

The Scheduling and Dispatch Processes A Basic Guide

Introduction

Scheduling and dispatch are complex interrelated processes that are essential to the operation of the power system. This document provides an overview of how EirGrid, as Transmission System Operator (TSO), manages these important processes and also identifies a range of useful publications available on EirGrid's website that are related to the scheduling and dispatch processes. Since the Single Electricity Market (SEM) was established, EirGrid and SONI (System Operator Northern Ireland) work in collaboration to schedule and dispatch generation plant.

Transmission System Operation

Electricity demand must be met by generating the exact amount required at any point in time. The responsibility for maintaining this balance between demand and supply is managed in real-time by EirGrid. Electricity is generated at a number of large power stations located at various geographical points around the country as well as at wind farms and other smaller facilities. Electricity, generated in bulk, is transported around the country on the high voltage transmission network to the main load centres such as cities and large towns as well as to large industrial sites. EirGrid has a duty to operate the power system in a safe, secure and economic manner for the benefit of all consumers.¹ The terms "Safe," "Secure" and "Economic" have specific implications in power system operation as outlined below.

- **Safe:** The transmission system must be operated in a way that endeavours to ensure the safety of the public, those working on the system and the plant operating on the system. Managing the safe operation of the transmission system is a fundamental aspect of EirGrid's role.
- **Security:** In operating the transmission system, EirGrid makes allowances for credible unforeseen events such as the sudden trip of a large generation unit or an item of transmission plant (a line, cable or transformer). EirGrid operates the transmission system in a way that after such an event the transmission system remains stable and

¹ Primary responsibility for dispatch and scheduling rests with EirGrid and the System Operator of Northern Ireland (SONI) as the TSOs on the island.

customers suffer no interruption to their power supply. Security of the demand/supply balance is usually maintained by carrying reserves of available power on the system. Maintaining reserve for example involves running plant below its full capacity or running additional generation than would otherwise have been scheduled in order to cater for an unplanned trip of a large generation unit. Security of the transmission system is monitored using sophisticated and powerful software tools that analyse the system in real-time and alert operators to potential risks of overloading transmission equipment or operating outside normal voltage standards. Operators can then either change the output of the generation units on a geographical basis or reconfigure the transmission network to eliminate or mitigate these risks. Security of supply is an essential element of a reliable electricity network.

- Economic: The transmission system is operated in an economic manner at all times. A unit commitment programme is run several times a day with up-to-date information to help ensure the system is operated economically. Generators bid in prices and the unit commitment programme produces an indicative schedule based on this. Optimal use of the tie-line (flow between EirGrid and SONI) and the reserve requirements for the island are taken into account in the unit commitment programme to provide least cost output. The indicative schedule ensures that there are sufficient generation resources committed to meet forecasted system demand at minimum production costs. Certain constraint costs are inevitable (e.g. reserve) but EirGrid seeks to minimise these by ongoing monitoring of the transmission system. It is important to note that the Regulatory Authorities (RAs) and the Market Monitoring Unit (MMU) for the Single Electricity Market (SEM) monitor and review constraints expenditure and the underlying rationale for dispatch decisions.

Operating the Transmission System

Since the introduction of the Single Energy Market (SEM) in November 2007, the generation of power on the island of Ireland has been scheduled and dispatched based on bids provided by conventional generators, Moyle interconnector capacity holders, demand side load blocks and the priority dispatch 'must-run' principle. EirGrid in association with SONI is charged with the scheduling (in advance) and dispatch (in real-time) of electricity on the transmission system.

Scheduling Process

Scheduling is the assignment of generation to meet anticipated demand. EirGrid and SONI have a duty to ensure that enough generation is scheduled to meet reliability requirements and therefore must coordinate generation schedules accordingly. Scheduling is performed on a daily basis by experienced power system engineers with the assistance of sophisticated unit commitment software tools. Information is co-ordinated between EirGrid and SONI and results in an indicative schedule of anticipated output per generator. The indicative schedule details the discrete MW set point for each generating unit at 30 minute intervals over a 30 hour time horizon starting at 06:00. This schedule takes into account reserve scheduling and the DC Moyle interconnector between Northern Ireland and Scotland.

