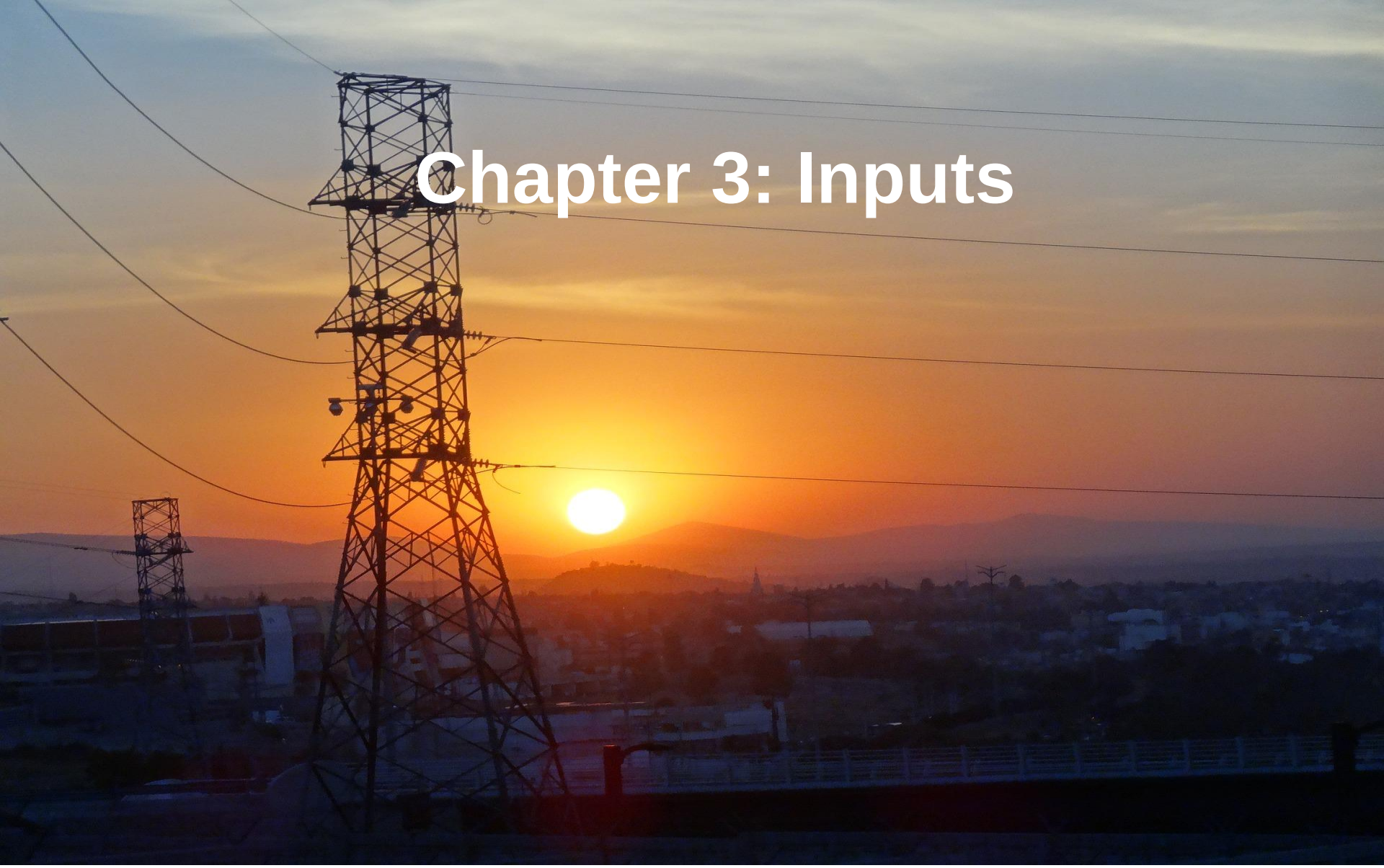

Chapter 3: Inputs

Foreword – (1/2)

- This section describes the data inputs to the scheduling and dispatch process including the source of the data and how it is used.

- There are thousands of data items that form inputs to the scheduling and dispatch process. These can be categorised as commercial data (the cost of energy from each unit), technical data (the capability of each unit) as well as parameters used to implement the objectives of the process (weighting policy objectives). The data comes from various sources (from Participants and System Operators) over varying timeframes (once a day to every second) and through different interfaces (energy market and power system). The data items, grouped by source, are summarised in Figure 3 in the following slide.

