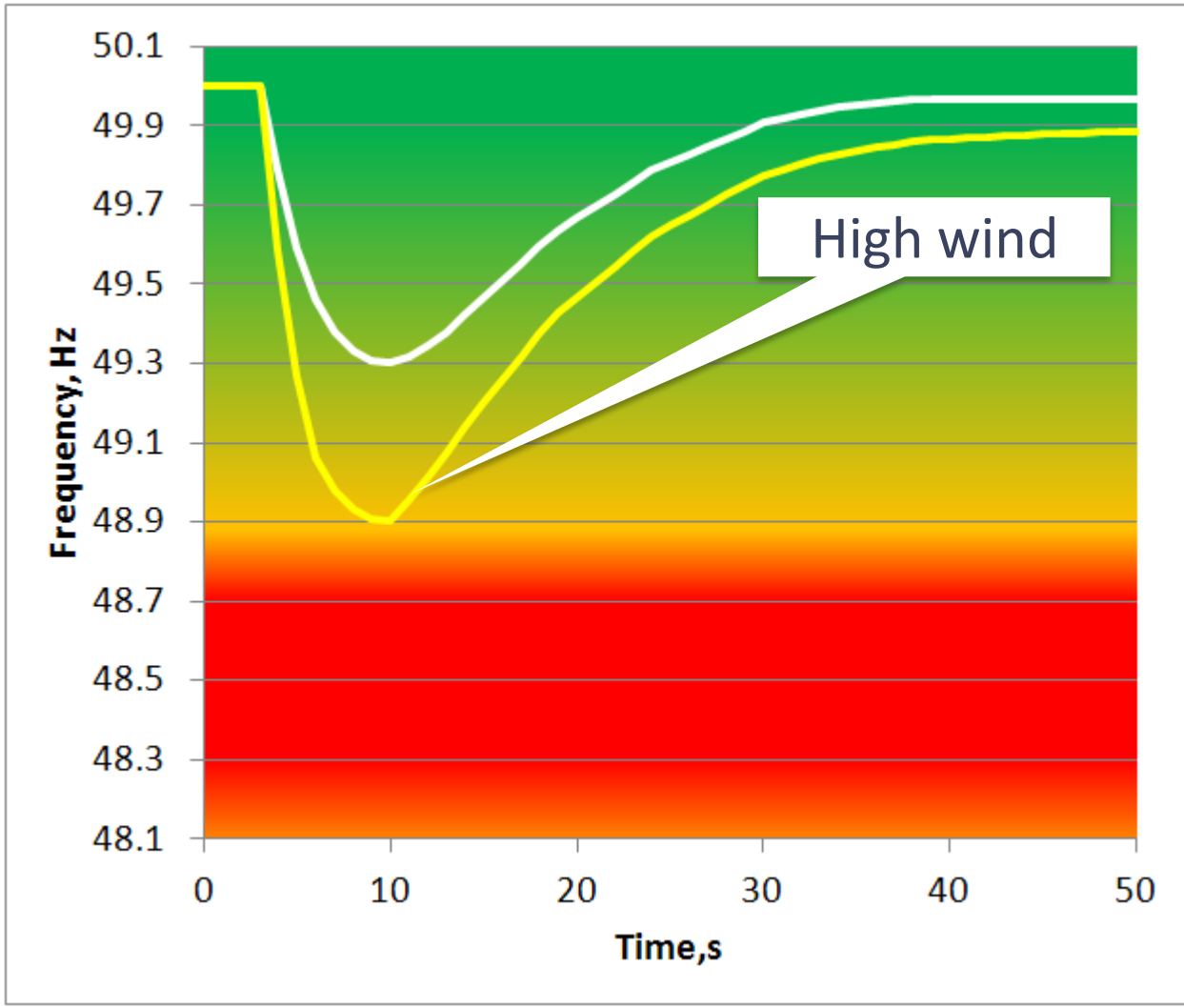

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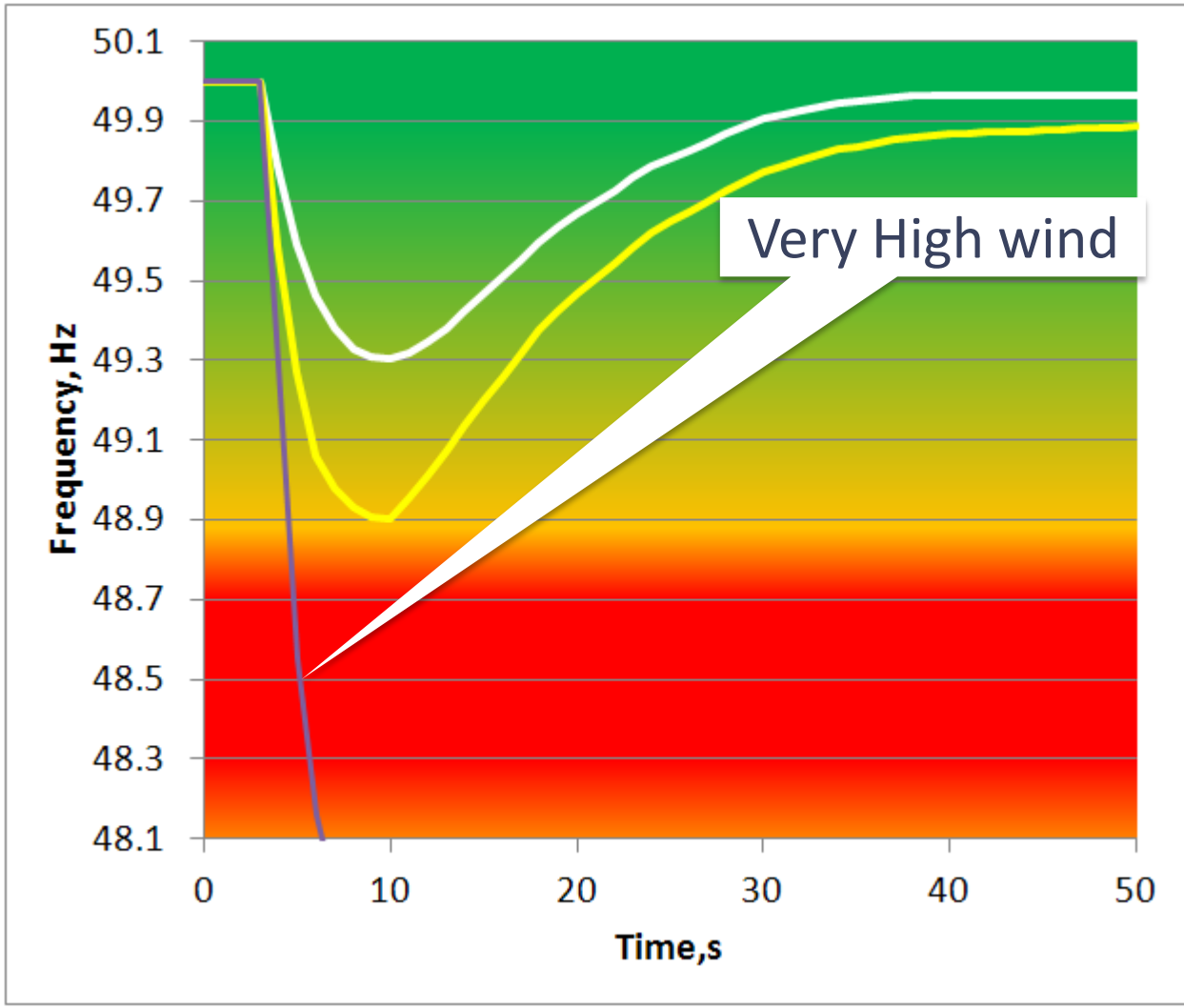