Dispatch Process

Dispatch is the refinement of the scheduling process and relates to the real-time control of all generation and transmission resources that are being used and/or are available to meet demand requirements. The dispatch process recognises the operational priorities of safety, security and economy. Dispatch aims to match demand with generation on a second by second basis, whilst maintaining tie-line flow schedules and adequate levels of operating reserve. The dispatch process also manages real-time fluctuations in system demand and the output of generators and system disturbances such as generation trips or transmission contingencies. Both System Operators use the bids and offers submitted by the generators for that day as the basis for optimising the dispatch.

Operational Timeline

For clarity, it is useful to simplify the scheduling and dispatch processes across an annual timeline; however, it is important not to draw a sharp line of distinction between these separate but interrelated stages:

- Long -Term Operational Planning and Scheduling (from one year to one month/week ahead).
- Short -Term Operational Planning and Scheduling (from one week to one day ahead).
- Near to Real -Time Systems Operation (from hours ahead to real-time).

Long-Term Operational Planning and Scheduling

EirGrid develops coordinated transmission and generation outage plans which are consistent with the requirements for the safe, secure and economic operation of the system and the needs of generators in respect of plant maintenance requirements and resource limitations. The generation and transmission outage programmes coordinate generator requests, annual maintenance and transmission outage considerations. Co-ordination of all these factors ensures transmission and generation outages are timed in such a manner as to ensure security of supply (adequate reserve margins) while minimizing constraint costs. The transmission and generation outage programmes are published at the start of the year. These are subject to change depending on resourcing, forced outages, overruns and other events. Every effort is made to accommodate requests for outages from stakeholders, where due to system conditions it is not possible to facilitate the requested outage EirGrid works with the specific stakeholder to find a workable alternative.

Short-Term Operational Planning and Scheduling

Operational planning for short-term scheduled outages takes account of current conditions.

A number of factors which affect generation scheduling are known from up to a week ahead and can be used to schedule plant. These factors include:

- System Demand - Load Forecast can be estimated up to a week ahead, but weather conditions in real-time can increase or decrease system demand.
- Reserve Requirements - There is a requirement on the system to have a certain amount of primary and secondary reserve to maintain system security in the event of a generator trip.
- Wind – It can be difficult to accurately forecast wind more than a day ahead. Predictions are often subject to inaccuracies right up to real-time as weather conditions change.
- Hydro Energy Limits - Are forecast up to a day ahead and are unlikely to change in real-time.

- Tie-line Limits – These are the physical limits on the amount of power and operating reserve that can flow North to South and vice-versa. It can be affected by transmission outages and generator availability.
- Generation Constraints - Generation constraints could arise for a number of reasons, for example:
 - Transmission Restrictions – Generation may have to be constrained on or off during particular periods (e.g. during the outage of a specific transmission line) to prevent circuit overloads and/or support transmission network voltage.
 - Operating Reserve – In order to cater for the sudden loss of a large generating unit, operating reserves are carried on generators so that they can quickly increase their output to replace the lost generation and mitigate the risk of load shedding. In order to achieve this, generators may be constrained down below their maximum output capability or generators may be constrained on to provide a quick acting source of reserve.

An indicative schedule is created taking account of the above factors. It is published at 16:00 hours for the following day and again at 01:00 hours on the day in question.

Real -Time Transmission System Operation

Real-time operation of the transmission system includes dispatching plant to meet system demand on an instantaneous basis. Even with an accurate indicative schedule, changes in system demand, wind and generator availability will mean that this indicative schedule and actual real-time dispatch will vary. Real-time operation of the power system is controlled in the National Control Centre (NCC). Experienced engineers in the NCC use the indicative schedule along with the submitted bids and generator technical data in dispatching the system. The instructions to generators are issued through a software tool EDIL (Electronic Dispatch Instruction Logger). Each generator can declare its availability through this tool and accept dispatch instructions from the National Control Centre.

To help operators make the optimal decision on the actual dispatch and scheduling of plant, the TSOs employ a number of support tools, including the Reserve Constrained Unit Commitment (RCUC) model, the State Estimator, Contingency Analysis models and Wind Forecasting models. Together these tools and predictive models provide a range of commercial and technical information about the power system, all of which helps the system engineer make efficient and cost-effective decisions regarding the scheduling and dispatch of plant. Some of this information, such as the data collected from the RCUC, feeds into the Indicative Operating Schedule produced by the TSOs, and is available on the SEMO website. It is important to note that neither RCUC nor the Indicative Operating Schedule influence the setting of market prices or market schedules.

