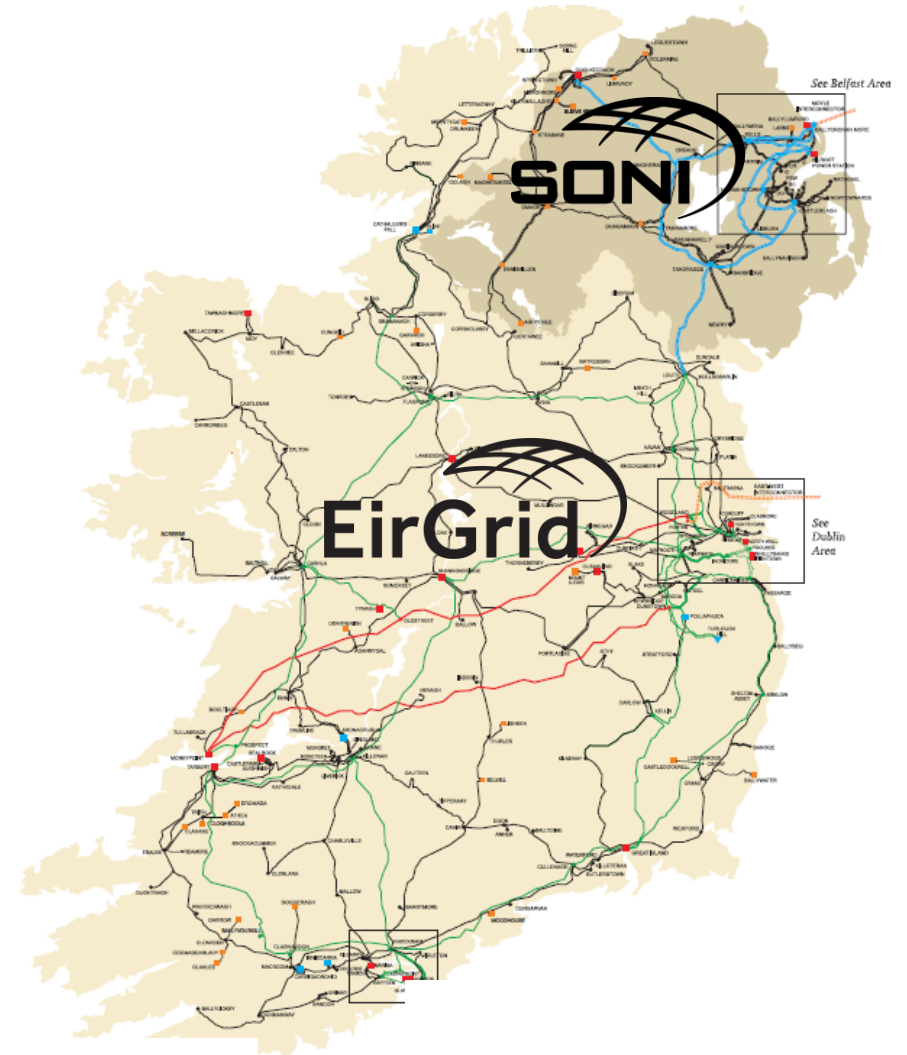
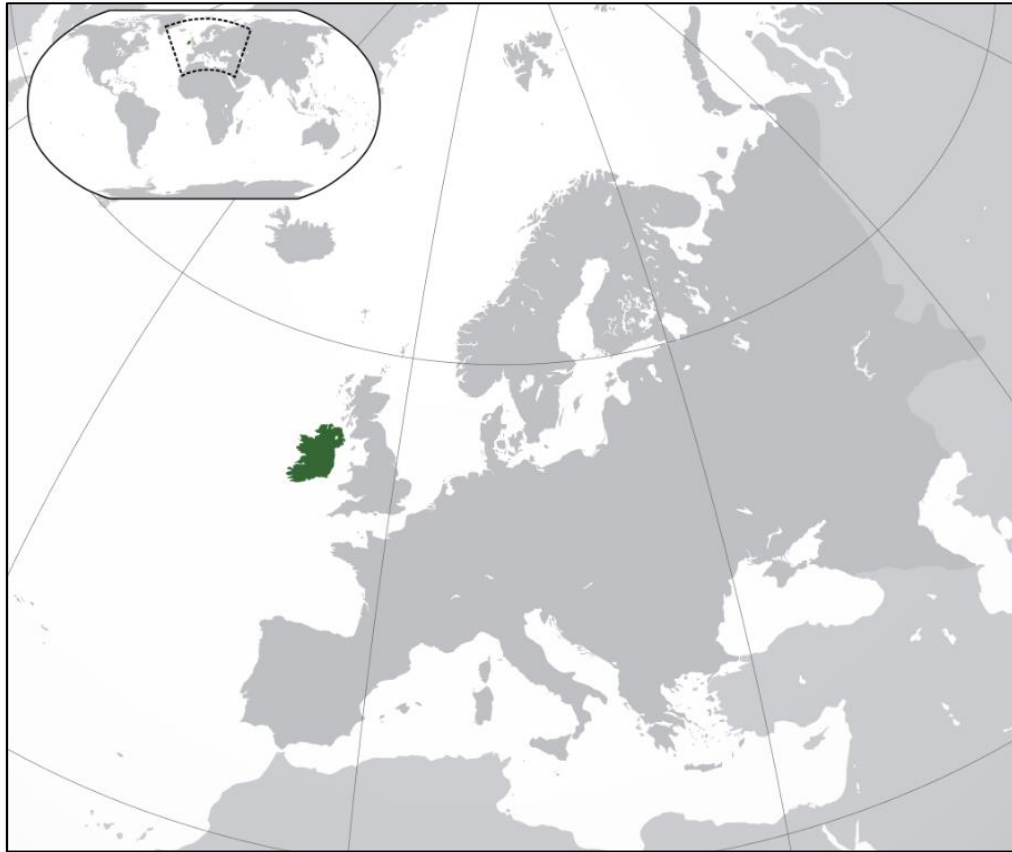


Look Ahead Security Assessments: Operations radar to navigate high IBR waters in the journey to Net Zero