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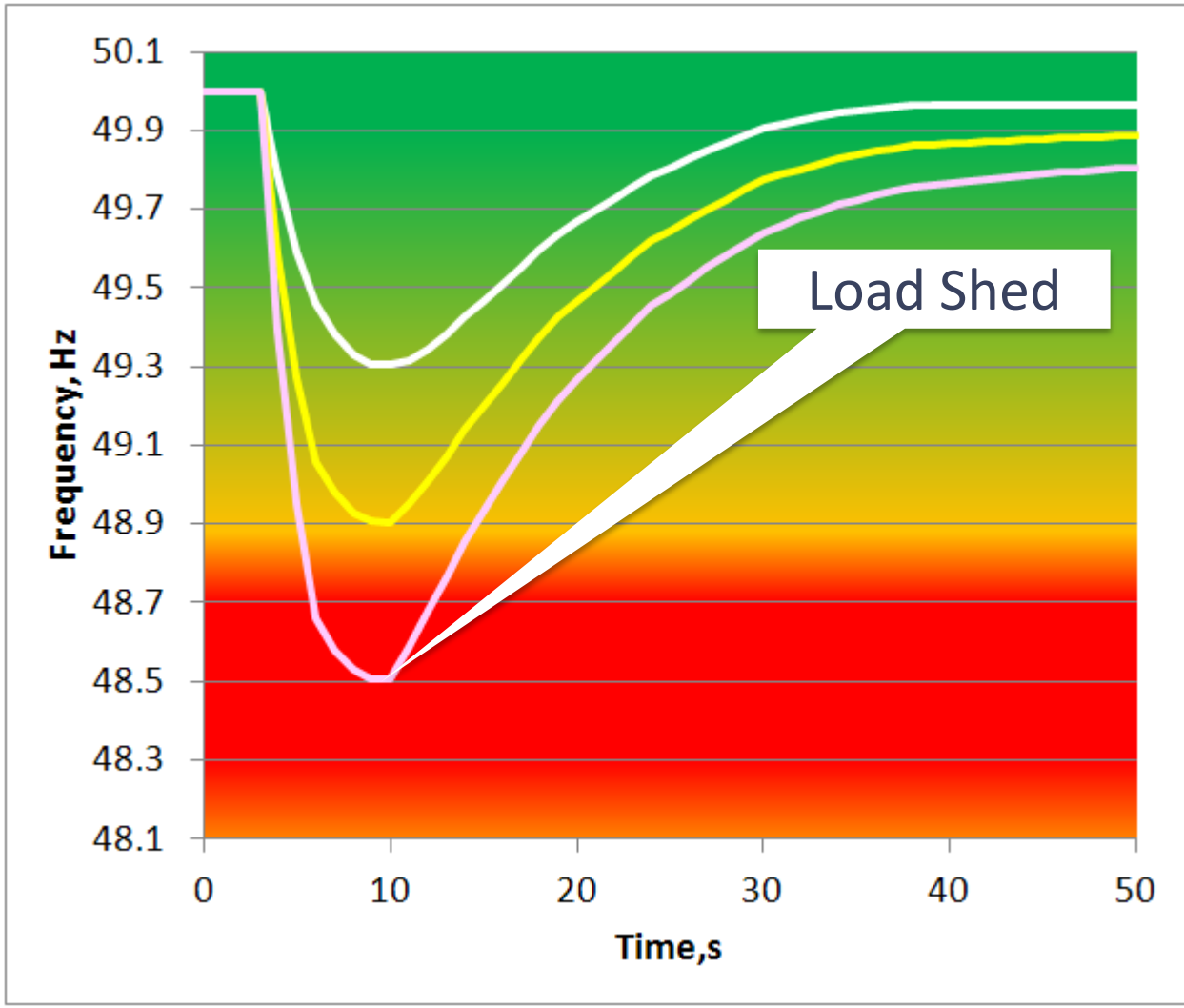
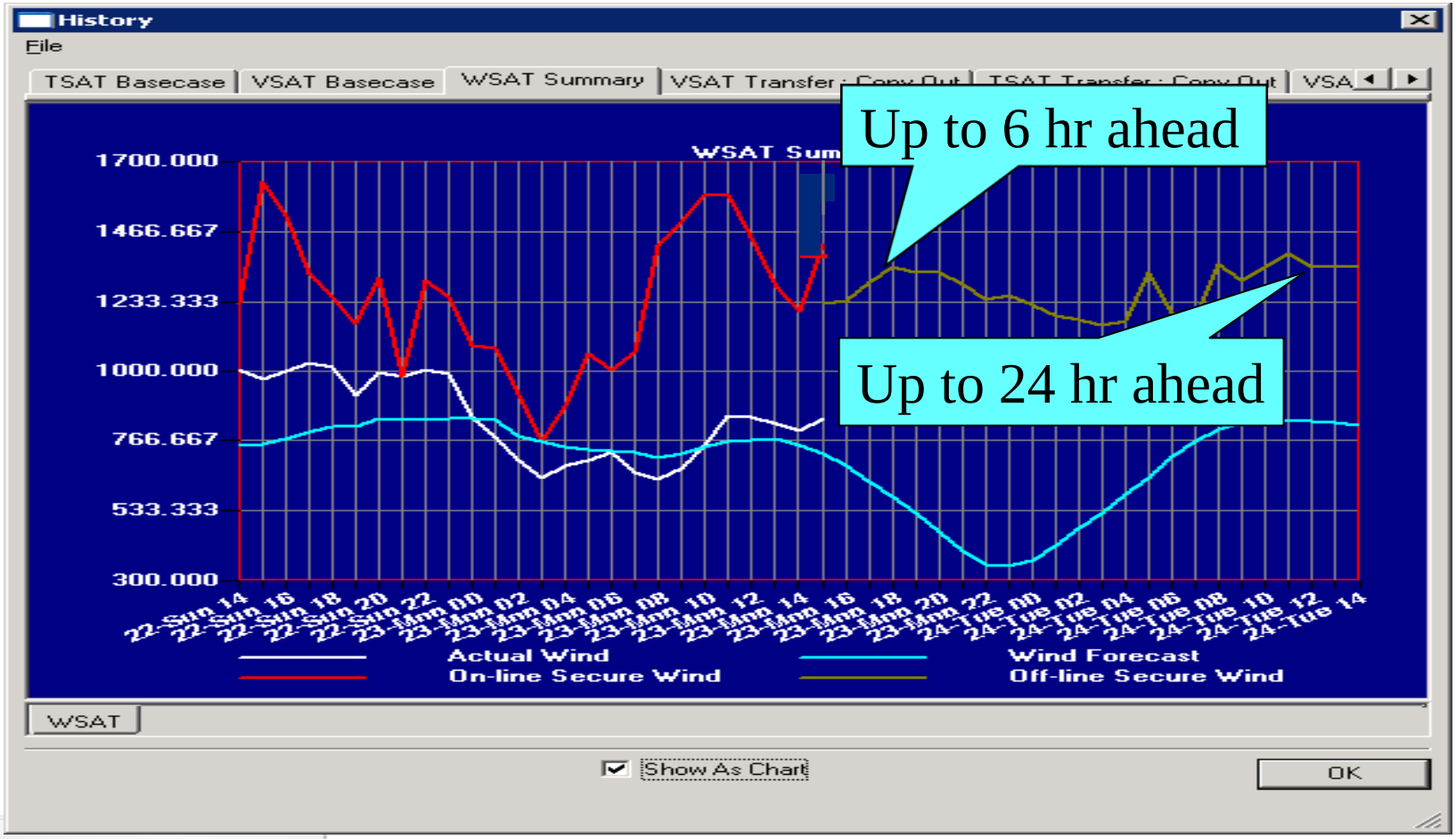


Ivan Dudurych. *Operational Security of Power Transmission System*

Next Steps: Forecast calculations



On-line WSAT Summary

WSAT provides a guidance how to operate a system with increasing wind generation by assessing the

Transient stability and

Voltage stability of the power system in ***Real case***

and by applying the stress tests on the system model in a form of ***Transfers*** for

- **Wind Increase** and/or
- **Load Increase**

to see at what levels of **wind** and/or **load** voltage security criteria are starting to become violated thus establishing

Secure levels of Wind and/or Load

Literature

- I. Dudurych , “On-line Assessment of Secure Level of Wind on the Irish Power System,” *Proceedings of IEEE PES Meeting*, July 25-29, Minneapolis, 2010.
- A. Rogers, J. O’Sullivan, I. Dudurych, “Operational Tools and Policies for Integrating Large Amounts of Variable Generation in Ireland and Northern Ireland,” *Proceedings of IEEE PES Meeting*, July 24-28, Detroit, 2011.
- I. Dudurych, A. Rogers, R. Aherne, L. Wang, F. Howell, X. Lin. “Safety in Numbers”, *IEEE Power & Energy Magazine*, March-April 2012, pp. 62-70.
- I. Dudurych, J. O’Sullivan, A. Rogers, D. Bell, S. Rourke, N. Kamaluddin “Tools for Handling High Amounts of Wind generation in National Control centre in Ireland,” *Proceedings of IEEE PES Meeting*, July 22-26, San Diego, 2012.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System Services

