# Operations Seminar

# Managing Dispatch Balancing Costs

26th May 2011

System Operator for Northern Ireland

EirGrid

# Agenda

- Introduction
- Overview of Dispatch Balancing Costs (30 mins)
- Ongoing Management of Dispatch Balancing Costs (15 mins)
- Forecasting Dispatch Balancing Costs (15 mins)
- Q&A

# 1: Introduction

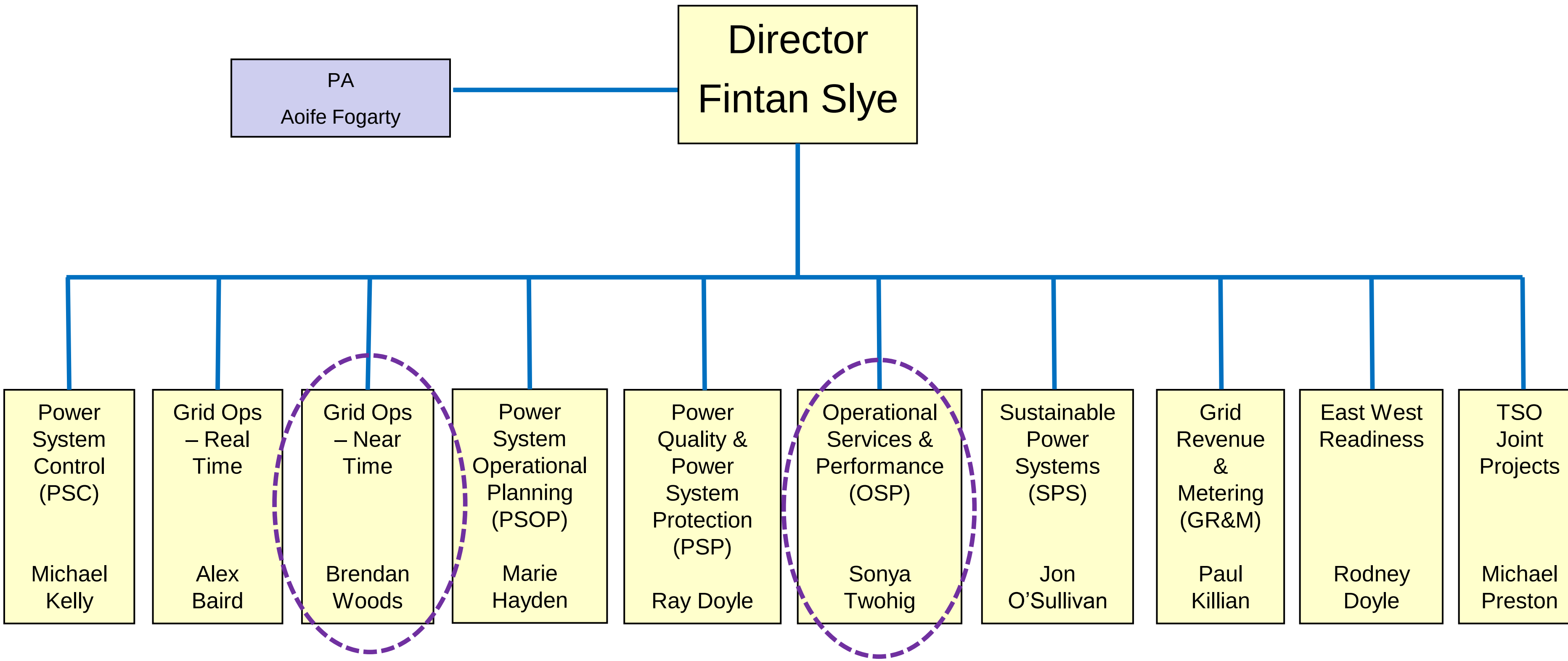
# Introduction

- Managing Dispatch Balancing Costs (DBC) is a TSO Role

- Operations: Cross TSO Function
  - EirGrid: Operational Services & Performance (OSP)
  - SONI: Near Time Operations