Marta Val Escudero, EirGrid
ESIG Webinar, 25/07/2023

Background to the Ireland & Northern Ireland Power System

The TSOs of Ireland and Northern Ireland



Background: All-Island Power System Overview

System

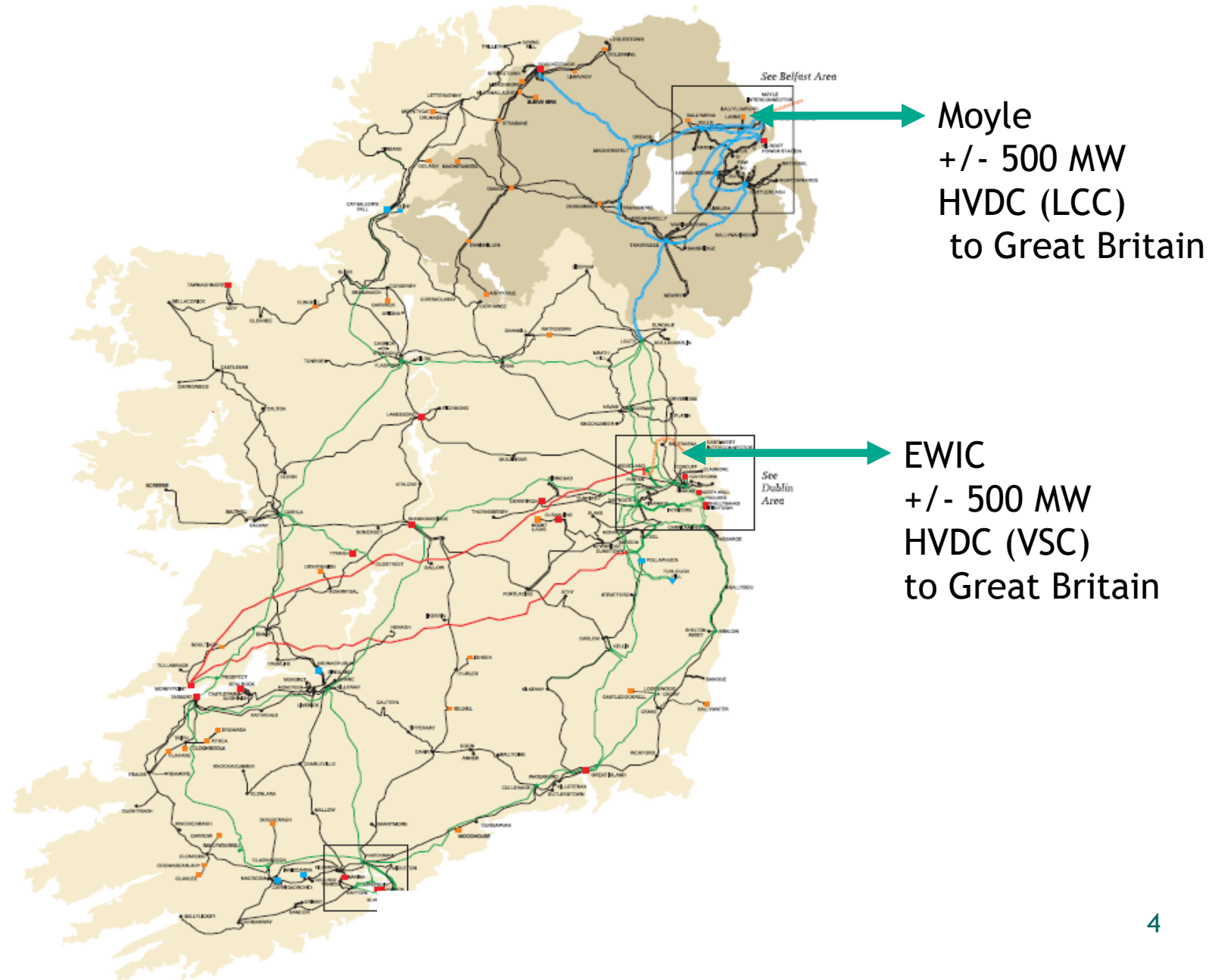
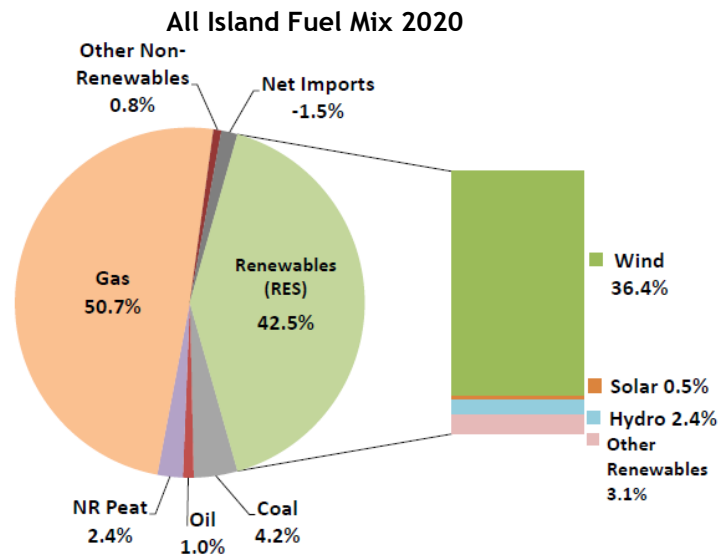
- Transmission: 110/220/275/400kV
- Single Synchronous Area & Market
- Two Jurisdictions / TSOs
- Jurisdictional Transmission Control
- All-Island Scheduling and Dispatch

Demand

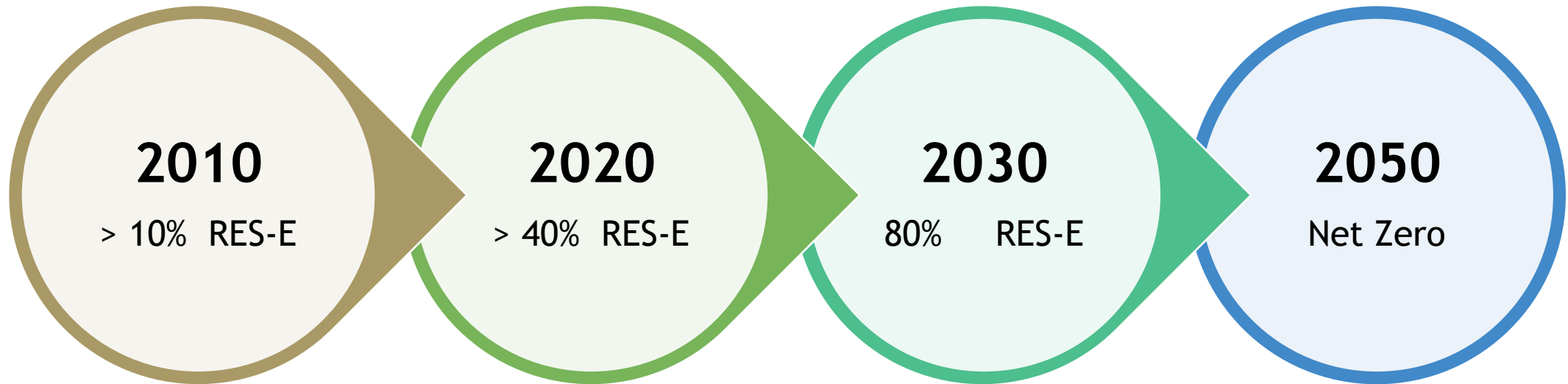
- Peak Demand: 7.0 GW
- Valley Demand: <2.5 GW

Generation

- Installed Wind: 5.9 GW
- Peak Wind: 4.6 GW (Feb 2022)