- The inputs we have described in this section are associated with scheduling and dispatch under normal circumstances. Abnormal events can arise whereby different inputs are taken into account and where different scheduling and dispatch processes apply.

Foreword – (2/2)

Policy Objectives

- Priority Dispatch categorisation
- Scheduling and Dispatch Policy Parameters

Participants / System Service Providers

- Technical Data - energy market and System Services
- Commercial Data - energy market and System Services
- Physical Notifications
- Availability / System Service Capability Declarations
- Unit Under Test

Ex Ante Markets

- Interconnector Schedules

System Operators

- Demand and Renewables Forecasts
- System Constraints
- System Service Requirements
- Interconnector Technical Data
- Prices and Volumes for Cross-Zonal Actions
- Real-Time System Conditions

Figure 3: Inputs to the Scheduling and Dispatch Process

Inputs Reflecting Policy Objectives – (1/2)

Priority Dispatch

- We give priority to the dispatch of certain generation types as required by European, Ireland and Northern Ireland legislation. The output of these units is maximised as far as technically feasible. Within this categorisation there is a hierarchy of units, this is defined in SEM Committee decision SEM-11-062 with the subsequent inclusion of Solar and Tidal generation as referenced in the SEM Committee's letter to us on 24 March 2017, and as illustrated in Figure 4 on the following slide. Note that this hierarchy sits within other dispatch requirements related to hydro stations during flood risk situations, the treatment of interconnector schedules (avoiding curtailment of market schedules), other units (non-priority dispatch) and TSO led Cross-Zonal Actions over the interconnectors.

Inputs Reflecting Policy Objectives – (2/2)

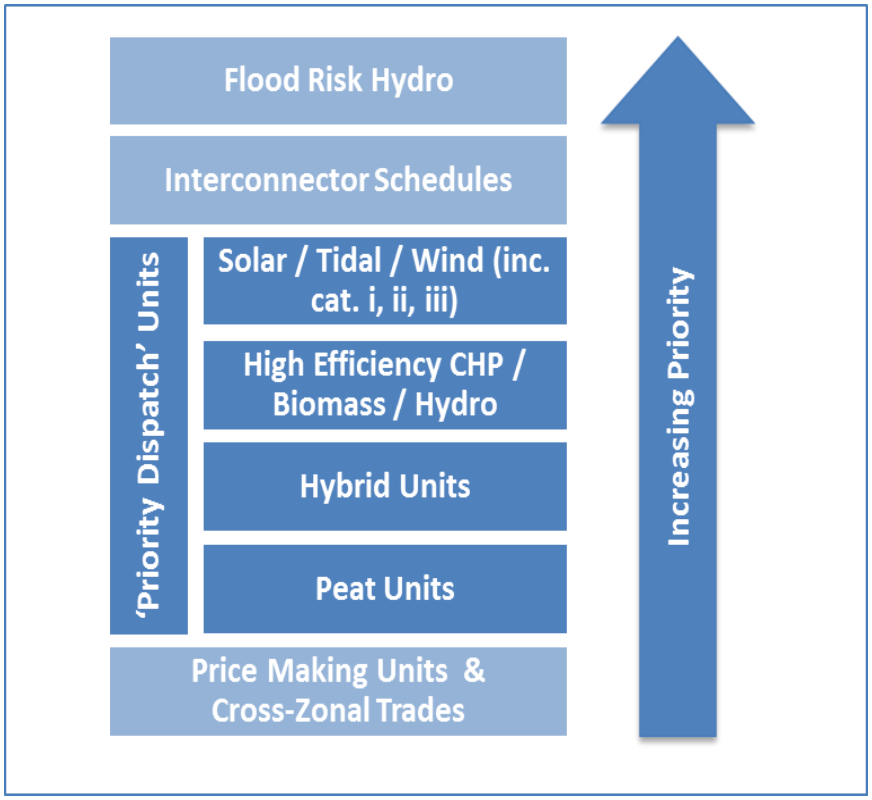

Figure 4: Priority Dispatch Hierarchy

- Within the wind category there are sub-categories reflecting the controllability of wind farms (wind farms that are controllable are given priority over wind farms that should be, but are not, controllable). Based on the guidance now provided by the SEM Committee on the treatment of Solar and Tidal units we will be updating our systems and processes to accommodate these unit types. This will include providing an update to this Controllability Categorisation process.
- We implement priority dispatch policy, and the associated hierarchy, by the application of a range of negative decremental prices to units classified as priority dispatch.