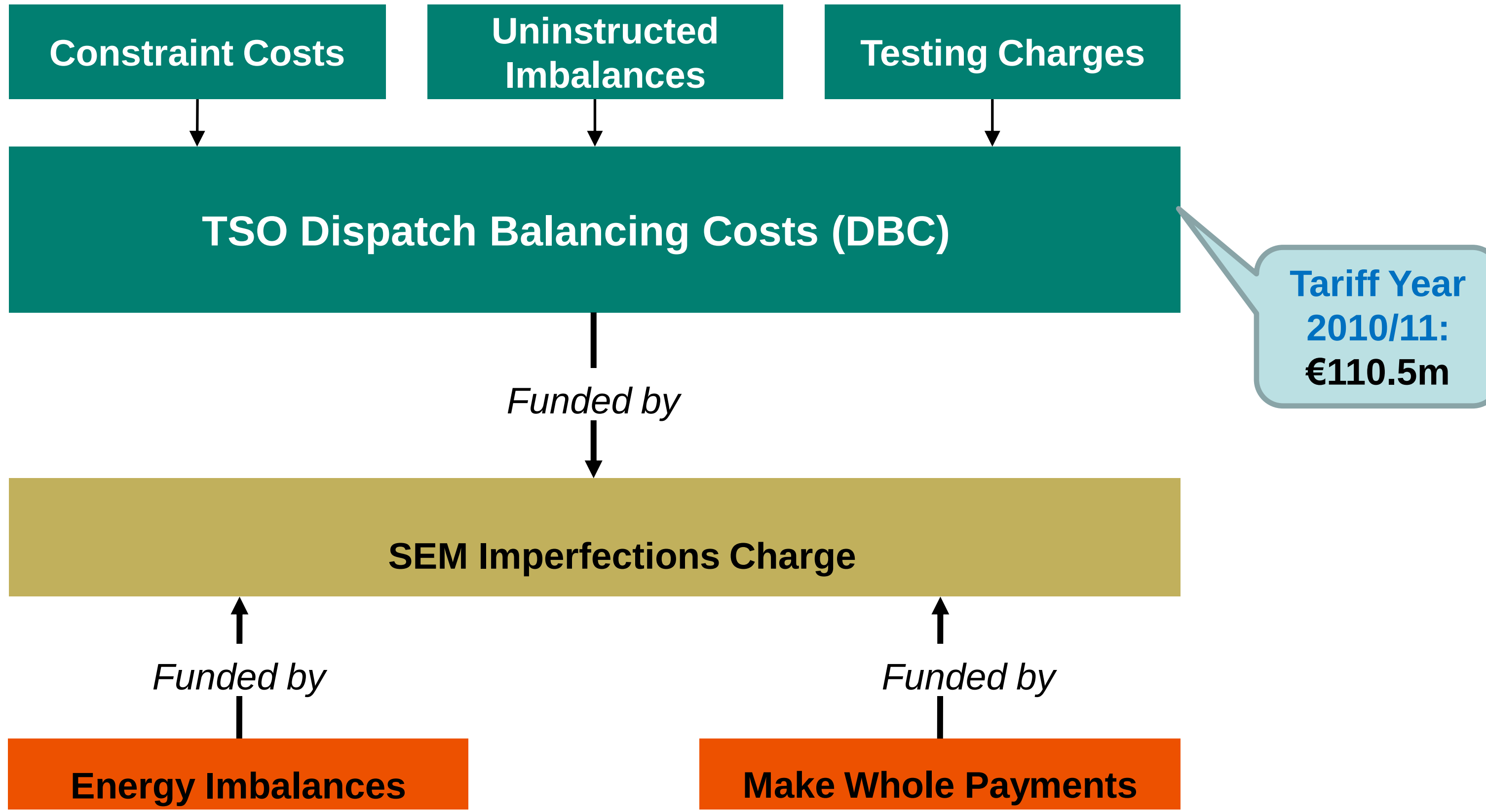
  - Significant interaction with other groups within Operations