Conclusion

Scheduling and dispatch are interrelated processes that are fundamental to maintaining the demand/supply balance and keeping the transmission system operating in a Safe, Secure and Economic manner. Scheduling is the assignment of generation to meet anticipated demand, while dispatch relates to the real-time control of all generation and transmission resources that are being used and/or are available to meet demand. Decisions regarding the actual scheduling and dispatch of plant are taken by experienced power system engineers who are supported in this task by a range of sophisticated operating tools and software applications. EirGrid and SONI work in collaboration to schedule and dispatch plant on an all-island basis.

The appendix contains a list of useful publications available on EirGrid's and SEMO's websites that are important to scheduling and dispatch.

Appendix

With the information below stakeholders can view for themselves the relevant TSO procedures relating to both dispatch and scheduling over different time periods.

General Publications

The Grid Code

The Grid Code is crucial to the smooth operation of the transmission system. This document details the rules that govern the operation, maintenance and development of the transmission system and the procedures that govern the actions of all transmission system users. The document ensures that all users are treated in a transparent and equitable manner. This document is available on the EirGrid website at www.eirgrid.com under the operations tab.

Trading and Settlement Code

The market rules are governed by the Trading and Settlement Code (TSC). This document sets out the terms for the sale and purchase of wholesale electricity in the All Ireland market. The Trading and Settlement Code is available on the SEMO website at: <http://www.semo.com/marketdevelopment/pages/marketrules.aspx>

Operating Standards

The operating standards for all existing or potential users of the transmission system are set out in a number of documents which are available on the EirGrid website at www.eirgrid.com. Operating Reserve Requirements, Transmission Constraints Groups and Transmission Planning Criteria are all published. General conditions of connection and Transmission use of System are also detailed in the website.

Operating Reserve Requirements

Information pertaining to the Transmission System Operators (EirGrid and SONI) Operating Reserve Requirements is available on the website at www.eirgrid.com.

Transmission Constraint Groups (TCGs)

The Transmission System Operators (EirGrid and SONI) have developed Transmission Constraint Groups (TCGs) which model different conditions on the system. TCGs are critical to producing a realistic Day Ahead Generation Schedule. The TCGs are available on the EirGrid website at www.eirgrid.com.

Annual Publications

Transmission and Generation Outage Schedules

The outage schedules for both generation and transmission are provided by both Transmission System Operators and are available on the Single Electricity Market Operator's website under Market Publications tab. These schedules are subject to change and are updated to the market operator in April each year. The relevant SEMO internet page can be accessed through the EirGrid website at www.eirgrid.com

Demand Forecast

Demand forecasting is a fundamental aspect of the system operators remit. Forecasting both wind output and system demand accurately is central to ensuring the security and reliability of the power system for all our users. The half hour system demand forecast for both Northern Ireland and Ireland is available for the full year on the SEMO website at: <http://www.sem-o.com/Pages/default.aspx>. This demand forecast is used in the determination of the Fixed Capacity Weighting Factor for each half hour in the year. The demand forecast is updated annually.

Transmission System Performance Report

Each year EirGrid publishes the Transmission System Performance Report. This details the transmission system performance from the previous year and has key metrics and statistics including line availabilities forced and faulted, and any new connections and new connection offers. This information is available at: www.eirgrid.com in the publications section.

Winter Outlook

The Winter Outlook report examines the capacity of the generation portfolio available to EirGrid to meet peak demands during the winter period. The report offers stakeholders a useful examination of demand, capacity and performance of generation and the available import capacity from Northern Ireland during the winter period. The report is available at www.eirgrid.com in the publications section

Monthly Publications

Monthly Availability Report

EirGrid publishes a report on the availability performance of generators the previous month. This report indicates, in aggregate, the availability performance of the system on a 52 week rolling basis, the actual availability, both scheduled and forced of each unit the previous month and a 3 month outlook of expected availability. This information is available at: www.eirgrid.com under the system performance data tab.