RENEWABLES REVOLUTION

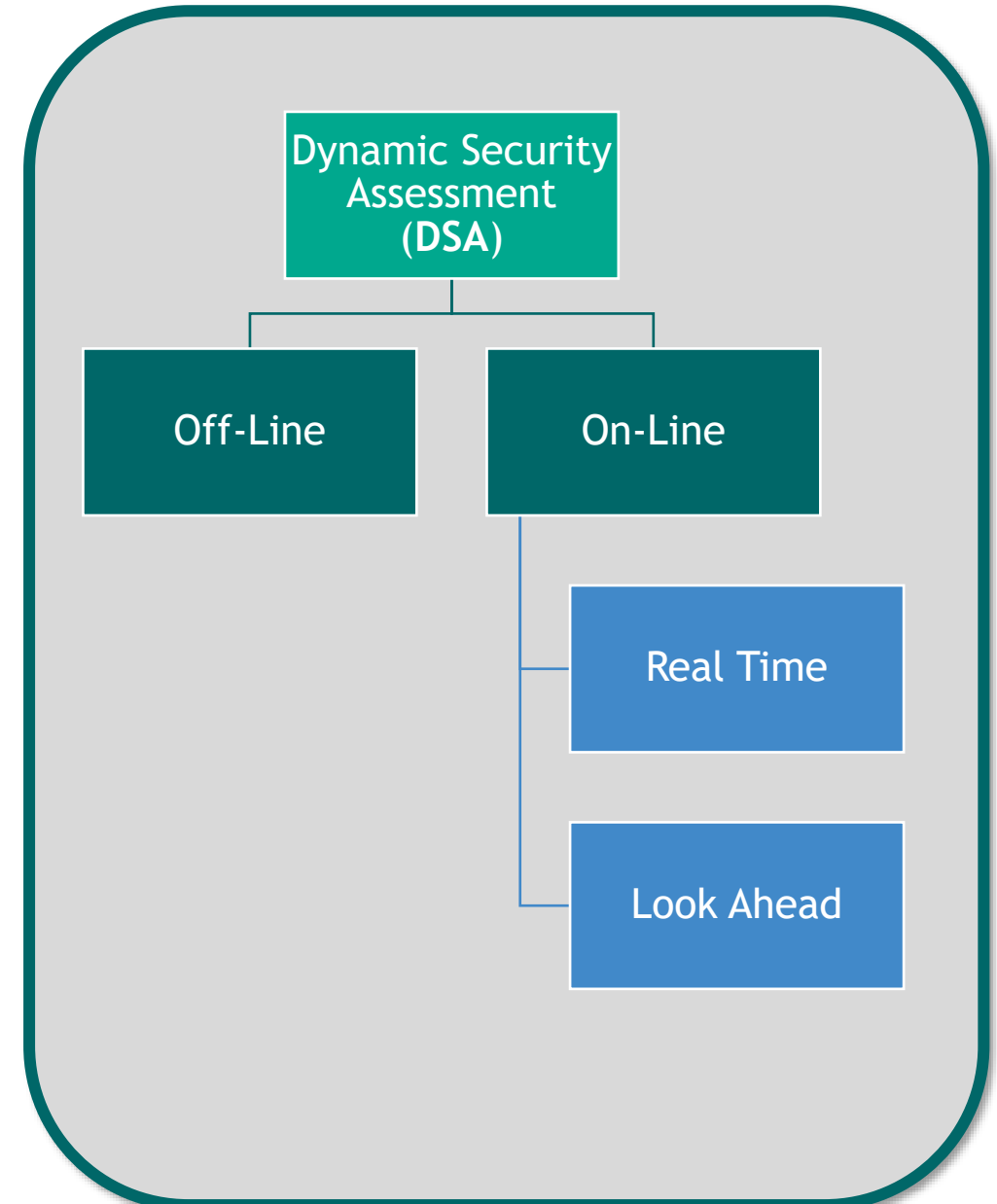
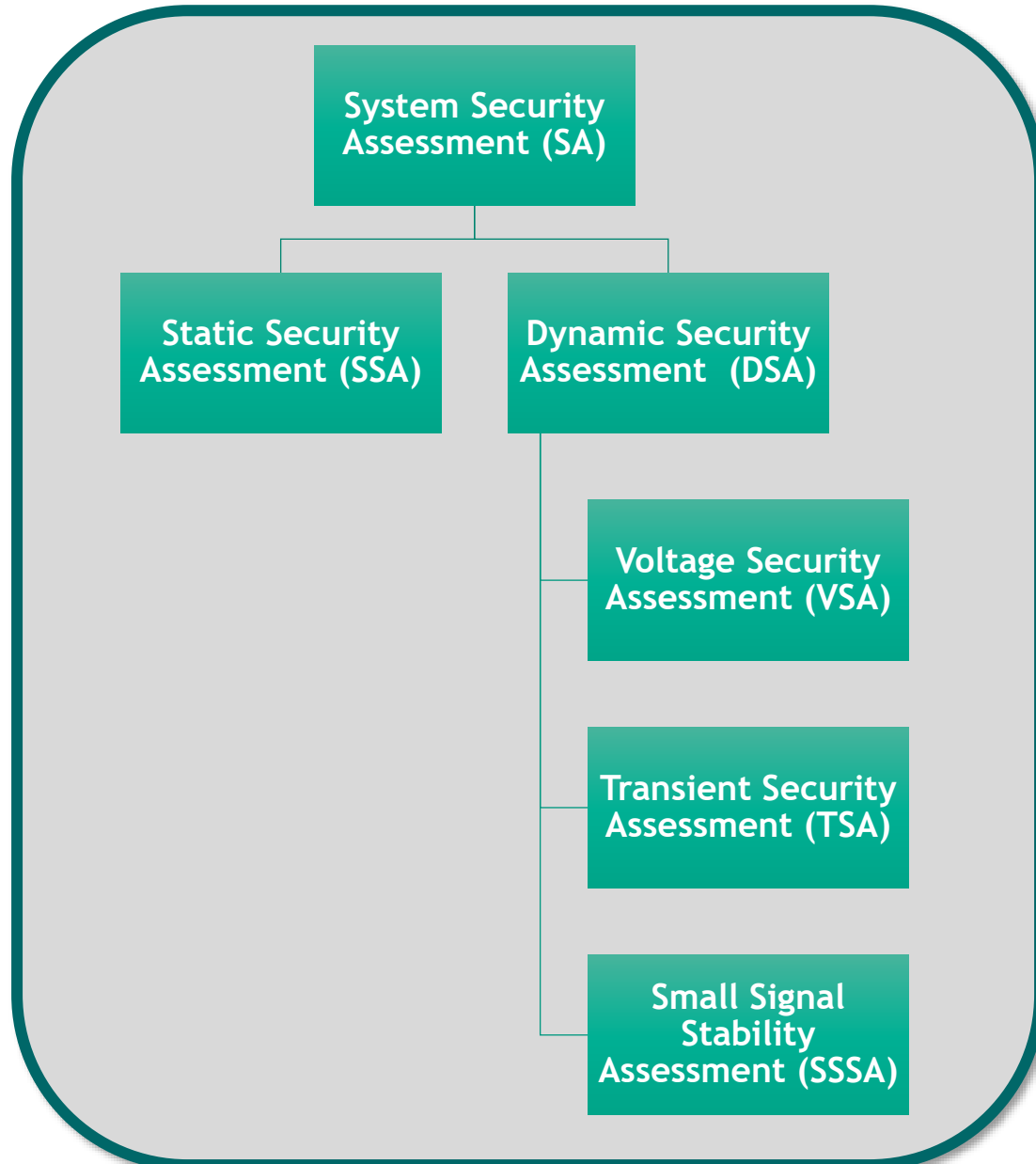