# Operations Organisation Chart

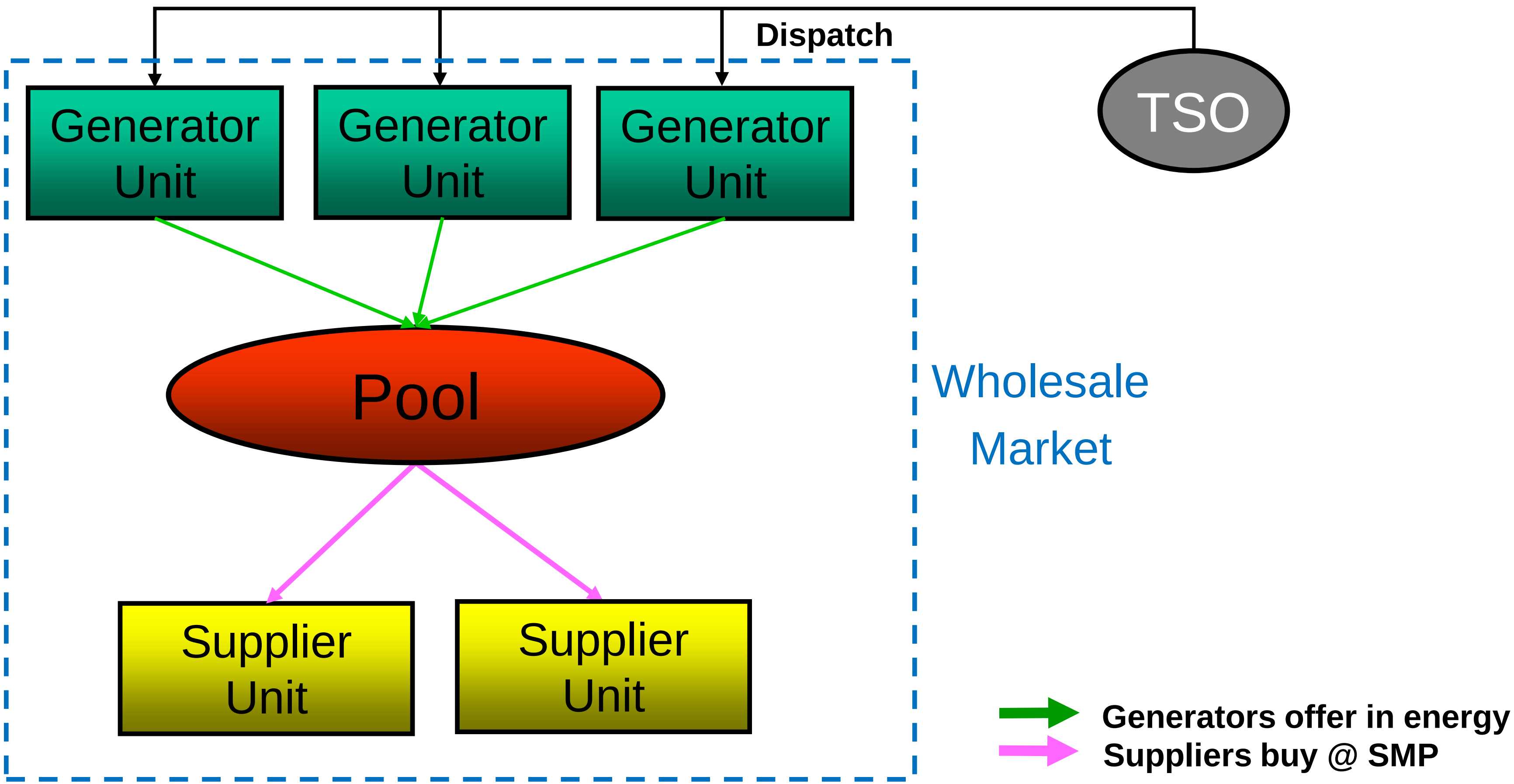


# 2: Overview of Dispatch Balancing Costs

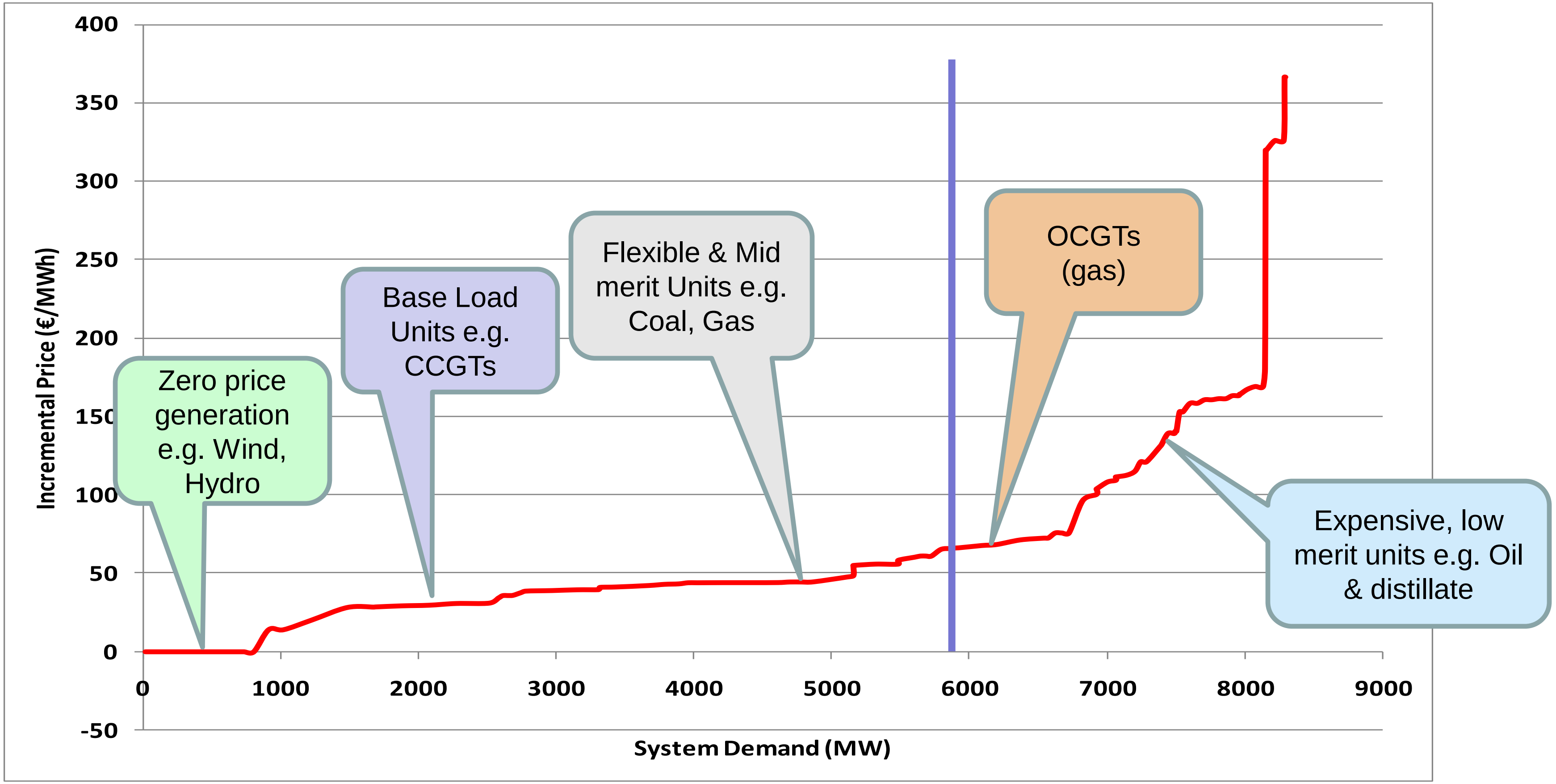
# Dispatch Balancing Costs



# SEM Structure



# Merit Order

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# SEM: Market Schedule

- Market Scheduling and Pricing (MSP) Software
  - Transmission and Security constraints not taken into account
  - Uses Generator commercial and technical data
  - Uses Generator Availabilities
- Objective: Minimise Production Costs
  - 30 hour optimisation time horizon
- Output
  - Price (SMP) for each half hour
  - Market Schedule Quantity (MSQ) for each Generator for each half hour