Scheduling and Dispatch Policy Parameters

Scheduling & Dispatch Policy Parameters

- Under our Licence, the RAs may determine policy parameters that apply in our scheduling and dispatch process to give effect to RA policy.

- The scheduling and dispatch policy parameters are:
  I. Long Notice Adjustment Factors (LNAF) relative to unit Notification Times;
  II. System Imbalance Flattening Factors (SIFF) relative to the System Shortfall Imbalance Index (SSII); and
  III. The Daily Time for fixing the SSII/SIFF for a Trading Day.

- Per SEM-17-046 of 7 July 2017, the SEM Committee has decided that, at go-live of the revised SEM arrangements, LNAF and SIFF will be zero and that the time to set SSII/SIFF will be determined at a later date. This decision also requires us to re-evaluate the determination of these factors in time for application from 1 January 2020.

- As these parameters will be set to zero at this time, they will have no impact on the scheduling and dispatch process and are not described further in this document.

Participants / System Service Providers – (1/2)

Participants / System Service Providers

- Technical Data - energy market and System Services
- Commercial Data - energy market and System Services
- Physical Notifications
- Availability / System Service Capability Declarations
- Unit Under Test

The following section describes Inputs provided by Participants and System Service providers.

Unit Technical Data

- TOD includes maximum and minimum output capabilities, ramp rates and notification times of units and is fundamental to the process of scheduling and dispatching units. Through the selection of predefined TOD sets, a participant can also determine their mode of operation (e.g. CCGT or OCGT mode) and/or fuel. The requirements for this data are set out in the Grid Codes SDC1 (Scheduling and Dispatch Code), TSC Part B D.3 (Timing of Data Submission), D.5 (Technical Offer Data), Appendix H (Data Requirements for Registration) H and Appendix I (Offer Data).

Participants / System Service Providers – (2/2)

- System Services data (which incorporate DS3 System Services and other System Support Services and Ancillary Services) includes operating reserve capability curves, reactive power capabilities and inertia. This data, along with TOD, is used to ensure that sufficient System Services are scheduled to meet the security requirements of the power system. The requirements for this data are set out in the Grid Codes (SDC1) and the relevant System Services agreement. This data is submitted and managed through the relevant System Services agreement and real-time declarations in our Electronic Dispatch Instruction Logger (EDIL).
- Unit technical data is used to perform validation of PNs, to develop schedules of units that utilise their technical capability to meet security and other requirements and to ensure that the dispatch of units is within their technical characteristics. We validate unit technical data through unit testing and on-going monitoring

Unit Commercial Data

- The requirements for submission of Balancing Market commercial offer data submissions are set out in Grid Codes SDC1, TSC Part B sections D.3 (Timing of Data Submissions), D.4 (Commercial Offer Data) and Appendix I (Offer Data). This commercial offer data takes two forms:
  - Complex Bid Offer Data: 3 part offer data comprising start-up, no-load and incremental and decremental price quantity pairs; and
  - Simple Bid Offer Data: incremental and decremental price quantity pairs.
- We will not make any adjustment to Participants' submitted commercial offer data even if there is a known error in this data. We will not make any adjustments in the scheduling and dispatch process for such errors. It is the responsibility of the Participant to update their commercial offer data in line with TSC rules.
- Commercial data associated with the provision of System Services does not currently form an input to the scheduling and dispatch process as each System Services considered in the scheduling and dispatch process is remunerated using common tariffs (i.e. a fixed payment rate per service is applied to each service provider). System Service providers are therefore selected based on their Balancing Market commercial offer data and their technical capability to provide a service.
- We select the appropriate commercial data set (complex or simple) for use in the scheduling and dispatch process. The objective of the scheduling and dispatch process is to minimise the cost of diverging from participants' Physical Notifications. Unit commercial data forms the basis of determining this cost.

