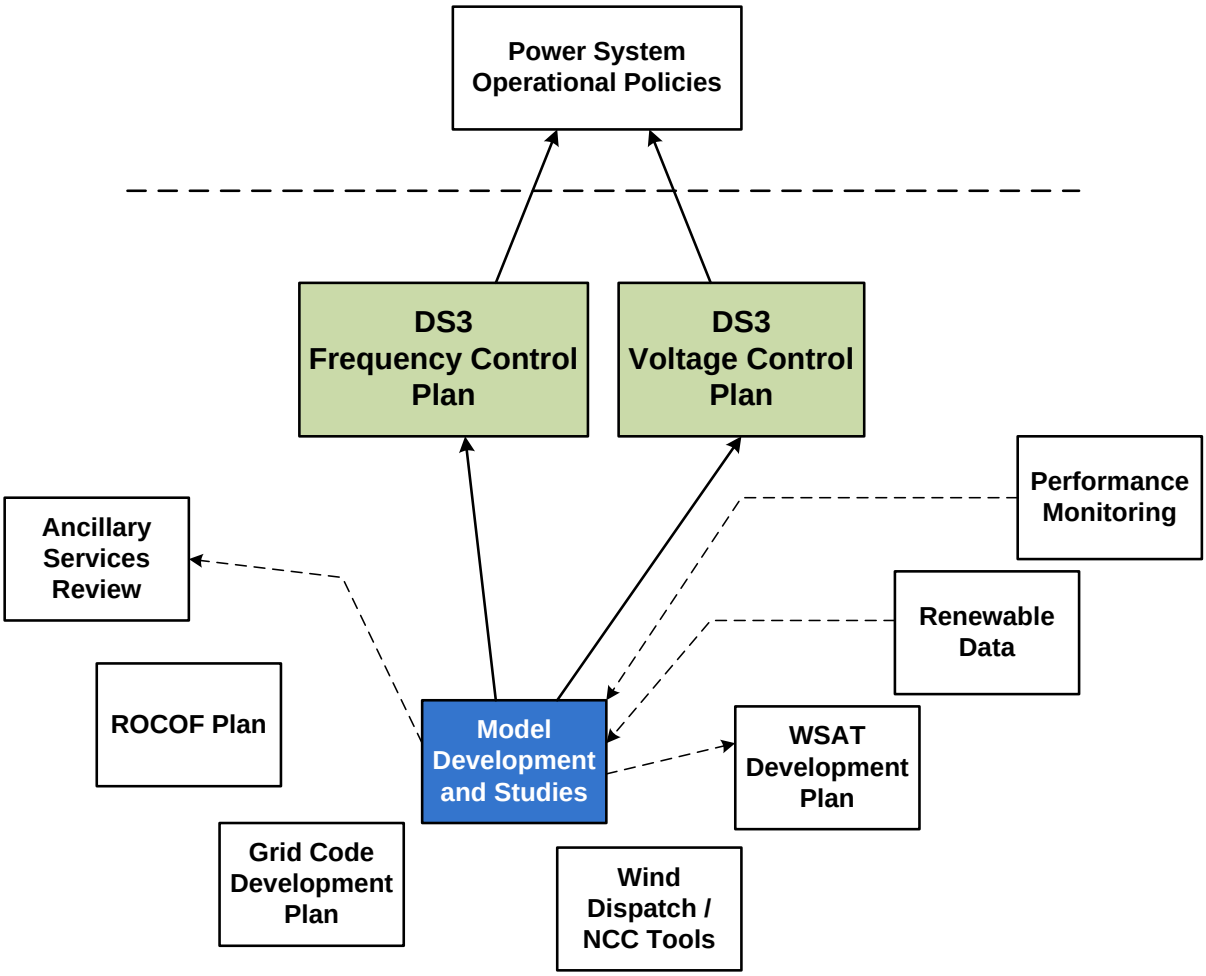
DS3:
Model Development & Studies Workstream