Clear decarbonisation agenda backed up by legislation

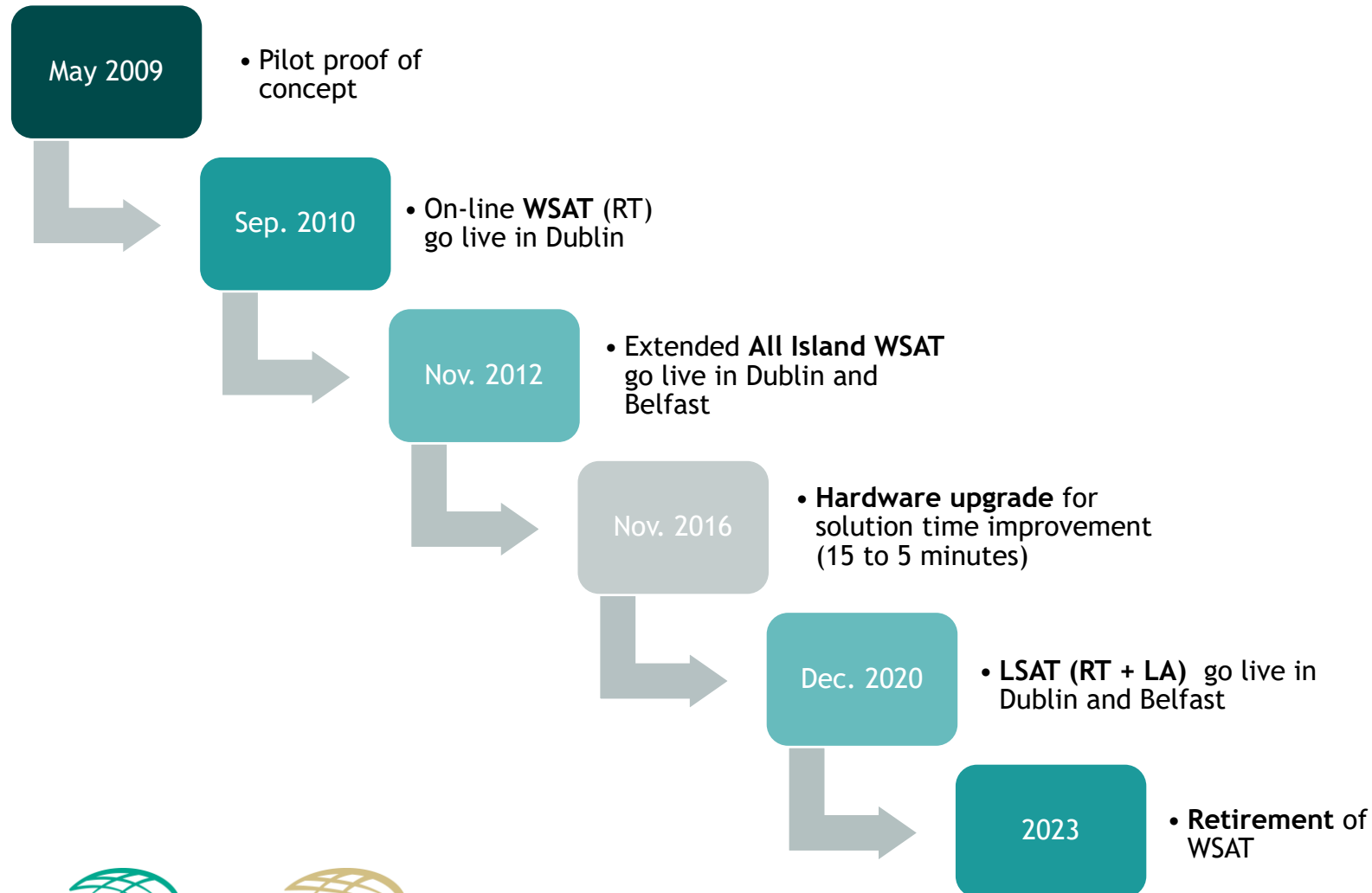
ON-LINE DYNAMIC SECURITY ASSESSMENT: REAL TIME AND LOOK AHEAD



Terminology



Our DSA journey





Why Look-Ahead DSA?

- Real Time DSA capabilities have supported integration of high levels of wind generation, up to 65% SNSP
- Operational complexity increases with level of non-synchronous renewables
- Forward looking DSA capabilities were identified as a requirement to increase SNSP above 65%
- Currently, we are operating at 75% SNSP
- Look Ahead provides adequate advance visibility of insecurities and allows implementation of effective correction actions in a timely manner

System Non-Synchronous Penetration

$$\text{SNSP} = \frac{\text{Wind} + \text{Solar} + \text{HVDC Imports}}{\text{Demand} + \text{HVDC Exports}}$$

LSAT in a nutshell

Look-ahead Security Assessment Tool (LSAT) is an on-line application to monitor **voltage security** and **transient security** of the transmission system in both **Real-Time** and **Look-Ahead** time frames

Key features:

- Full integration of EMS (GE E-terra) and DSA (Powertech DSATools) applications
- Interfaces with other applications:
 - Market Management System (MMS)
 - Outage Management System (OMS)

Critical requirements:

- **Availability** → redundancy in DSA servers and data transfers
- **Speed** → high performance servers and distributed processing
- **Accuracy** → regular monitoring and validation against system incidents
- **Visualization** → clear presentation of results in dashboard
- **Archiving** → results are archived and available for off-line analysis and auditing at any time



LSAT Functionality

On-Line Real-Time

- Automatic process
- 5 minutes cycle
- Start from EMS State Estimator Solution

On-Line Look-Ahead

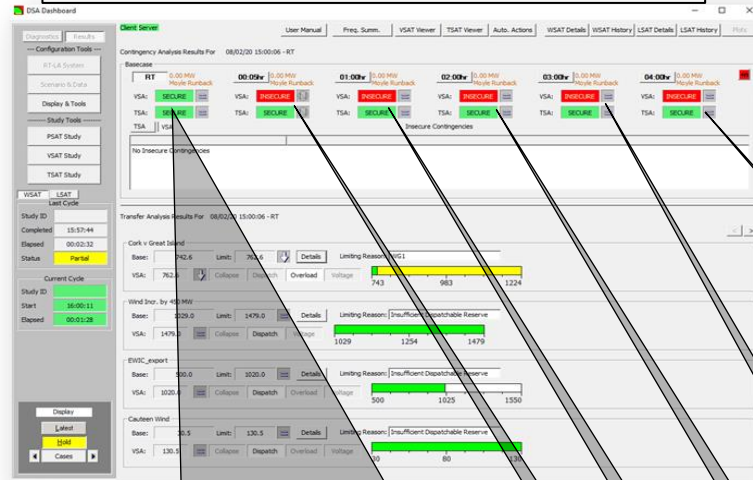
- Automatic process
- User selectable frequency and period of analysis
- Look-ahead time-points
- Based on Market Schedules and Outage Plans

Off-Line Study

- Manually triggered
- User selectable period of analysis
- Look-ahead time-points
- User defined generation schedule and planned outage input data