# Generator Payments & Charges

- Energy payments

- Constraint payments
- Uninstructed Imbalance payments
- Testing Tariffs

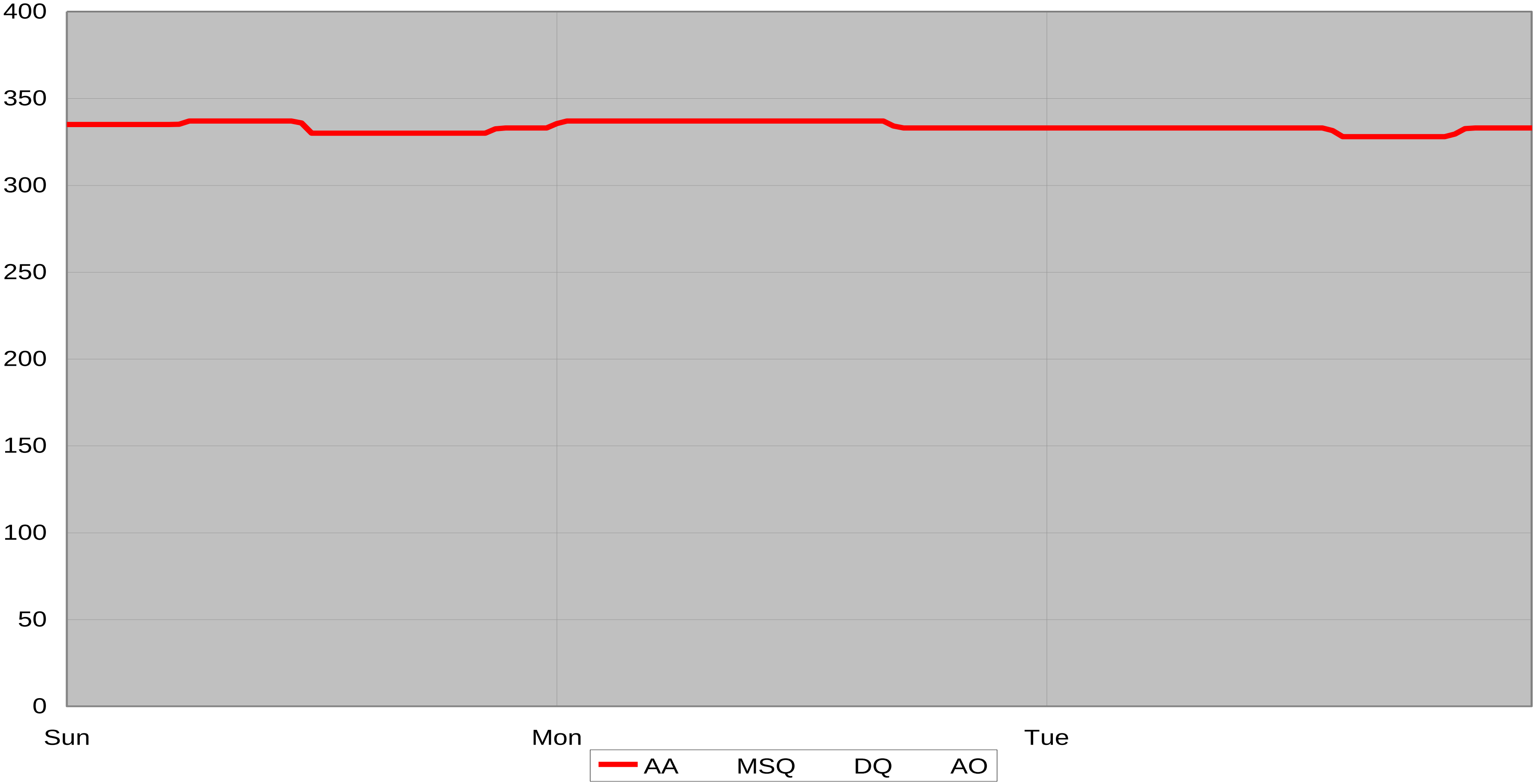
} **DBC**

- Make-Whole payments

# Energy Payments

- Energy Payments to all Generator Units based on:
  - Market Schedule Quantity (MSQ)
  - Market Price (SMP)