Physical Notifications

Participants / System Service Providers

- Technical Data - energy market and System Services
- Commercial Data - energy market and System Services
- Physical Notifications
- Availability / System Service Capability Declarations
- Unit Under Test

Physical Notifications

- Physical Notifications (PNs) are submitted by Participants as their intended output excluding any accepted offers and bids (i.e. the PN does not reflect any balancing action that we take on the unit). It is Participants' responsibility to ensure that their PNs are consistent with the Technical Offer Data for their units.
- All dispatchable Participants are required to submit PNs. Non-dispatchable Participants will not be obliged to submit PNs (even if they have traded or expect to trade in the markets) but may elect to do so for information purposes. We will use our own forecasts of their output as an implicit PN for these non-dispatchable units.
- A unit's PN is used along with its incremental and decremental cost curves to form a composite cost curve that is used within the scheduling and dispatch process. PNs for units under test are also flagged to ensure that the PN is prioritised within the scheduling and dispatch process.

Availability and System Services Capability Declarations – (1/2)

Participants / System Service Providers

- Technical Data - energy market and System Services
- Commercial Data - energy market and System Services
- Physical Notifications
- Availability / System Service Capability Declarations
- Unit Under Test

Availability and System Services Capability Declarations

- Participants are required to submit and maintain forecast active power (MW) availability for their units with real-time updates provided as this information changes. Updates to System Service capabilities are also required from System Service providers.

- Forecast availabilities submitted by Participants via the BMI are:
  I. a Forecast Availability Profile;
  II. a Forecast Minimum Output Profile; and
  III. a Forecast Minimum Stable Generation Profile

Availability and System Services Capability Declarations – (2/2)

- Real-time availability declarations are also provided by Participants via EDIL interface with the TSOs. Requirements for real-time availability declarations are set out in Grid Codes SDC1.
- It is the responsibility of Participants to ensure that forecast availability aligns with real-time availability declarations in EDIL. For example, if a unit trips, the Participant will re-declare its availability to zero in EDIL and, if appropriate, update the forecast availability via the BMI in line with the allowed forecast availability submission window.
- Non-dispatchable wind units provide a real-time availability signal via our Energy Management System (EMS). Forecast availability for non-dispatchable wind comes from our wind forecast.
- For dispatchable units, real-time System Services declarations such as reactive power or operating reserve capabilities can be made in real-time via EDIL. Requirements for the declaration of System Services are set out in Grid Codes SDC1. Any longer term changes to System Service capability are managed through the respective System Services agreement in place with each System Service provider.
- We select the appropriate availability data (forecast or real-time) for use in the scheduling and dispatch process. Unit availability data determines the technical capability range available to be utilised in the scheduling and dispatch process. The approach for solar generation is expected to follow the wind model. We are currently developing these arrangements.

Unit Under Test Notification

Participants / System Service Providers

- Technical Data - energy market and System Services
- Commercial Data - energy market and System Services
- Physical Notifications
- Availability / System Service Capability Declarations
- Unit Under Test

Unit Under Test Notification

- To facilitate unit testing which requires a specific running profile, Participants submit PNs via the BMI specifying the period that the unit is requested to be under test with a test flag. Any PN submission that includes a PN with a test flag will require manual approval by the TSO before it is accepted in to the scheduling and dispatch systems. Any subsequent modifications to a test PN, including cancellation is also subject to our approval.
- The type of test being requested by a unit will determine the notification time required by us to assess and approve a test and incorporate into the scheduling and dispatch process. The Grid Codes set out definitions for the categorisation of tests as either a Significant Test or a Minor Test (OC8 in the EirGrid Grid Code, and OC10 and OC11 in the SONI Grid Code).
- We will prioritise a unit under test in the scheduling and dispatch process so that its PN is respected as far as technically feasible.

Ex-Ante Market Interconnector Schedules

Ex Ante Markets

- Interconnector Schedules

Interconnector Schedules

- Interconnector schedules are an output of each ex-ante market. These are notified to us following completion of the day-ahead market with updates following as a result of intraday trading.

- Interconnector schedules are represented as fixed demand and/or generation profiles within the scheduling and dispatch process.