ON-LINE LSAT



RT

LA

Immediate Past

Future

-5 mins

Now

Market Trade periods

Day+1

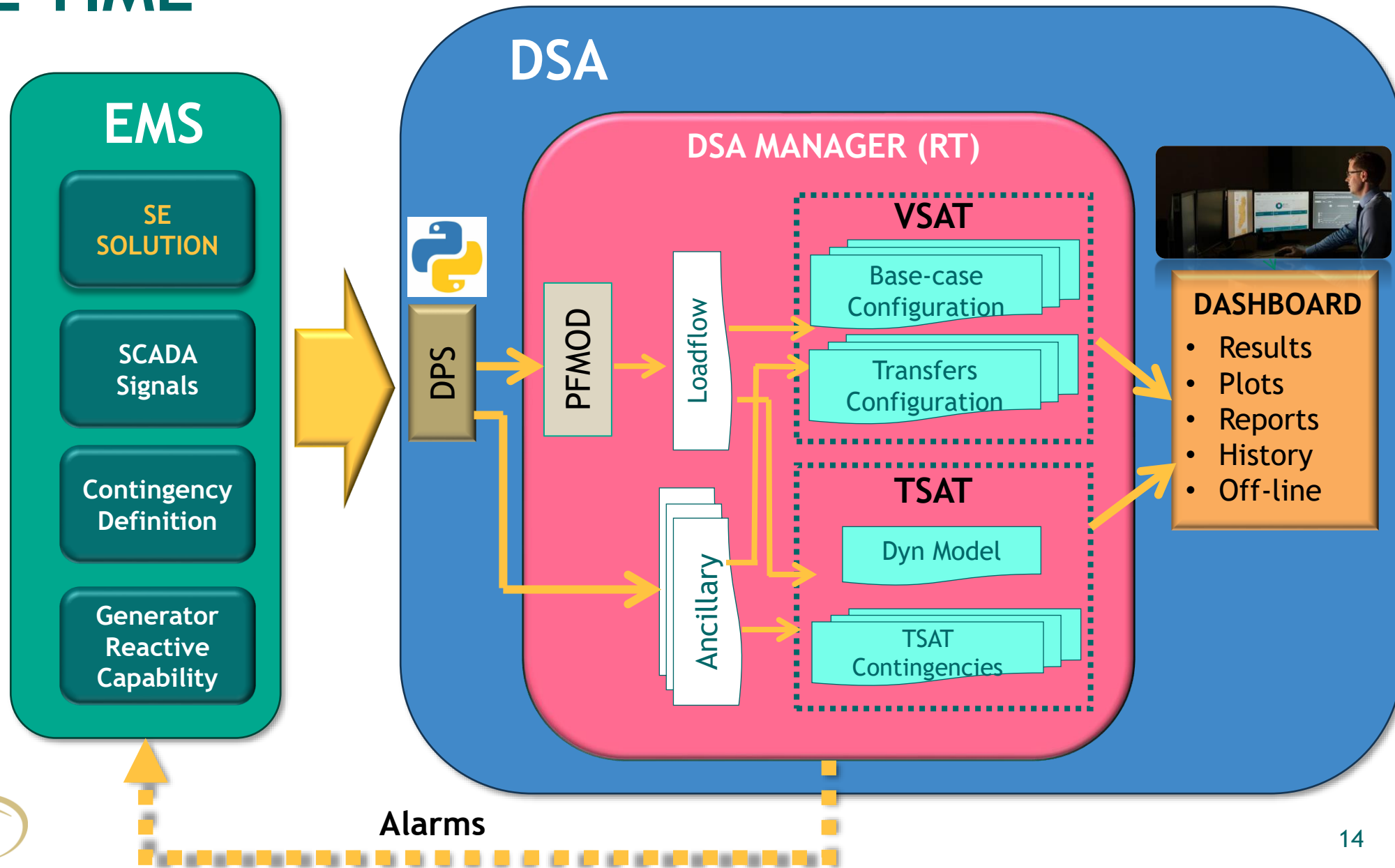
Performance

Model size

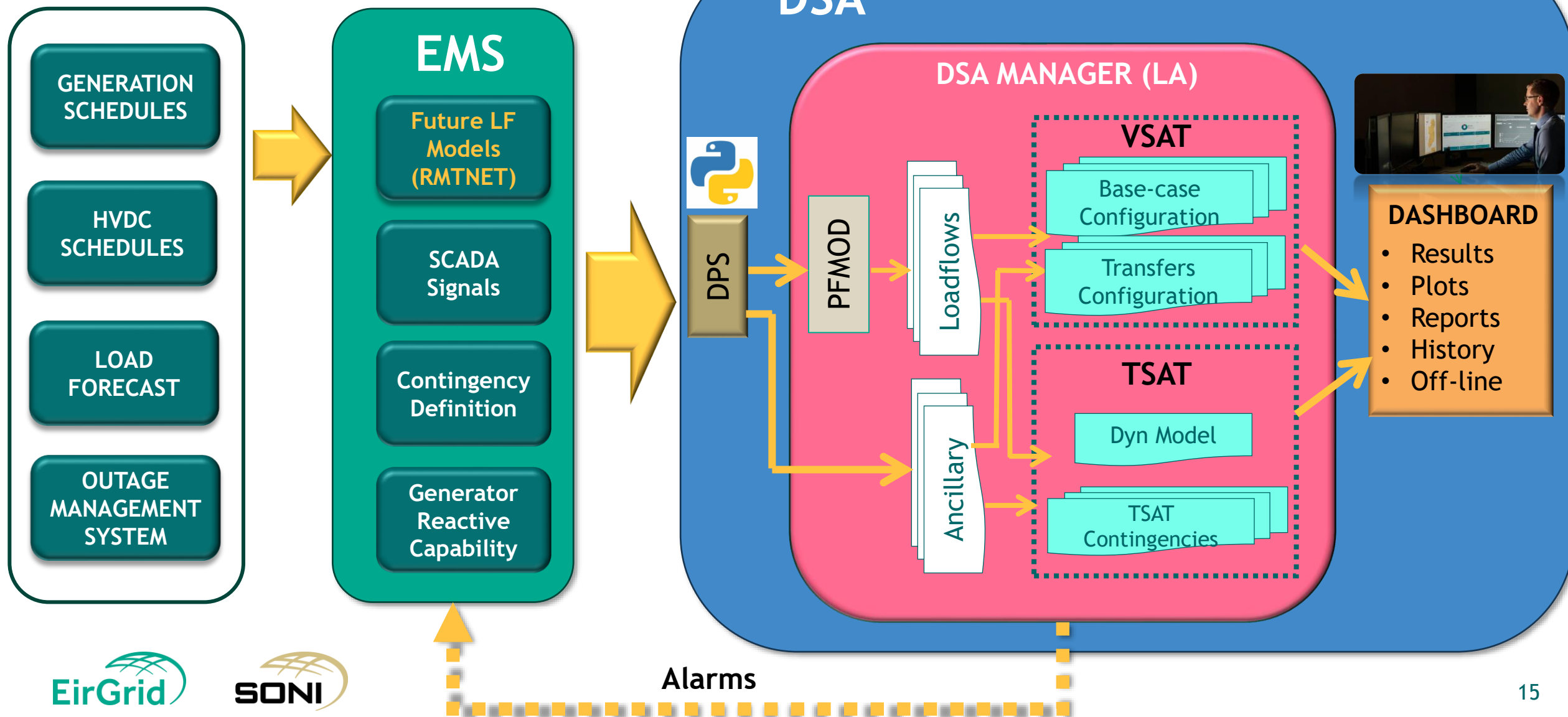
Component	number
Bus	1500
Generator	420
Line	850
Transformer	900
Load	650
HVDC LCC	1
HVDC VSC	1