CONTEXT

The Facilitation of Renewables (FOR) study was a detailed and wide-ranging study that covered many different aspects of power system stability and power system operation with high levels of wind. The purpose of the DS3 programme is to implement the necessary actions arising from the FOR study results: introduce changes to operational policies where necessary; develop mitigation strategies; change or improve the standards via Grid Code and Performance Monitoring; incentivise system services via the System Services review; and develop our existing dynamic models and run new studies and simulations where necessary. The Model Development and Studies Plan (MDSP) will provide inputs into the Frequency Control and Voltage Control workstreams. It will also interact closely with the WSAT development plan.



Key inputs into the Model Development and Studies Plan will be Performance Monitoring data, and Renewable data.

Aims of Model Development and Studies Workstream

The main aim of this workstream is to inform future operational policies related to the integration of large amounts of wind onto the Irish system, and to develop and validate the dynamic model of the Ireland and Northern Ireland system so that the TSOs, or any impartial observer would have confidence in the results of the studies carried out using those models. Another aim is to streamline and automate the studies process, so that extensive studies on different aspects of power system operation can be carried out more quickly. This may involve using scripting tools to provide a control layer above the actual simulation tools, into which information on dispatches, sensitivities, and key outputs can be fed.

This workstream will produce a procedure for the development of operational software models. This procedure will identify the information sources, detail any necessary data conversions and will facilitate the production of a useable software model for analysis purposes. While the main objective is the creation of a fully validated WSAT model it is important that in parallel All-Island PSS/E models are developed to facilitate long term planning and other TSO business objectives on the Island of Ireland.

Model Development and Validation

EirGrid and SONI use a number of different packages including PSS/E, DSA Tools (PSAT, VSAT, TSAT, WSAT), and PowerFactory. PSS/E is used extensively in planning studies in both EirGrid and SONI. The DSA Tools are more geared towards online studies, but are also used for operational studies. (WSAT is part of the DSA Tools suite.) PowerFactory is used for in-depth three-phase fault analysis, harmonic studies, and electromagnetic transient studies.
Model development has been ongoing for many years, but mainly on a jurisdictional basis. One aim of this workstream is to produce a functioning all-island model for PSS/E and DSA Tools that has been cross-validated. It will also incorporate special protection schemes and windfarm interface protection schemes, as well as load-shedding schemes and static reserve.

Model validation is ongoing in both EirGrid and SONI. For example, formal processes have been developed to compare system frequency events against the performance of TSAT (Transient Stability Assessment Tool). Processes will also need to be developed to validate/verify the performance of other dynamic models (excitation systems / machine parameters).

Main Studies Required

As well as developing network models, another objective of this workstream is to carry out studies supporting other DS3 workstreams for example voltage and frequency control. Some examples of the areas of investigation identified in the FOR studies will be looked at in more detail on a case by case basis and are listed below.

Frequency-related

a) Loss of largest infeed study: *Quantifying the limit on generator/windfarm size, by looking at effect on frequency and constraint costs*

b) Minimum conventional generation *study: Determining if there is a minimum number of conventional generators that must always by online to maintain voltage stability and transient stability of the power system.*

c) *Voltage-induced frequency dip study: Looking at the effect of transmission system faults on the outputs of windfarms. Quantifying the resulting energy imbalance and the effect on frequency and ROCOF, and transient stability of the system.*

d) Frequency regulation study: *Quantifying the frequency regulation issue with high wind penetrations. How much will the frequency fluctuate, and what actions does the TSO need to take to mandate additional sources of frequency regulation.*

e) Wind Governing and Emulated Inertia Study: *Looking at the effect of wind governing and emulated inertia (fast-acting response) from windfarms on system frequency and reserve. Determination of appropriate settings and consequences for curtailment levels. . It may also be necessary to consider high frequency effects on the system for high wind and exporting dispatch scenarios.*Ramping requirements study: *Looking at historical statistics on ramping requirements and extrapolating these results for high wind penetrations. What ramping services will the system require and how best to provide these services.*