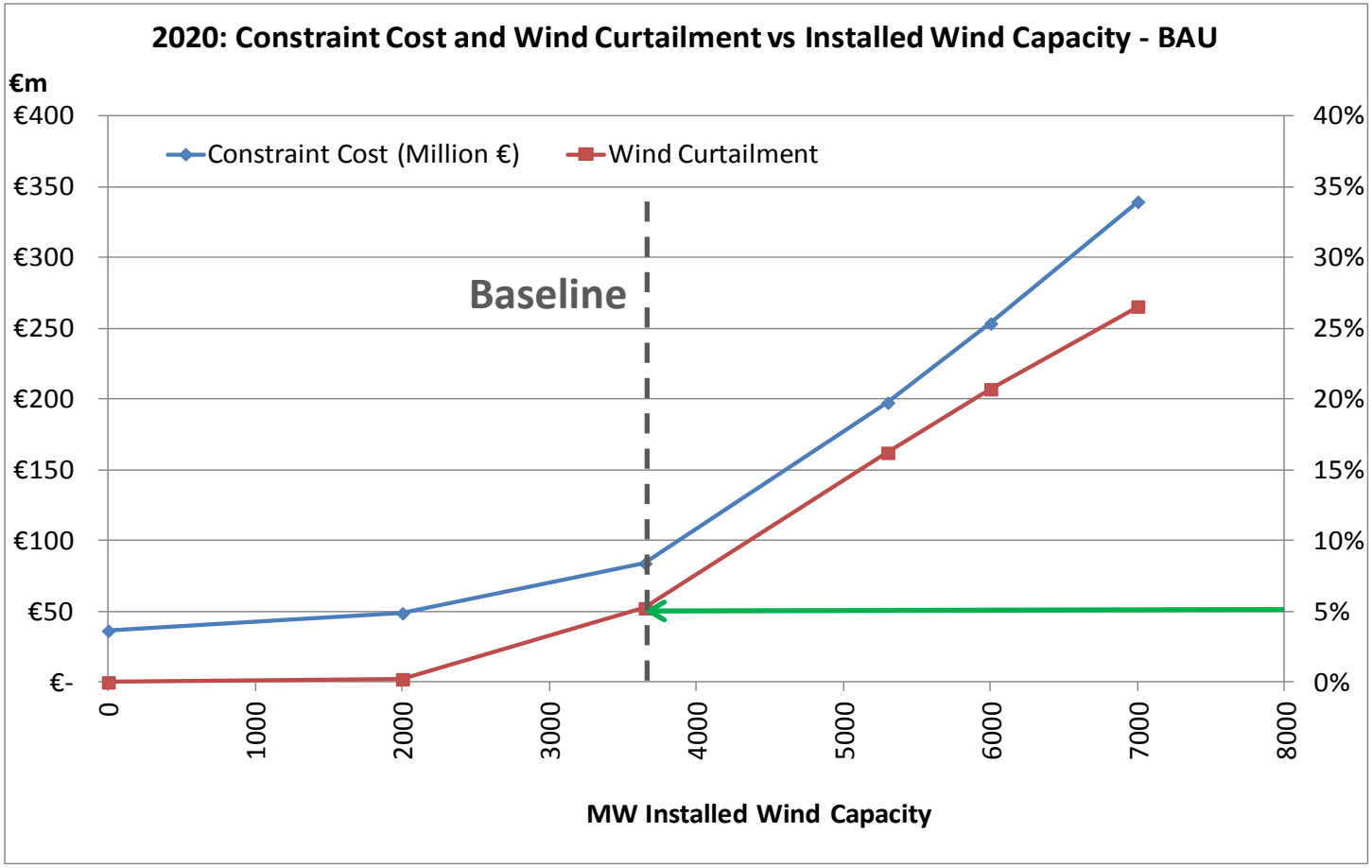
19 March 2013

Jon O'Sullivan

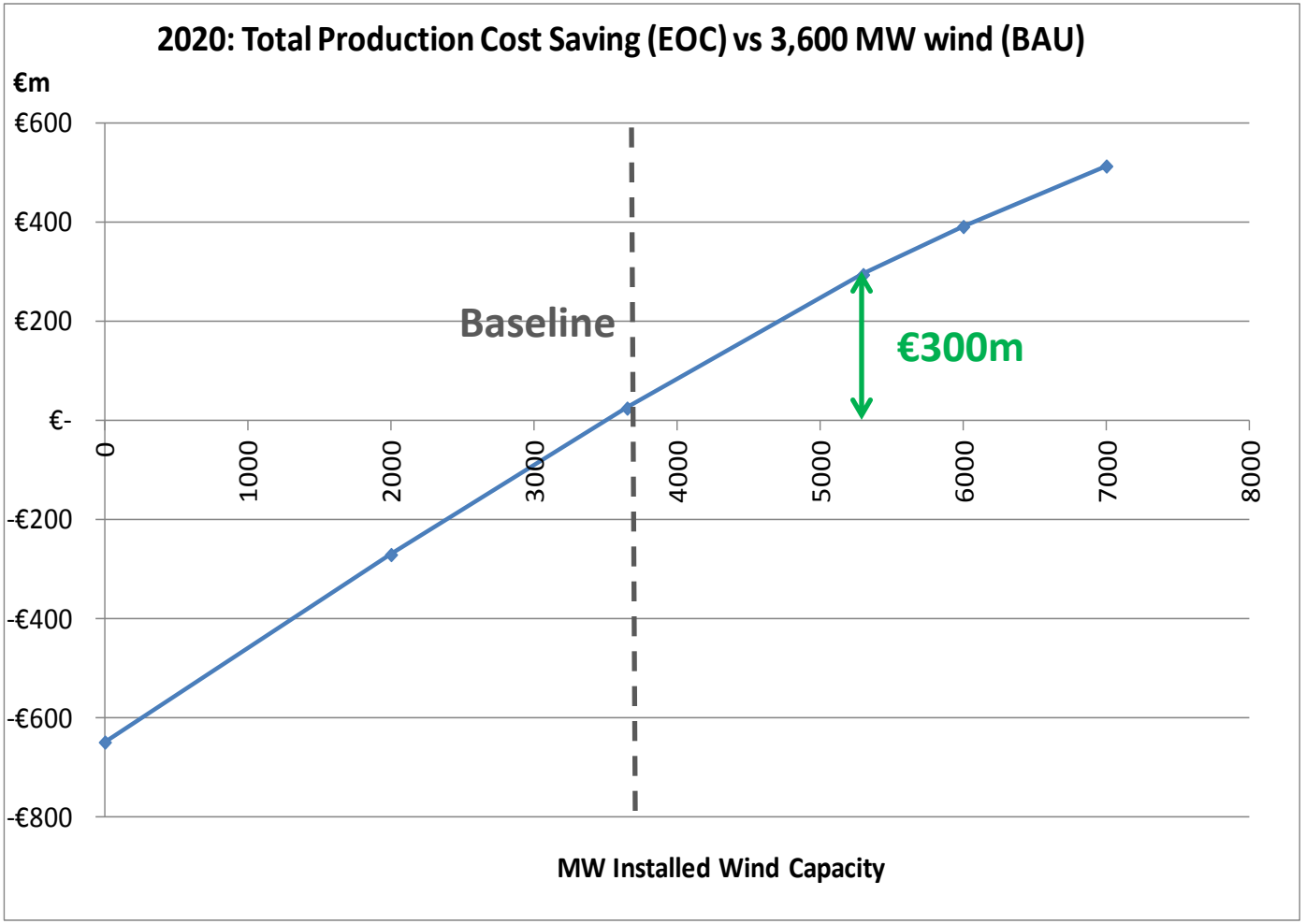
Third Consultation Paper: Finance

- Value-based approach
  - Valuation methodologies
  - Proposed valuation
- Allocation of money between consumers and products
- Remuneration Approach – dispatch-dependent
  - Illustration for typical generators
  - Impact on Capacity Mechanism
- Proposed contractual arrangements
- Link to Grid Code: modifications and compliance
- Final Product Designs
  - Including worked example

Valuation from production costs studies



Valuation from production costs studies



Allocation of SS funds

- Benefit allocation between consumers and providers
  - SEMC decision
- Allocation between products
  - Four methods considered: pro rata → optimisation
- Propose that allocation mechanism fixed to provide degree of certainty
  - Long-term (8-12 years)

Next Steps

- 31st Mar - TSO Recommendations including response to consultation and detailed modelling results to the RAs
- June - SEMC proposed decision
- Sep - SEMC High level decision

Phase 2 Begins:

- Contract design
- System Build
- Performance monitoring
- Rate determination
- Operational Date 1st Oct 2015

Significant Response

- 20 bilateral meetings held
- 26 responses received
- Broad consensus from respondents
  - Valuation approach
  - Allocation method

- Significant concerns
  - Revenue sufficiency
  - Impact on Capacity Payments
  - Length of Contract
  - Dispatch vs. Capability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Ds3 Advisory Council
RoCoF Work stream

19th March 2013

Tom McCartan

Proposed RoCoF Modifications

All Island RoCoF Modification

- RoCoF Standard of 1 Hz/s measured over 500 ms.

Northern Ireland RoCoF Modification

- Initial requirement of 2Hz/s was requested.
- Considering concerns of generators and awaiting further studies a requirement of 1Hz/s has been proposed.