- **Real-Time**
 - 5 minutes per cycle
- **Look-Ahead**
 - 3 minutes per cycle

LSAT REAL TIME

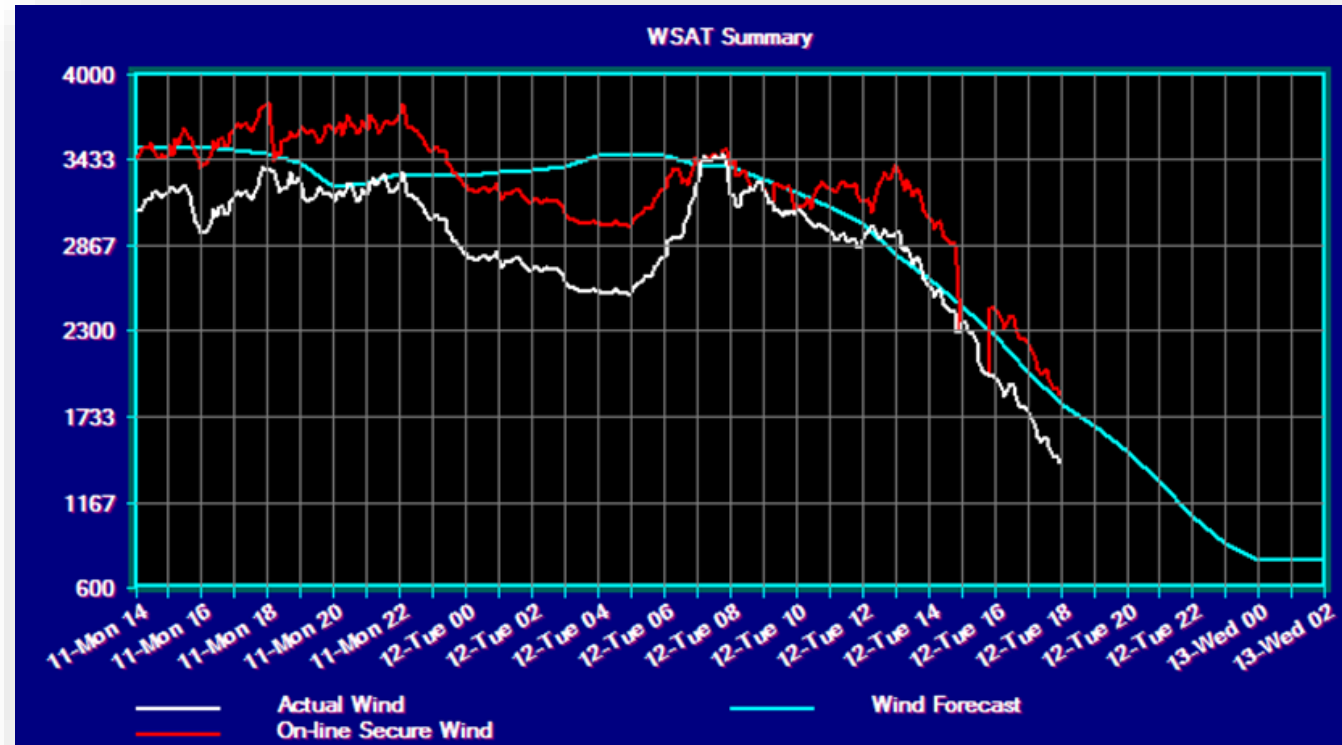


LSAT LOOK AHEAD



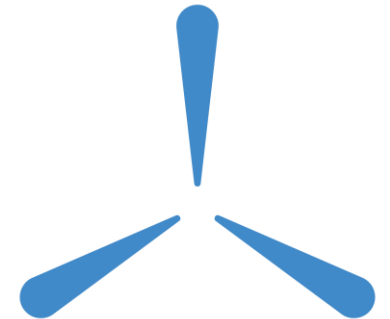
Voltage Security Assessments (VSAT)

- Load-flow simulations
- Base case and Transfer analysis
- Contingency list imported from EMS at each cycle (~ 900 ctg)
- Generator reactive capability limits adjusted during transfers
- Special Protection Schemes are represented
- We want to know:
 - Is base-case secure?
 - Distance to insecurity?
 - Secure level of wind?



Transient Security Assessments (TSAT)

- Phasor-Domain simulations
- Combination of generic and UDM models
- Over **800** pre-defined contingencies running to 15 seconds
- Early termination feature for secure contingencies
- Post contingency we want to know:
 - Are all synchronous machines still synchronized?
 - Does system frequency stay within limits?
- In Rotor-Angle insecure scenarios, Preventative Control Measures (PCM) are suggested



Frequency Summary Display

Freq. Summ. VSAT Viewer TSAT Viewer Powerflow Regulation RT Details RT History LA Details LA History Plots

Contingency Analysis Results For: 27/10/2022 23:56:28 - RT

RT/LA detailed results & analysis tools

REAL TIME

LOOK AHEAD

Offline Study Tools

Display & Tools

Study Tools

PSAT Study

VSAT Study

TSAT Study

RT LA
Last Cycle

Study ID
Completed 17:06:23
Elapsed 00:04:24
Status Completed

Current Cycle

Study ID
Start 17:06:45
Elapsed 00:02:11

RT/LA cycle information

	RT	00:00hr	01:00hr	02:00hr	03:00hr	04:00hr	05:00hr	06:00hr	07:00hr
Moyle Runback:	0 MW	0 MW	141 MW	200 MW	221 MW	164 MW	129 MW	0 MW	0 MW
VSA:	SECURE	SECURE	SECURE	SECURE	SECURE	SECURE	SECURE	SECURE	SECURE
TSA:	SECURE	SECURE	SECURE	SECURE	INSECURE	SECURE	SECURE	SECURE	SECURE

Basecase analysis summary

Case Date & Time

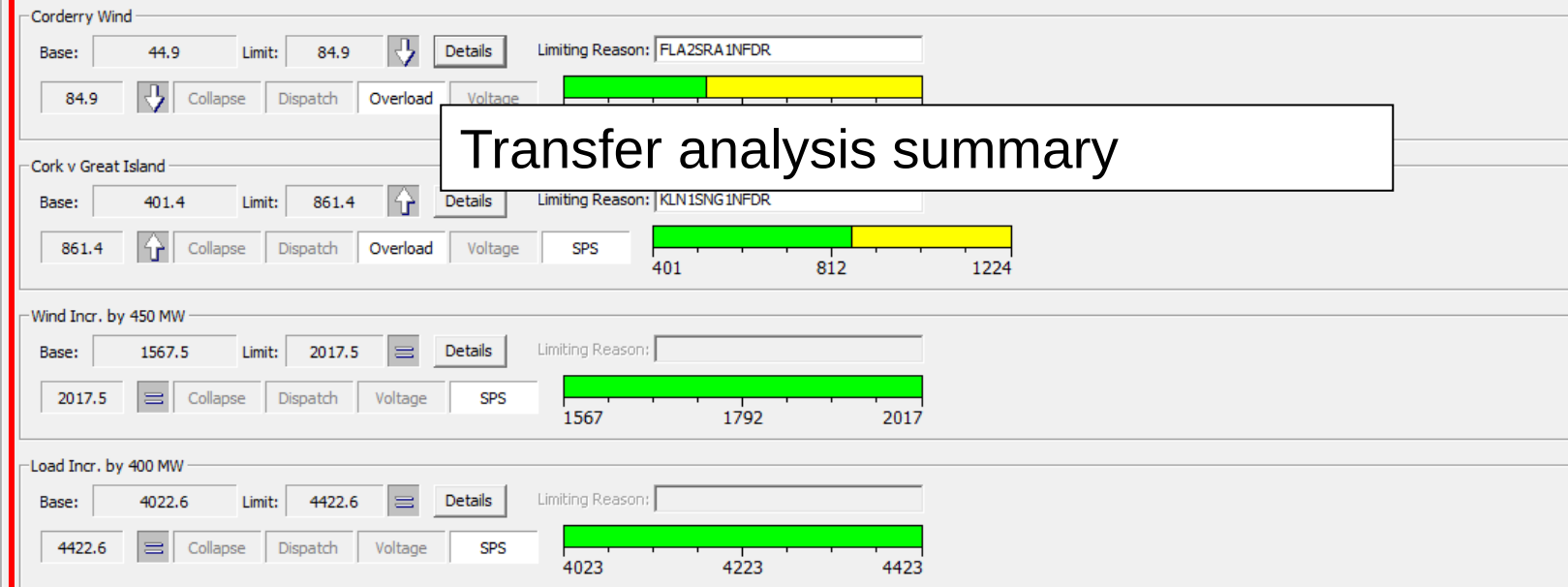
Insecure Contingencies

No Insecure Contingencies

Look-Ahead Input Data Files:
lf.csv 2022/10/27 22:03:32 un.csv 2022/10/27 22:03:50
hvdc.csv 2022/10/27 22:03:32 os.csv 2022/10/27 20:15:51