# Example



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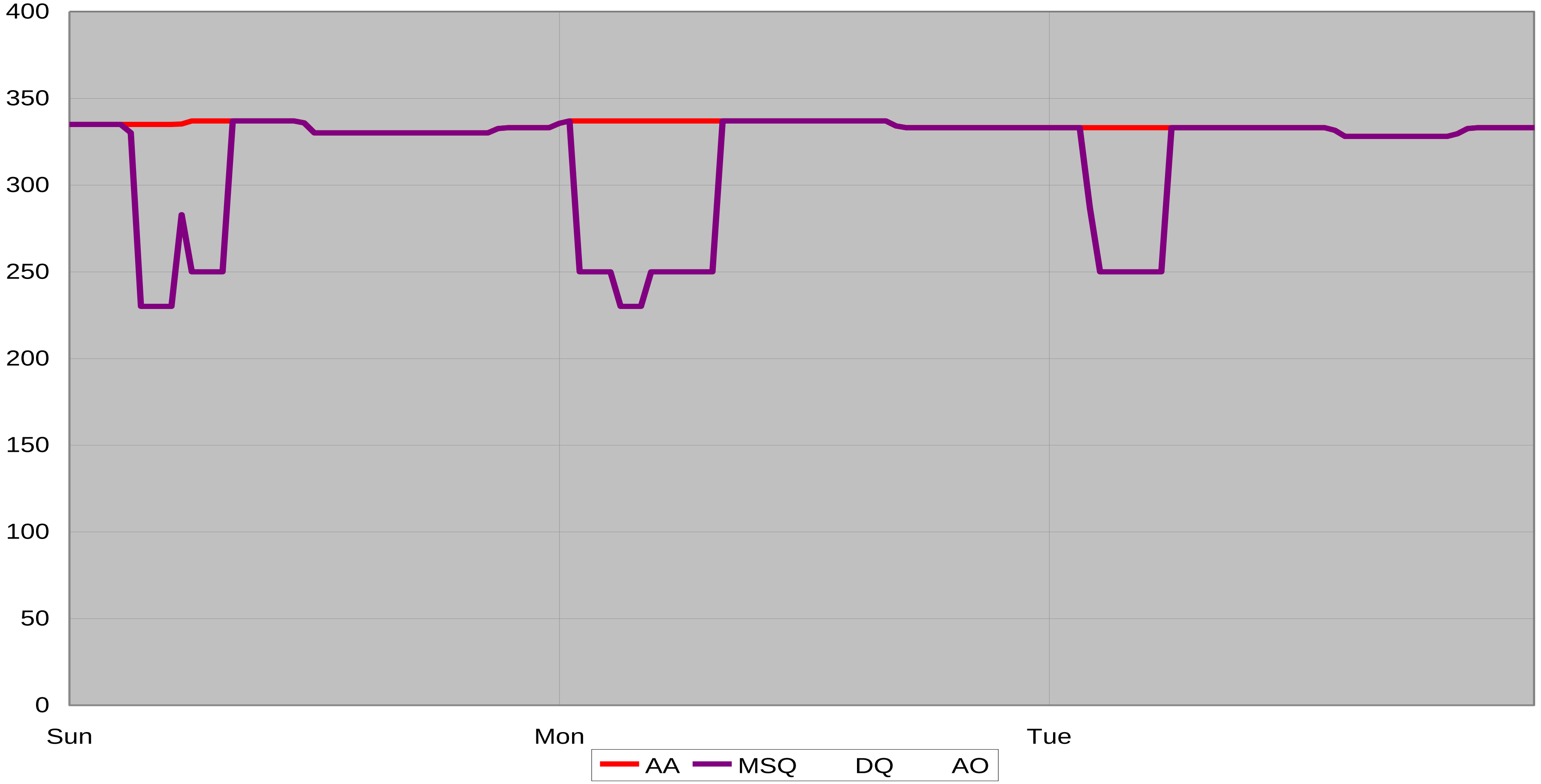