System Operator Inputs

System Operators

- Demand and Renewables Forecasts
- System Constraints
- System Service Requirements
- Interconnector Technical Data
- Prices and Volumes for Cross-Zonal Actions
- Real-Time System Conditions

- System operators referred to in this section are: the Distribution System Operator (DSO) in Ireland (ESB Networks Designated Activity Company) and the Distribution Network Operator (DNO) in Northern Ireland (Northern Ireland Electricity Limited), the GB TSO (National Grid plc), the Interconnector Owners ICOs (Mutual Energy Limited and EirGrid Interconnector Designated Activity Company) and the TSOs in Ireland and Northern Ireland (EirGrid and SONI).

Demand Forecast – (1/2)

System Operators

- Demand and Renewables Forecasts
- System Constraints
- System Service Requirements
- Interconnector Technical Data
- Prices and Volumes for Cross-Zonal Actions
- Real-Time System Conditions

Demand Forecast

- We produce demand forecasts representing the predicted electricity production required to meet demand including system losses but net of unit demand requirements ('house-load').
- The forecasts are based on historical jurisdictional data for total generation (conventional and wind). The total generation is used as a proxy for the total demand. The forecasts for each jurisdiction are calculated separately due to the different demand profiles in Ireland and Northern Ireland, and to reflect the differences in some bank holidays and special days. The forecast only reflects the generation visible to us via SCADA, so deeply embedded generation or micro-generation is not factored in. The forecasts themselves are produced using a proprietary software package. The algorithm learns the relationship between the system demand and a set of predictor variables (day of week, time of day, week of year, special days, average hourly temperature) based on historical data. It then creates a prediction for each half hour of the forecast period.

Demand Forecast – (2/2)

- We produce a 5 day demand forecast at half hour resolution on a daily basis. We then update this forecast on a continuous basis to account for actual demand conditions and interpolate the forecast to a 1 minute resolution for use in the scheduling and dispatch process.

- Demand forecasts are produced in line with Grid Code obligations - OC1.6 in the EirGrid Grid Code and OC1.5 in the SONI Grid Code.

- In our scheduling process we develop plans that schedule sufficient generation to meet our demand forecast.

Renewables Forecast – (1/2)

System Operators

- Demand and Renewables Forecasts
- System Constraints
- System Service Requirements
- Interconnector Technical Data
- Prices and Volumes for Cross-Zonal Actions
- Real-Time System Conditions

Renewables Forecast

- We procure wind power forecasts from two forecast providers. These forecasts include the forecast power output from each wind farm greater than or equal to 5 MW along with the total aggregate forecast power production and an uncertainty of the aggregate power forecast. Standing data, such as location, turbine number, type and model and hub height, for each wind farm is provided to the wind forecast providers. In addition, meteorological measurements and SCADA from each site (where available) are sent to the providers on an ongoing basis. This information is used by the wind forecast providers to develop and train models for each wind farm. Numerical Weather Predication models along with the developed wind power prediction models are then used to produce the wind power forecasts.

- Wind forecasts do not include curtailment forecast as these are only implemented in real-time operation. The forecast providers are supplied with wind farm outages information where these are available.

Renewables Forecast – (2/2)

- Each forecast provider provides us with a forecast every 6 hours, at 15 minute resolution with a time horizon of 120 hours. We then merge these forecasts, blend them with current wind conditions on a continuous basis and interpolate to a 1 minute resolution for use in the scheduling and dispatch process.

- Note that while wind participants may submit PNs representing their forecast production, these are not used in the scheduling and dispatch process. Rather we develop schedules that utilise our own forecast of renewables. This approach is driven by the Priority Dispatch categorisation of renewable generation.

- The impact of solar generation is becoming increasingly significant on the operation of the power system so we are currently developing our forecasting capability in this area. We will provide updates on this development as appropriate.

Constraints – (1/2)

System Operators

- Demand and Renewables Forecasts
- System Constraints
- System Service Requirements
- Interconnector Technical Data
- Prices and Volumes for Cross-Zonal Actions
- Real-Time System Conditions

Constraints

- Constraints impose limits on the physical operation of units in order to maintain operational security requirements under normal and contingency (failure of an item of equipment, e.g. transmission line or unit) conditions. An illustration of some of the constraints on the Ireland and Northern Ireland power system is provided (see figure 5).