Grid code modifications in Ireland and N Ireland submitted to NIAUR and CER for approval on 21st December 2012.

Progress to date

Industry Interactions

- Significant discussions as part of the Joint Grid Code working group.
- Joint Grid Code Working Group paper developed - position of all parties.

TSOs

- Have developed and published a TSOs' Opinion paper.
- Grid code modifications proposed to the Regulatory authorities.
- DNV Kema report commissioned on impact of RoCoF on conventional generators.

DSOs

- Both DSOs have undertaken separate studies to assess the impact of increased RoCoF standards, the full findings have not been shared with the TSOs.

Regulatory Authorities

- Conventional generators have been asked to give an indication of the cost associated with the impact assessments they believe are required on their plant and equipment in order to meet the RoCoF requirements.
- Decision required on the TSO RoCoF Grid code modifications.

RoCoF Timeline

Q2 2013?	Decision on RoCoF Modifications by Regulatory Authorities.
2013?	Decision on conventional Generators' OEM studies.
2013/2014?	DSOs' implementation plan
2013?	Conventional generators either start OEM studies or seek derogations (dependent on regulatory decision).
2014?	Testing and analysis of RoCoF capability.

Outstanding issues

Same issues as those from 6 months ago:

Date for finalisation of DSO reports.

- Will require further discussions with the TSOs.

Regulatory input on the cost recovery for generators.

Regulatory decision required on Grid Code proposals.

TSOs cannot move from present 50% SNSP level until resolution of the outstanding RoCoF issues.


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Performance Monitoring
&
Testing

Michael Preston

System Services
Performance Monitoring
Grid Code
Demand Side Management

Frequency Control
Voltage Control
Renewable data
System inertia

Models Development
Control Centre Tools
AI Wind Security Assessment Tool

Monitoring - why changes ?