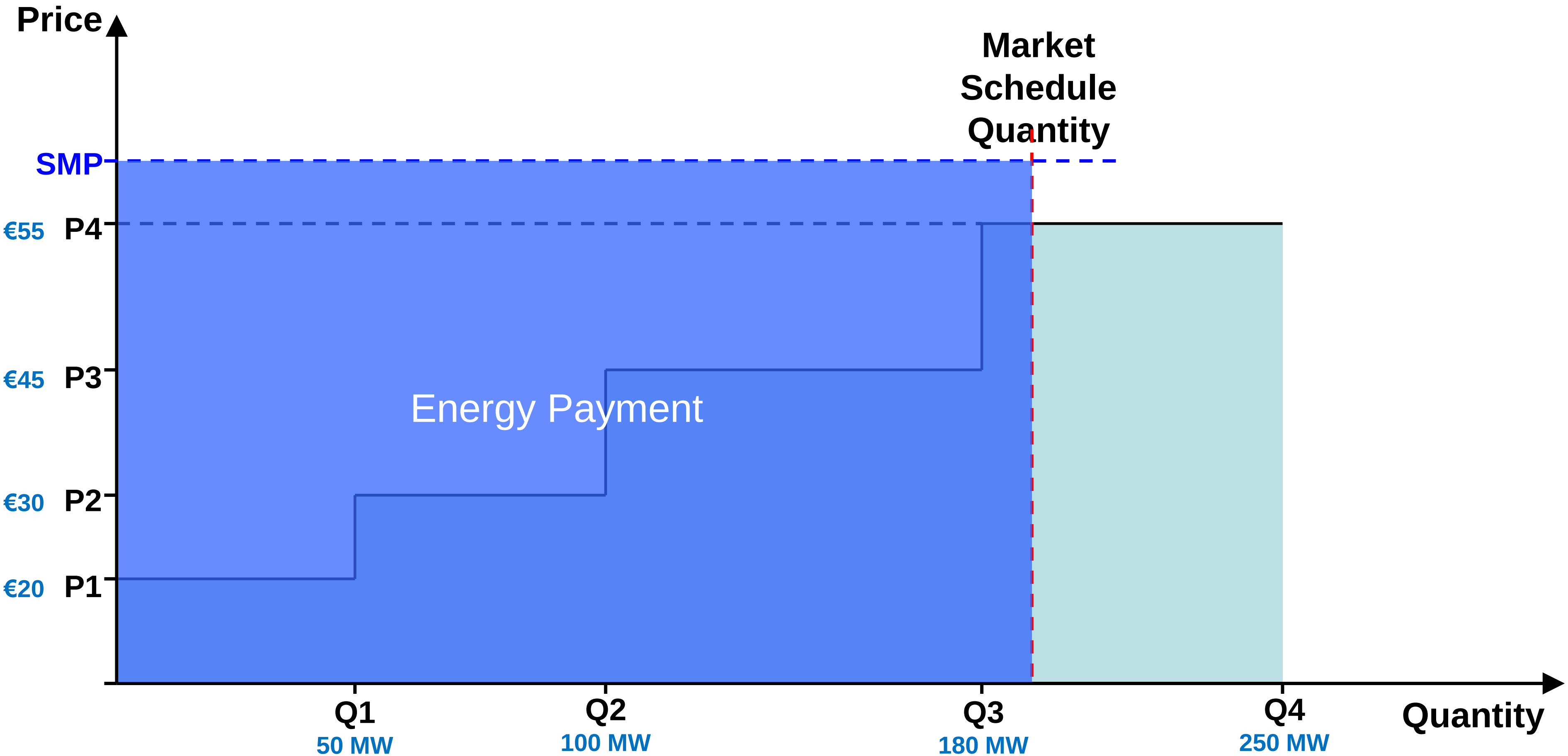
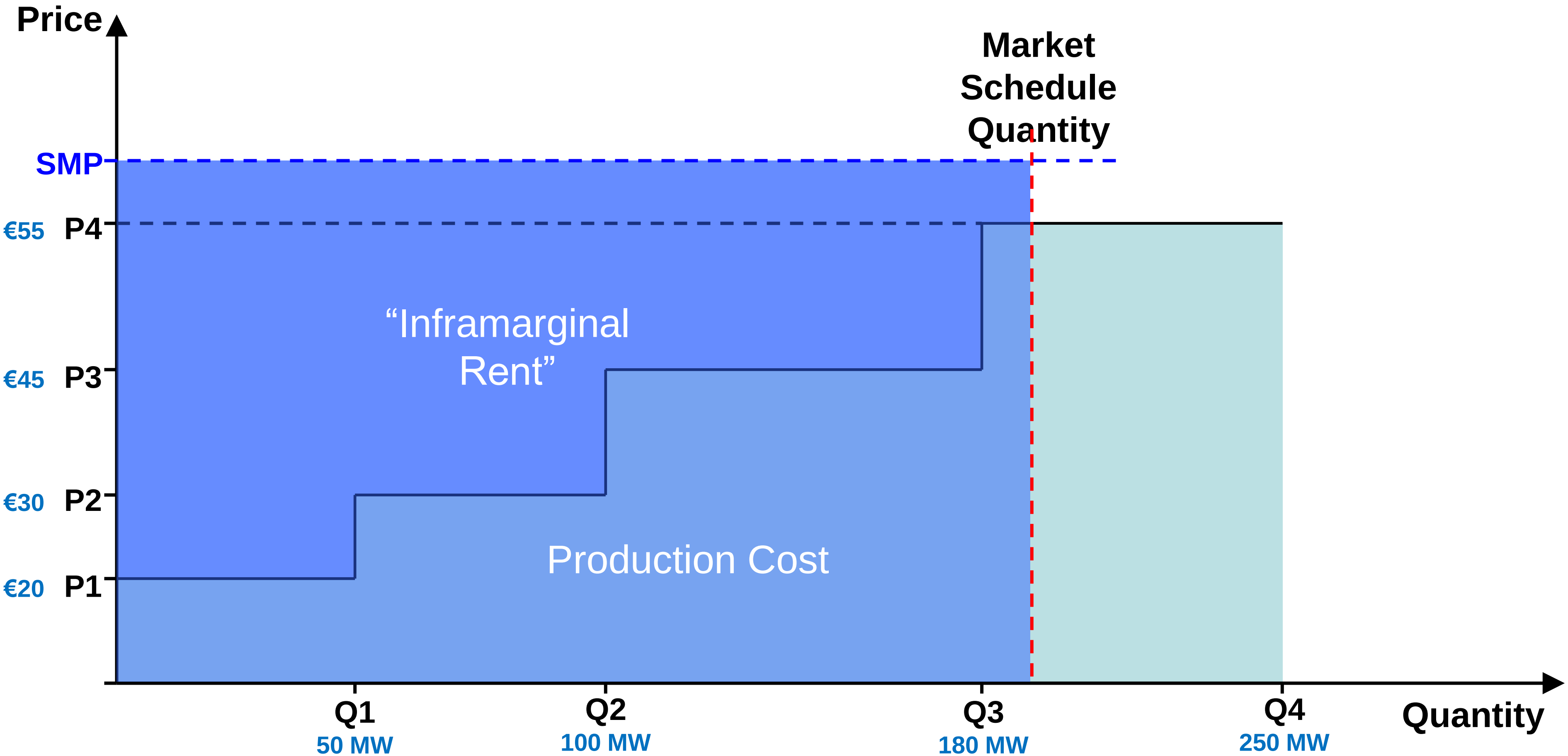