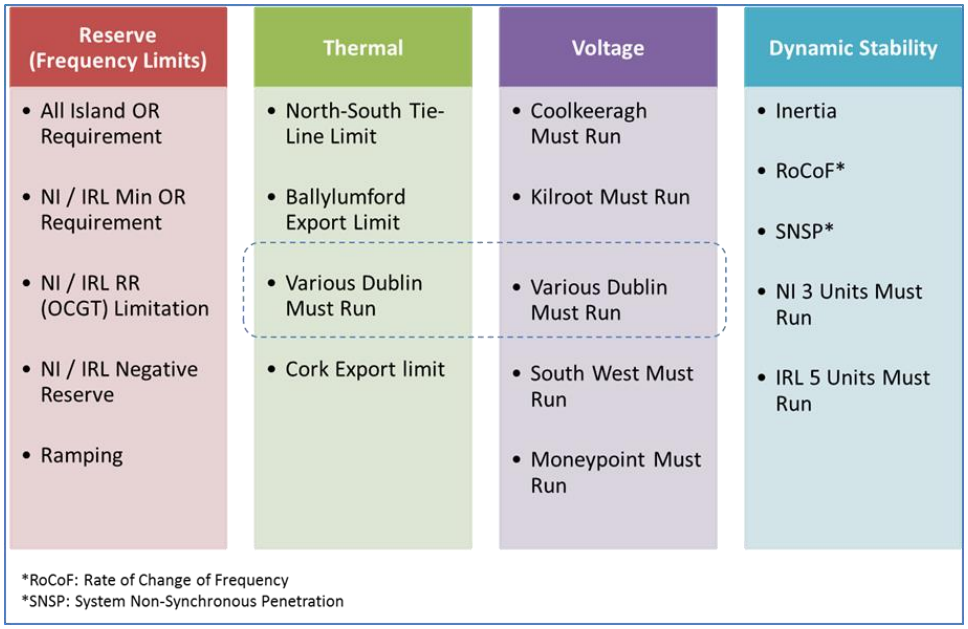

Figure 5 Illustration of Power System Constraints

Constraints – (2/2)

- In real-time operation of the power system there is a need to respond to forced outages or unexpected constraints as it is not possible for all scenarios to be covered in the weekly look-ahead analysis. We perform security analysis every five minutes which considers circuit loadings, system voltages and transient stability for a range of contingencies. This real-time analysis runs in parallel with the scheduling and dispatch and may result in constraints arising that are not reflected in the schedules.

- Constraints may also arise on distribution network connected units. Where such constraints impact on the our ability to dispatch/control units, the relevant DSO/DNO will inform us so that the constraint is reflected in the scheduling and dispatch process.

- Participants' PNs are not required to respect these constraints (only the physical constraints of the units themselves) so a key aspect of the scheduling and dispatch process is the application of these constraints to the PNs to produce a schedule and dispatch that is physically secure. Constraints modelled in the scheduling tools also form a key input to the Imbalance Pricing process through the setting of System Operator Flags.

System Service Requirements

System Operators

- Demand and Renewables Forecasts
- System Constraints
- System Service Requirements
- Interconnector Technical Data
- Prices and Volumes for Cross-Zonal Actions
- Real-Time System Conditions

System Service Requirements

- The provision of System Services (such as operating reserves and reactive power) from service providers is required to support the secure operation of the power system. We specify the requirement for System Services in a number of ways:
  I. 'must run' requirements to support the provision of reactive power from units in particular locations on the power system,
  II. relatively static system requirements such as the minimum system inertia level,
  III. dynamic requirements for operating reserves which are a percentage of the Largest System Infeed (LSI) on the system.

- We publish requirements for the System Services modelled in the scheduling and dispatch process in our Operational Constraints Update.

Interconnector Technical Data

System Operators

- Demand and Renewables Forecasts
- System Constraints
- System Service Requirements
- Interconnector Technical Data
- Prices and Volumes for Cross-Zonal Actions
- Real-Time System Conditions

Interconnector Technical Data

- The ability to transfer power over the interconnectors is a function of the capacity of the interconnectors and the capacity of the transmission systems on either side. We co-ordinate the setting of the interconnection capacities with the ICOs and GB TSO. These capacities feed into the ex-ante markets and the scheduling and dispatch process.
- We are currently developing a Cross-Zonal Capacity Calculation process for determining the interconnection capacities between the markets with the SEM and BETTA Regulatory Authorities.. This document is expected to be published prior to market trial.
- The determined capacities are provided to the ex-ante markets as the limits to allowable cross-zonal (between SEM and BETTA) exchanges of power. We also use these capacities in the scheduling and dispatch process to determine available capacity for Cross-Zonal Actions.
- We set the operational ramp rate applied to each interconnector. This is a MW/min ramp rate that is applied in the physical dispatch of each interconnector.
- The interconnectors can also provide a number of System Services. These capabilities are as agreed in the relevant System Services agreement that we have in place with the ICOs.