- The TSOs in both jurisdictions have always monitored the performance of the plant they dispatch

- The basis of secure and economic system operation relies on the expected plant performance to match actual performance

- The changing plant portfolio requires a greater degree of plant performance from conventional plant and introduces a large element of non synchronous generation (greater uncertainty)

Current Monitoring Process

- Ad hoc approach – as and when required
- Manual observation of plant
- Limited systematic monitoring e.g.
  - Generator loading / de loading automatically recorded and analysed for GPI purposes
  - Post event reserve analysis

Enhanced Monitoring Process

- Standardise and harmonise the performance monitoring and testing processes
- Systematic approach to monitoring
- Transparent for generators

DS3

1. Increase certainty of how system is performing

2. Use information to improve modelling => greater certainty

3. Facilitate incentivisation of products by measuring performance to ensure the portfolio performance is delivered

Enhanced Performance Monitoring

- Proposed High Level Requirements developed by TSOs in Q4 2012
- This is an all-island harmonised approach to enhance the performance monitoring process for both TSOs and generating units
- Expands and improves process developed to date
- Enhanced Performance Monitoring will also be utilised to monitor new System Service products

Enhanced Performance Monitoring

DATA

- Phased roll-out of high speed recording at all sites
- Required to analyse performance for products delivered in zero to fifteen second timeframe
- Data will be shared with customers

Enhanced Performance Monitoring

- **Fast Frequency Response**
  2 seconds of the start of the event and is sustained for at least 15 seconds

- **Fast Post-fault Active Power Recovery**
  Fast Post-fault Active Power Recovery is provided where a generator recovers its active power to at least 90% of its pre-fault value within 250 ms of the voltage recovering to at least 85% of its pre-fault value

- **Dynamic Reactive Power capability**
  The reactive response of the generators shall be proportionate to the magnitude of the Voltage dip. Reactive Power response shall be supplied with a Rise Time no greater than 70ms, a Percentage Overshoot of no greater than 20%, and a Settling Time no greater than 500ms.

Enhanced Performance Monitoring

ANALYSIS CARRIED OUT BY MONITORING SYSTEM

- Will look at all Grid Code and contractual requirements (including new System Services)
- Active Power Performance (from syncing to de-syncing)
- Availability Performance (is unit declaring per capability curves, windfarm signal quality, etc)
- Reactive Power Performance (is unit following dispatched value, etc)
- Frequency response

Enhanced Performance Monitoring

REPORTING

- Web based Graphical User Interface
- Generators can download data and reports
- Removes need for emails
- Events and data as close to real-time as allowable

Next Steps

- Internal approval of high level enhanced PM requirements
- Updated plan based on detailed project planning phase at end Q1 2013
- Industry presentation on enhanced PM requirements and feedback from industry on these during Q2 2013;
- Procurement and development of IT system required to carry out enhanced performance monitoring
- TSOs will seek invitations from interested conventional, wind, interconnectors and DSU/AGU to be involved in testing new system
- Industry updates on progress

Testing & Commissioning

– Four all-Island workshops held with Industry

– Recommendations published on websites

– TSOs currently developing implementation plan for delivering recommendations

Testing Philosophy

- Testing will be either by physical demonstration or model verification through compliance monitoring

- Grid Code compliance will be assessed :
  - at application stage
  - commissioning of the unit
  - via performance monitoring

- Models need to be updated to reflect the unit performance

- All tests will be carried out at a wind farm level.

Fault Ride Through & Dynamic Reactive Power Capability

- No physical testing planned
- Any turbine Type Tests carried out should be submitted to the TSOs
- Requirement for dynamic models at time of application,
  - Studies carried out to verify Grid Code compliance
- Compliance monitoring will be carried out through ongoing performance monitoring
- Models will need to be updated if required (and re-submitted) post commissioning
- Enhanced performance monitoring systems will monitor compliance against the Grid Code requirements utilising high speed data

Reactive Power & Frequency Response

- Static Reactive Power tested by demonstration
- Frequency Response will be tested via a frequency injection signal
- Test Procedures will be developed


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SO Interconnector Countertrading

19th March 2013

Conor Kavanagh

SO Interconnector Countertrading Overview

- Purpose
- Current Activity
- Project on enhancing SO capability


Glasgow
±250 MW
(medium term restriction)
Moyle Interconnector
Belfast
Woodland
East West Interconnector
Dublin
Irish Sea
Holyhead
Liverpool
Deeside
±250 MW up to start of March 2013 outage
±500 MW from ~ May 2013

Current Arrangements

- Interconnector users buy capacity and bid energy into SEM.
- Market schedules on interconnectors predominantly full/high import (GB→NI, GB→IE).
- Oversupply of generation on the island during periods of low demand.
- SEM-11-062 decision sets the hierarchy which requires SO Interconnector Countertrading after gate closure prior to re-dispatch of priority dispatch generation.
- SO Interconnector Countertrading
  - Contractual Arrangements in place with National Grid
  - Reciprocal services between the System Operators
  - Daily exchange pricing information; Manual processing requests; ex-post data to SEM/BETTA; Transparent data access