Transfer Analysis Results For: 27/10/2022 23:56:28 - RT

Transfer analysis summary



RT/LA case browser

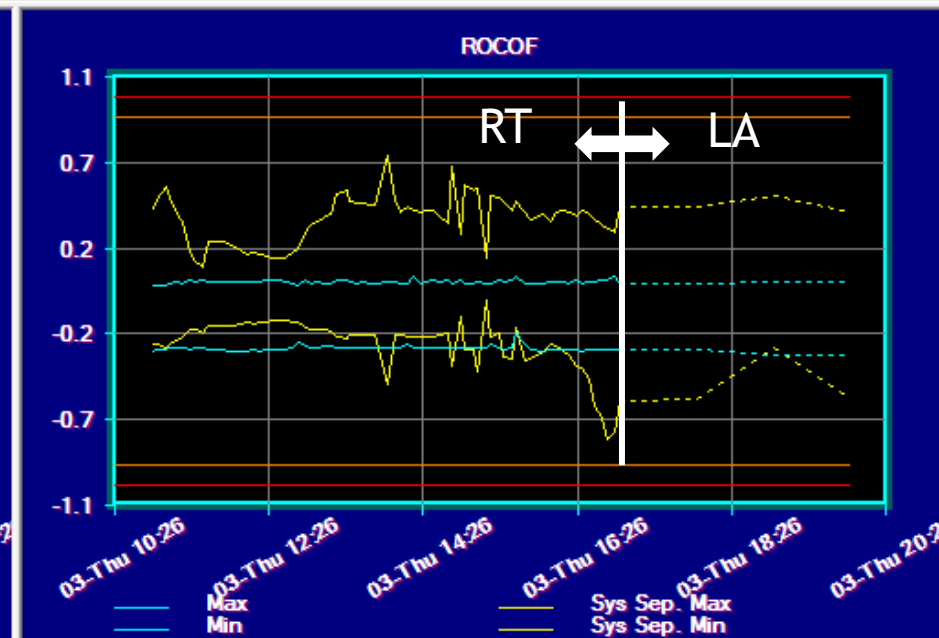
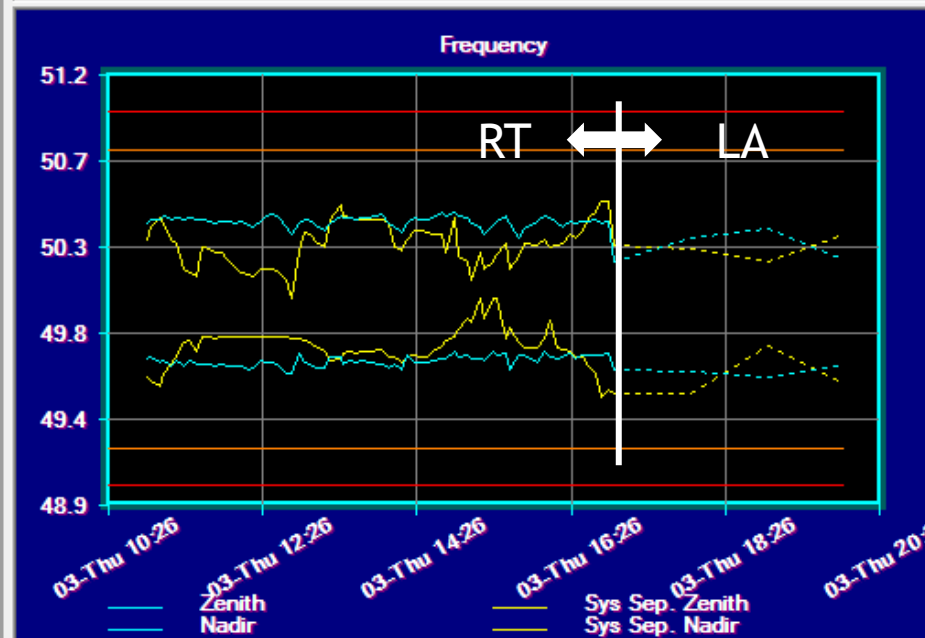
Display
Latest
Hold
Cases

File

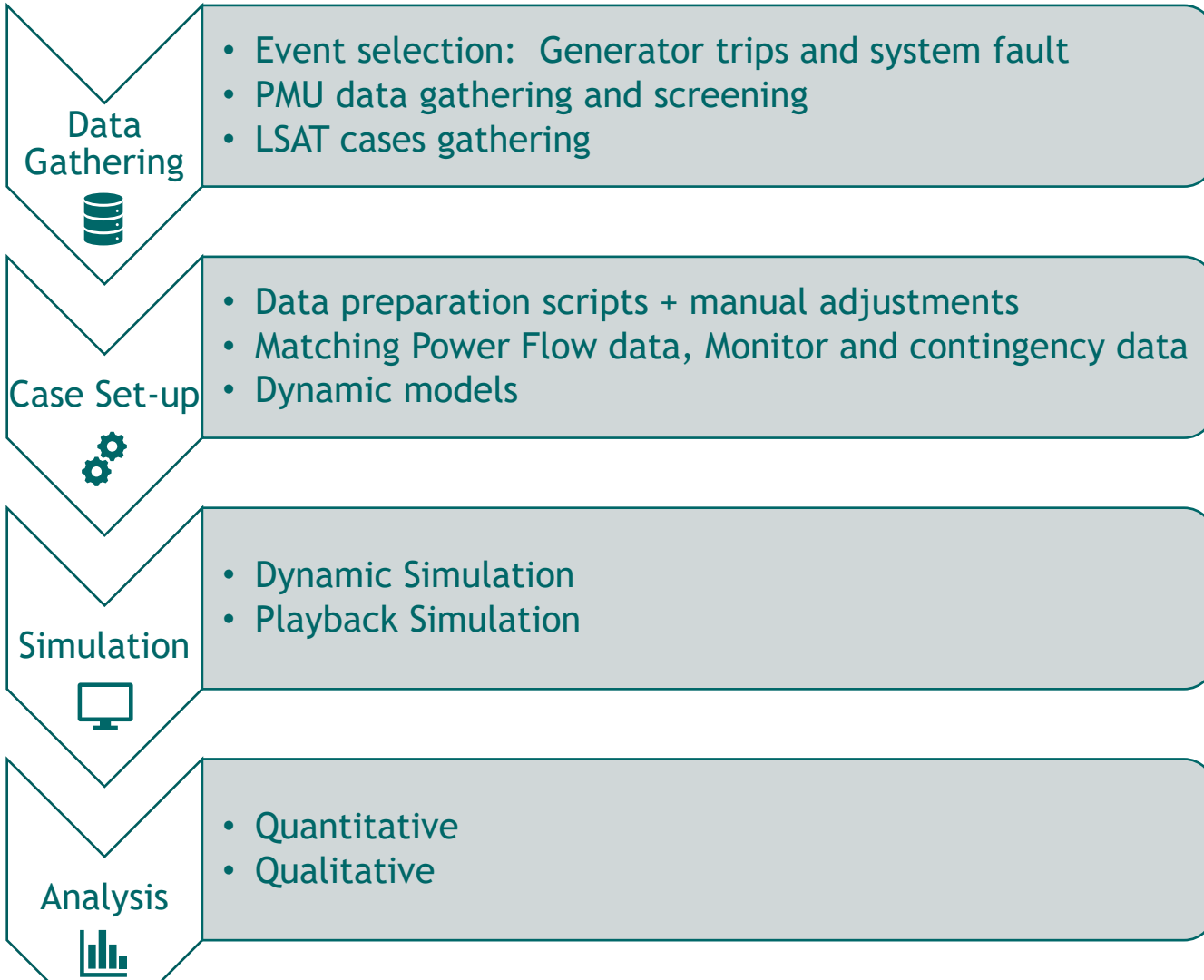
Time	Nadir (Hz)	Nadir Contingency	Zenith (Hz)	Zenith Contingency	Negative COF (Hz/s)	Negative Contingency	Positive COF (Hz/s)	Positive Contingency	Sys. Sep Nadir (Hz)	Sys. Sep Zenith (Hz)	Sys. Sep COF (Hz/s)	Sys. Sep COF (Hz/s)
03/11/202...	49.65	GTISLAND GI	50.21	BPS 30-KEL	-0.334	GTISLAND GI	0.056	GLANAGOW	49.54	50.35	-0.557	0.411
03/11/202...	49.58	GTISLAND GI	50.38	LOUTH-WOC	-0.329	GTISLAND GI	0.049	GLANAGOW	49.75	50.20	-0.295	0.488
03/11/202...	49.61	GTISLAND GI	50.33	BALTRS10-C	-0.307	AGHADA AD_	0.043	AGHADA AD_	49.49	50.26	-0.556	0.434
03/11/202...	49.62	GTISLAND GI	50.20	BPS 30-KEL	-0.306	AGHADA AD_	0.044	AGHADA AD_	49.49	50.29	-0.564	0.440
03/11/202...	49.71	GTISLAND GI	50.42	BLAKET90-M	-0.307	AGHADA AD_	0.076	POOLBEG PB	49.51	50.53	-0.726	0.306
03/11/202...	49.70	GTISLAND GI	50.41	BLAKET90-M	-0.305	GTISLAND GI	0.061	POOLBEG PB	49.47	50.52	-0.766	0.325
03/11/202...	49.70	GTISLAND GI	50.42	BLAKET90-M	-0.307	GTISLAND GI	0.059	POOLBEG PB	49.60	50.46	-0.650	0.344
03/11/202...	49.70	GTISLAND GI	50.42	BLAKET90-M	-0.307	GTISLAND GI	0.055	POOLBEG PB	49.64	50.44	-0.597	0.366
03/11/202...	49.70	GTISLAND GI	50.42	BLAKET90-M	-0.307	GTISLAND GI	0.054	POOLBEG PB	49.69	50.37	-0.451	0.395
03/11/202...	49.68	GTISLAND GI	50.41	BLAKET90-M	-0.312	GTISLAND GI	0.044	GTISLAND GI	49.70	50.33	-0.399	0.417