Demand forecast

The half hour system demand forecast for both Northern Ireland and Ireland is available for the full month ahead on the SEMO website: <http://www.sem-o.com/Pages/default.aspx>

Generator Maintenance Schedules

The month ahead a generator maintenance schedule for both Northern Ireland and Ireland is on the SEMO website. This publication is updated monthly and is available at: <http://www.sem-o.com/Publications/Pages/GeneralPublications.aspx>

EirGrid Monthly Electricity Statistics Update

EirGrid publishes Monthly Electricity Statistics detailing electricity demand growth which are available on the EirGrid website at www.eirgrid.com under the Operations tab.

Transmission Outage Schedules

The TSO publishes by one working day before the start of each month, a transmission outage schedule for a two month period. The Transmission Outage Schedules can be found on the SEMO website at: <http://www.sem-o.com/Publications/Pages/GeneralPublications.aspx>

Weekly Publications

Weekly Peak Demand

The Weekly Peak System Demand is the maximum system demand recorded in any week. The Weekly Peak System Demand used in this display is the electricity production required to meet national electricity consumption, including system losses and generators' requirements. It includes power imported via the interconnector and an estimate of the power produced by wind generators, but excludes some non-centrally monitored generation. This information is available at: www.eirgrid.com under the system performance data tab.

Data Publication Report

An excel spreadsheet is available on the SEMO website (on the SEMO website <http://www.sem-o.com/marketdata/Pages/PricingAndScheduling.aspx>) generators in the SEM. This contains all commercial and technical offer data, half hourly metered energy, dispatch, availability profile and market schedule quantities. There is sufficient data to determine which units were constrained up or down, by how much and what the constraint cost. In addition, this spreadsheet contains the ex-ante and ex-post initial system marginal and shadow prices. The shadow prices, combined with the commercial offer data, can be used to determine the uplift and unit setting the marginal price.

Daily Publications

SEMO Public Website Daily Information

The SEMO website <http://www.sem-o.com/pages/default.aspx> produces information in XML format each day. This data covers a wide range of business requirements, including information in assisting the dispatch and scheduling process. The following relevant information is available on the EirGrid and SEMO websites:

Indicative Actual Operating Schedules

The forecasted output levels of units operating in the SEM based on the Reserve Constrained Unit Commitment application when it was run at 01:00 hours for the trading day in question. It is published in XML format at 16:00 hours every day ex-post.

Interconnector

The available transfer capacity of the Moyle interconnector, the individual interconnector user's modified nominations after gate closure and any SO-SO trades performed between Northern Ireland and Scotland.

Generator Information

The actual Dispatch Instructions issued to the generators, their half hour metered quantities and all their commercial and technical offer data.

Forecasts

A four day rolling half hourly system demand profile for both jurisdictions is available at 9:30 hours each day. A two day rolling half hourly wind forecast for both jurisdictions is available at 09:30 hours.

Actual Wind and Demand

The EirGrid website carries on its home page (www.eirgrid.com) updated graphs of the load profile and wind and is updated in real-time.

Information Specific to Individual Market Participants and Generating Units

Operational Schedules

Through the market participant interface (MPI) each generating company can see their own indicative operating schedule on a half hour basis for 24 hours. This is updated at 16:00 hours and 01:00 hours each day. The schedule is the outcome of the Reserve Constrained Unit Commitment (RCUC). This uses the technical and commercial offer data submitted into the market, forecasts of wind and load, updated with real-time information, combined with system wide reserve requirements and additional mathematical constraints, known as Transmission Constraint Groups (TCG). In addition, each control centre issues operational schedules for the large generators by email. In the Republic of Ireland this is primarily used to assist generators in managing their gas position. These emails are based on the RCUC outputs. This service is provided to generators as some of them have an intermediary acting on their behalf in the SEM.

Electronic Dispatch Instruction Logger (EDIL)

Each dispatchable generating unit has EDIL installed. This software application contains all the technical operating characteristics and declarations for each unit. Each generation unit declares its availability and its ancillary services. The Grid Controller dispatches the generating units on this software. The Generator can then accept this instruction and changes its output based on this.

Meter Data Portal

Through the Meter Data Portal, EirGrid offers generation units' access to Validated and Un-Validated information in 15 minute intervals. The Validated data meter information represents Net Exported Meter Data in 15 minute intervals and is used for settlement purposes in SEMO. The Un-Validated meter data information represents meter data in 15 minute intervals read directly from the generation unit's meters. This data is not used for settlements purposes