SO to SO Services

Cross Border Balancing

- System Security
- Priority Dispatch
- Maintain Interconnector Capacity

- 200 MW on each IC
- Regulated Price Floor

Emergency Assistance

- System Security – capacity shortfall or system security risk

Emergency Instruction

- NGET to EirGrid to ↓ power flow during system emergency

Static Frequency Response

- Low Frequency & High Frequency triggered power transfer change

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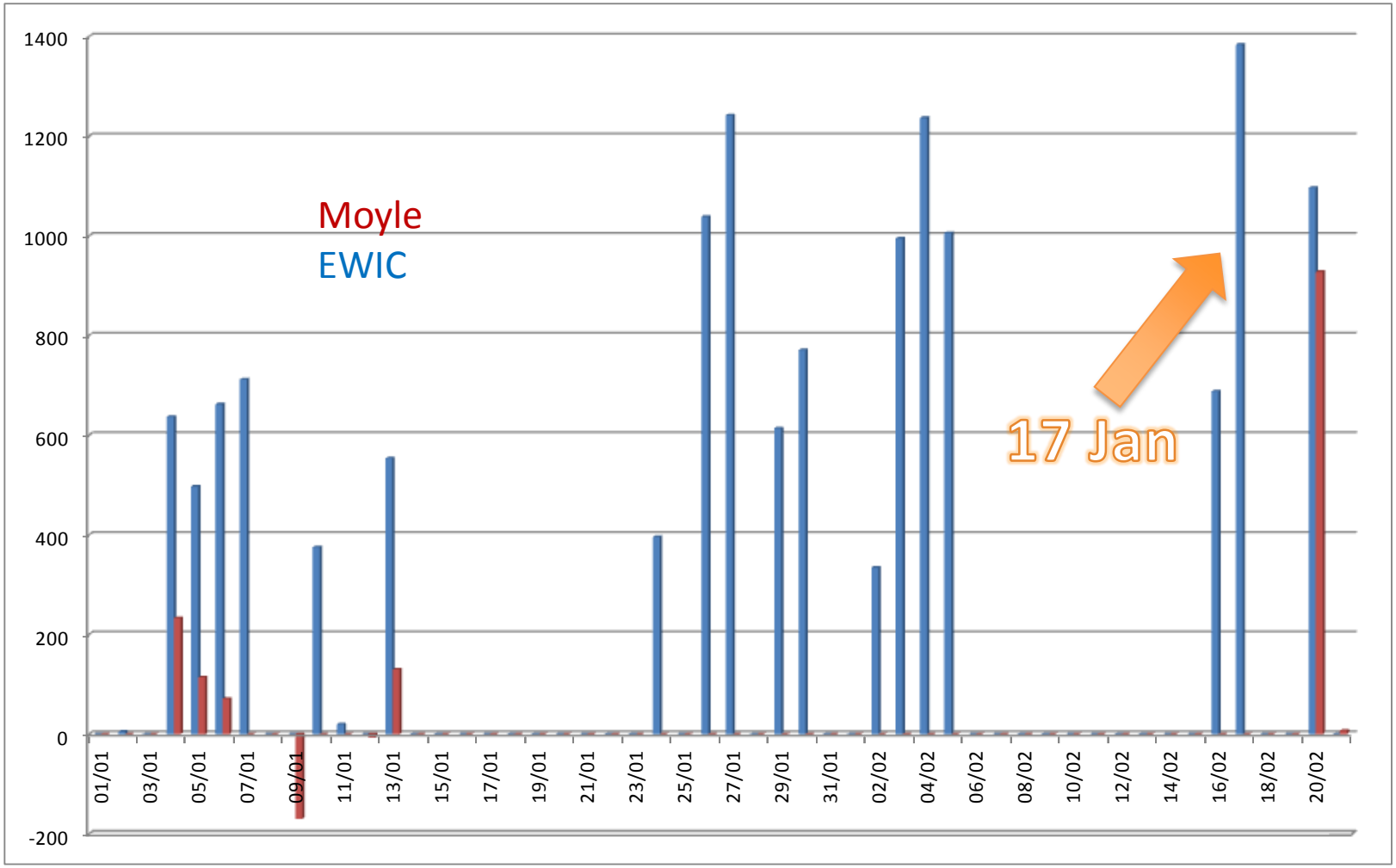
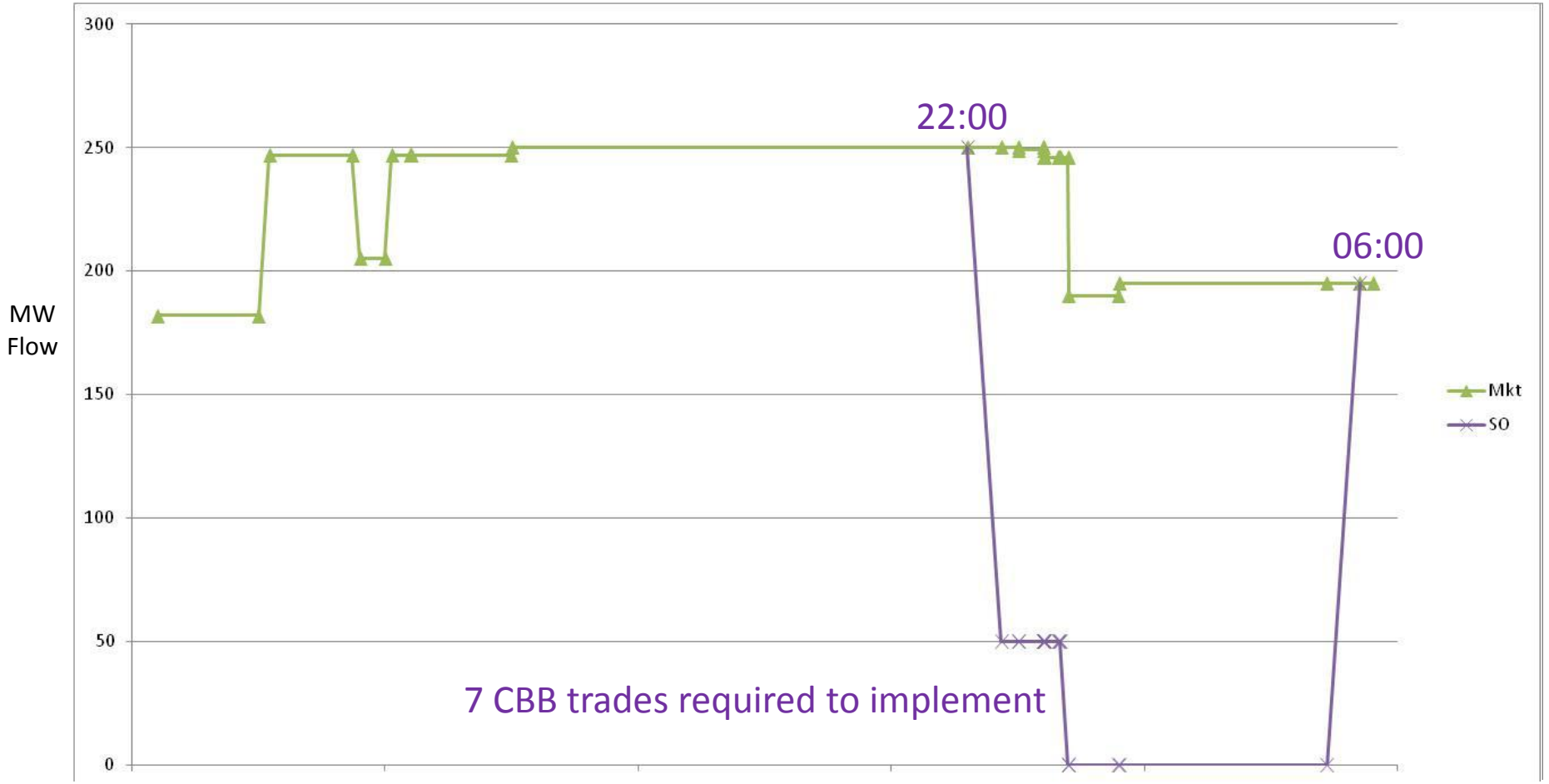
Usage of SO-SO services in 2013