RT

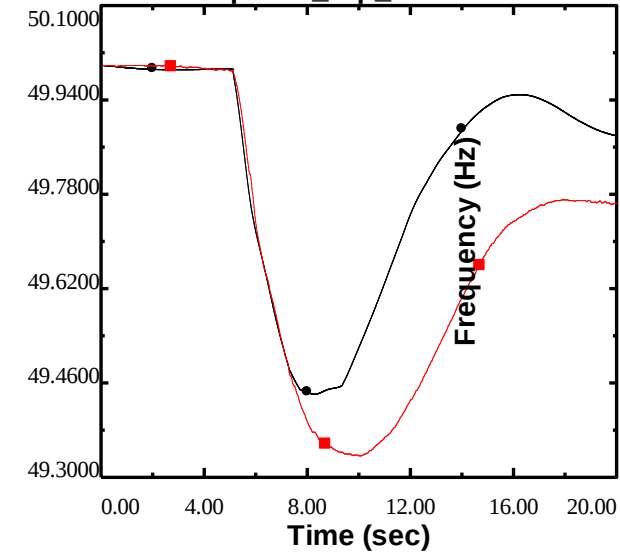
LA



Dynamic Model Validation

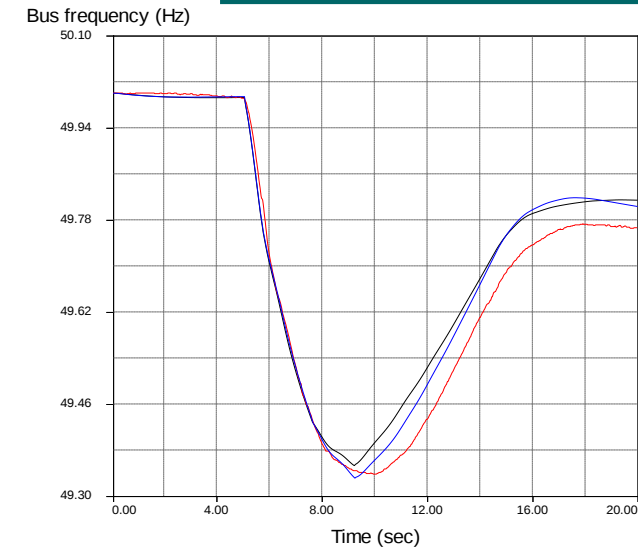


Original model



Simulation results
PMU data

Tuned model parameters



Simulation results
(1)
Simulation results
(2)
PMU data

Sharing our experience (i)

- DSA assessments are as good as the starting loadflow case
 - RT: SE solution. Generally good.
 - LA: RMTNET solution can be challenging. Highly dependent on the voltage regulation settings and the outage definition. Continuous improvements.
- Arming SPS and other model parameters
 - RT: use SCADA signals
 - LA: logic implemented in python dynamically updating model parameters
- Model upkeep
 - Consistency in bus/equipment naming between EMS and DSA files
 - Adding dynamic models for new equipment in synch with EMS
 - Regular review and update of SPSs and TSAT contingencies
 - Pre-production testing environment with live data feeds
 - Continuous monitoring and updating by dedicated team → do not underestimate the effort required!!



Sharing our experience (ii)

- Over 12 years of DSA operation 24/7. Improvements introduced over the years.
- LSAT Project delivered during covid-19 lockdown
 - Fully remote
 - Multi-disciplinary skills and cross-functional project team
 - Project team geographically dispersed across multiple time zones
 - Complex new interfaces required
 - Step-change in computing power requirements
 - Excellent vendors support
- Operator experience
 - Training: before roll out and periodic refreshers
 - Continuous feedback
 - Confidence built over time
 - Actions taken in Control Rooms based on LSAT outcomes



Proven Benefits

LSAT provides **radar-like** guidance on how to operate the power system in a safe and secure manner while minimizing wind curtailment.

It helps maintain power system security **under all conditions**, including abnormal scenarios that may not have been captured in off-line studies supporting operational constraints.

It has become a critical decision support tool that allows **pushing the operational boundaries** to integrate more renewables in Real Time operations with confidence. Currently, operating at **75% SNSP, 1 Hz/sec** and running a trial with reduced number of synchronous units online.

Key contributor for **meeting government renewable targets**.



A wide-angle photograph of an offshore wind farm. Numerous white wind turbines with three blades each are spaced out across a calm, greyish-blue sea. The sky is a pale, hazy blue, suggesting an overcast day. The perspective is from a low angle, looking across the water towards the turbines in the distance.

Thanks for your
attention