Prices and Volumes for Cross-Zonal Actions – (1/3)

System Operators

- Demand and Renewables Forecasts
- System Constraints
- System Service Requirements
- Interconnector Technical Data
- Prices and Volumes for Cross-Zonal Actions
- Real-Time System Conditions

Prices and Volumes for Cross-Zonal Actions

- While interconnector (Moyle and EWIC) schedules are determined by the ex-ante markets, they can, under defined circumstances, be adjusted by us through Cross-Zonal Actions. Cross-Zonal Actions is the collective name for a number of services that are available to us to reduce or increase imports or exports on the interconnectors.

- **Note**: We are currently developing the services that will be available for application under the revised SEM arrangements (subject to RA consideration). The arrangements will include the specific services that will be made available, arrangements for determining and exchanging offered energy volumes and associated prices and how such services are utilised.

Prices and Volumes for Cross-Zonal Actions – (2/3)

The table below describes the existing Cross-Zonal arrangements in place.

Cross-Zonal Action	Description
Trading Partner	We have trading arrangement in place with a BETTA trading partner that allows us to trade in the gap between closure of the existing SEM market and the BETTA market. This is the main route available to us for trading under the existing SEM arrangements. This mechanism is used for facilitating Priority Dispatch (increasing exports to GB rather than curtailing wind generation in SEM) and management of system constraints (such as reducing interconnector imports or exports to manage the interconnector as a largest system infeed or outfeed thus reducing reserve requirements).
Cross-Border Balancing – CBB	We have trading arrangements in place with the GB TSO. We exchange offers and bids for volumes of energy and prices on a daily basis however the service is only available on a rolling 1 to 2 hour timescale from real-time (post BETTA Balancing Market gate closure). Given the tighter timescales of this service and the availability of the existing Trading Partner arrangements, this CBB mechanism is not frequently used by us or the GB TSO.
Emergency Assistance - EA	We have an Emergency Assistance arrangement in place with the GB TSO. This service is an emergency service that allows either party to request emergency cross-zonal assistance from the other party. The service would be utilised during capacity shortfall scenarios. A fixed price is agreed by us in advance (although any higher CBB price would apply if the service was activated) and a fixed volume is made available.
Emergency Instruction - EI	We have an Emergency Instruction arrangement in place with the GB TSO. This service is an emergency service that allows either party to instruct a reduction in interconnector flow towards zero. The service would be utilised during an operational security event such as a circuit overloading and results in the application of a reduced Net Transfer Capacity (NTC) on the interconnector.

Note: These arrangements remain under review and are subject to change.

Prices and Volumes for Cross-Zonal Actions – (3/3)

- Any utilisation of Cross-Zonal Actions takes place after closure of the cross-zonal markets. Cross-Zonal Actions utilise spare interconnector capacity – they do not restrict the interconnector capacity offered to the markets or undo the market position of Participants.

- Depending on the arrangements ultimately developed, the prices and volumes of energy offered as part of the non-emergency actions may form an input to the scheduling and dispatch process.

Real-Time System Conditions

System Operators

- Demand and Renewables Forecasts
- System Constraints
- System Service Requirements
- Interconnector Technical Data
- Prices and Volumes for Cross-Zonal Actions
- Real-Time System Conditions

Real-Time System Conditions

- We collect information on the real-time status of the power system via our Energy Management System (EMS) and Supervisory Control and Data Acquisition (SCADA) system. This information includes:
  I. the status of transmission circuits being in or out of service,
  II. the status of units (on/off)
  III. power-flows on circuits and interconnectors
  IV. real-time demand
  V. real-time wind output
  VI. system voltages
  VII. system frequency

- Our scheduling process takes 'snapshots' of the real-time status of the power system so that the most up to date system conditions, along with forecast conditions, are modelled in our scheduling systems.

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