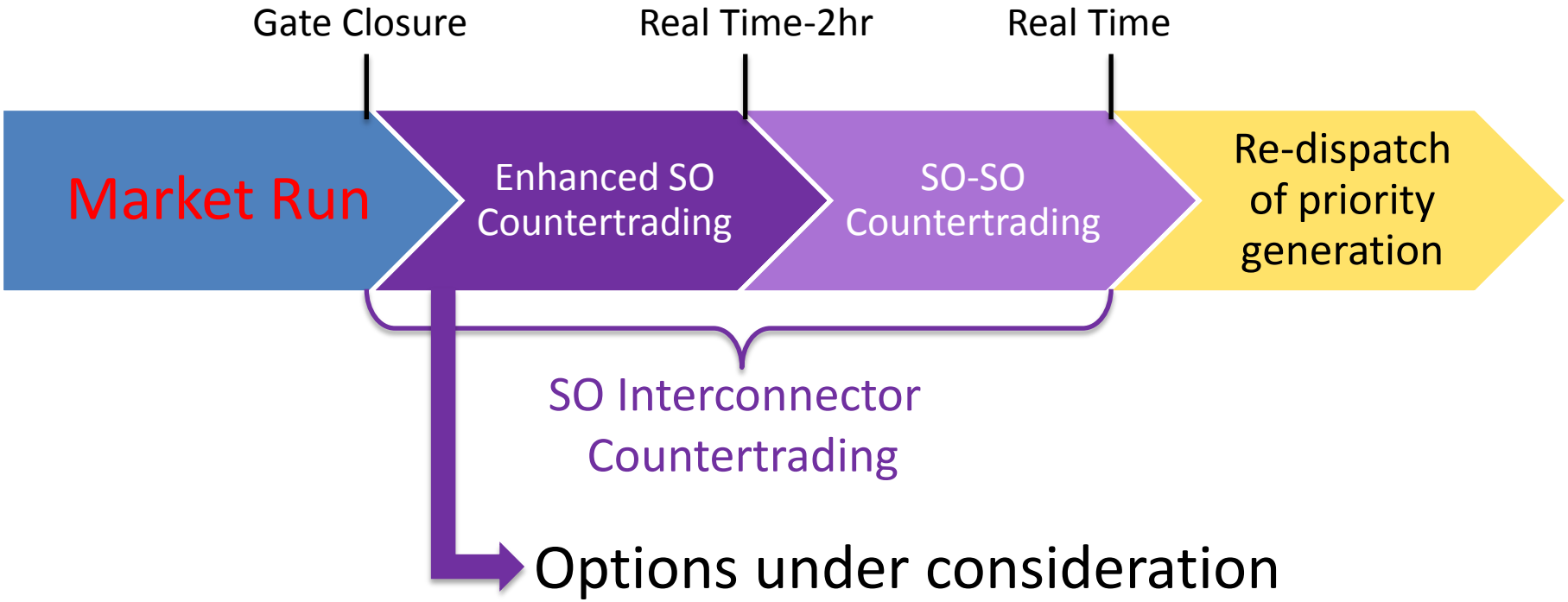
Source: SEM

EWIC schedule for TD 17th February



Project on enhancing SO Capability

Key objective: Further alleviate curtailment of priority dispatch generation in the short-term.



Options under consideration

1. SO Countertrading via a UK Power Exchange
2. Procure a third party service
3. Interconnector Trade exchange

Project Updates

- January: Note on options

  http://www.eirgrid.com/media/TheOperationoftheEastWestInterconnector.pdf
- March: Updates
  - National Grid arrangements
  - Additional information on public data on services

  http://www.eirgrid.com/media/InformationNoteOnSOInterconnectorCountertrading.pdf
- *April: Update on option(s) being pursued*
- *Project Progress is option(s) dependent*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DS3 Advisory Council Review

19th March 2013

All

DS3 Programme Outlook

- Project will evolve over the coming months
  - Enhanced role for the RAs
  - Progress for certain workstreams is dependent on output of DSOs work
  - Progress is dependent on decisions on System Services, RoCoF etc.
  - Move toward implementation of change in operational policies

- What is the best way to progress over the next phase?
  - Role of Advisory Council
  - Interaction between stakeholders