Voltage-related

f) Distributed voltage control study and windfarm voltage co-ordination: *How best to manage the reactive power resources from DSO and TSO connected windfarms, given the various control modes that they can operate under.*

g) PV analysis of system / Overcompensation study: *Carry out full Power-Voltage analysis of the power system to determine likelihood of voltage collapse, and determine if system is overcompensated i.e. if the system has too much shunt capacitance relative to the capacity of the transmission network.*

h) Synchronous Condensers / Dynamic Reactive Power study*: Consider the impact of synchronous condensers and other dynamic reactive power sources on the transient stability of the power system.*

i) SNSP / Metrics / Quantifying Synchronous Torque Study: *General analysis of the best metrics to use for determining system stability with high wind penetrations, and quantifying the reduction in synchronizing power at high winds.*

There will also be a requirement to re-run the FOR analysis for a more wide-ranging set of dispatches and sensitivities at some point in the future. This will be contingent upon developing procedures for a streamlined approach to these very extensive studies, as mentioned above. Such studies may be based on half-hourly dispatches for a whole year, with a variety of sensitivities, such as operational policy changes. As such, they could not be carried out manually, but would need to be fully automated, and the analysis of the studies would also need to be automated.

Key Outcomes:

- Create a working all-island model in PSS/E and DSA Tools / WSAT that has been validated against several system events. This model will be the basis of the rest of the studies.
- Results to be fed into Frequency Control and Voltage Control workstreams.
- Generate recommendations on each of the studies listed, along with recommendations for changes to operational policy, or recommendations for further study
- Establish processes for validating governor and excitation models, and for comparing major system events against simulations.
- Create a streamlined study process that can use scripting capabilities inherent in DSA tools / PSS/E for in-depth studies with multiple sensitivities and dispatches.

Assumptions and Risks

This workstream will create base case models for studies, the input assumptions covering variables such as dispatch, portfolio, wind penetration levels and demand will be defined at the study planning stage.

The majority of the studies will require a working all-island model that includes dynamic models for wind governing response and emulated inertia response. This may involve the use of consultants for model development in PSSE or TSAT. There also may be a requirement for work by Powertech Inc. who develop WSAT, and the dynamic models that are used in it.

The scope of this workstream may change depending on the requirements of the frequency control and voltage control workstreams. It will also depend on the outcomes from the Grid Code workstream and the decisions by industry and regulators on the ROCOF issue.

MODEL DEVELOPMENT AND STUDIES FOR DS3 PROJECT - HIGH LEVEL PLAN

Model Development and Validation	Dependencies on DS3 Workstreams	Action	Timeline
• Develop all-island model for PSS/E / WSAT	WSAT	TSOs	Q2 2012
• Develop process for Exciter Validation	Performance Monitoring	TSOs	Q2 2012
• Develop process for validating all –island model against system events	Performance Monitoring / WSAT	TSOs	Q3 2012
• Develop streamlined process for carrying out large system studies	WSAT	TSOs	Q4 2012
System Studies			
• Frequency Response following a large disturbance	Frequency Control	TSOs	Q2 2012
• Loss of Largest In-feed Study	Frequency Control	TSOs	Q1 2012
• Frequency Regulation Study	Frequency Control	TSOs	Q2 2012
• Study of Ramping Requirements	System Services / Grid Code	TSOs	Q2 2012
• Develop streamlined approach to studies	WSAT	TSOs	Q4 2012
• Investigate voltage dip induced frequency dip	Frequency Control	TSOs	Q1 2013
• Distributed Voltage Control and Dynamic Voltage Support Study	Voltage Control / Grid Code	TSOs	2013
• PV Analysis and Overcompensation Study	Voltage Control	TSOs	2013
• Other studies	Various / Grid Code	TSOs	2014/2015