# Energy Payment



# Energy Payment



# Constraint Payments

- Apply if Market Schedule Quantity ≠ Dispatch Quantity

- T&SC calculation:

$$CONPuh = TPD \times \begin{bmatrix} (DQLFuh \times DOPuh + DNLCuh + DQCCLFuh) \\ -(MSQLFuh \times MOPuh + MNLCuh + MSQCCLFuh) \end{bmatrix} + DSUCuh - MSUCuh$$

Constraint Payment

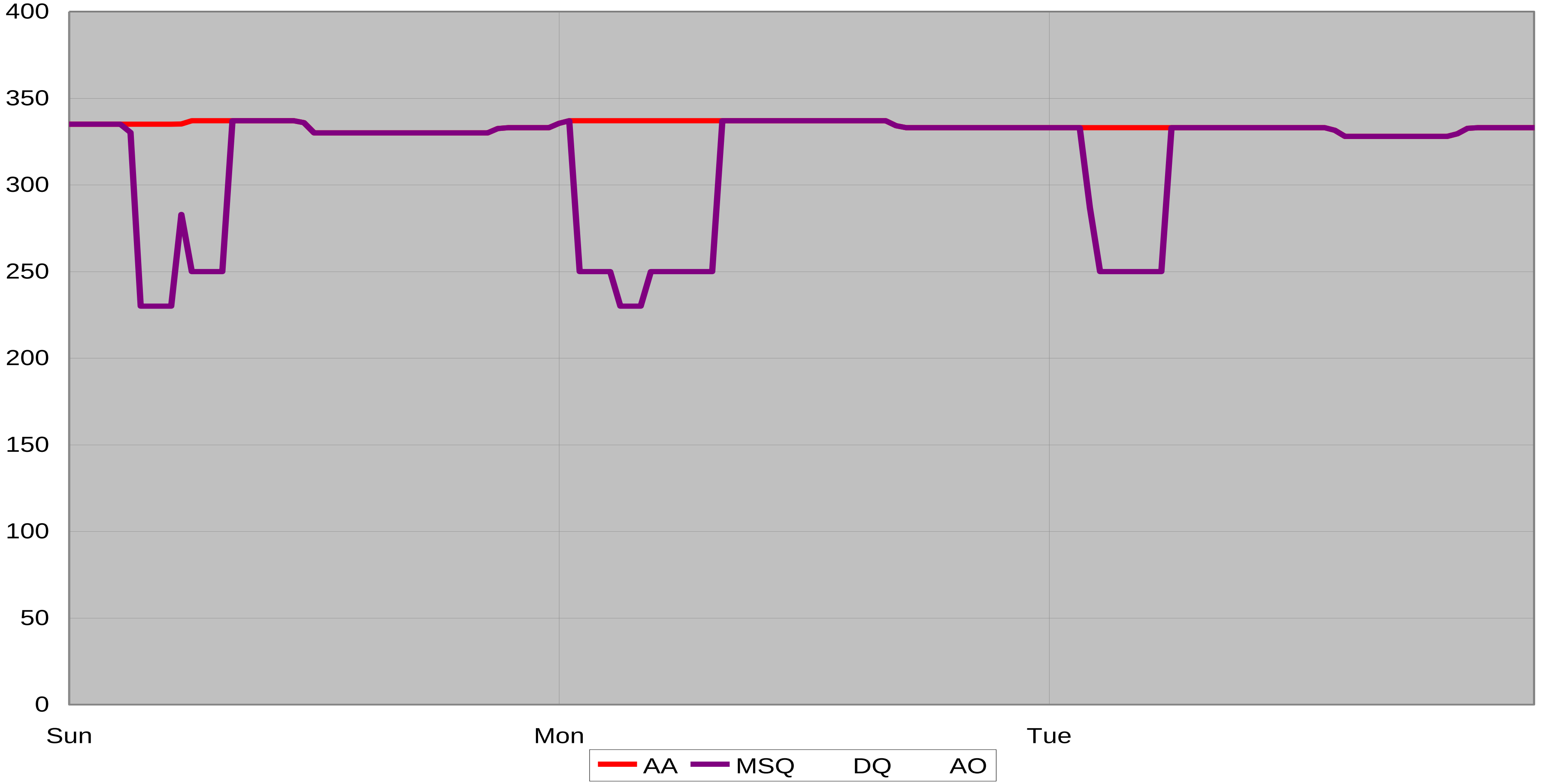
= Production Cost (Dispatch) – Production Cost (Market)

- Principle: Generators kept financially whole

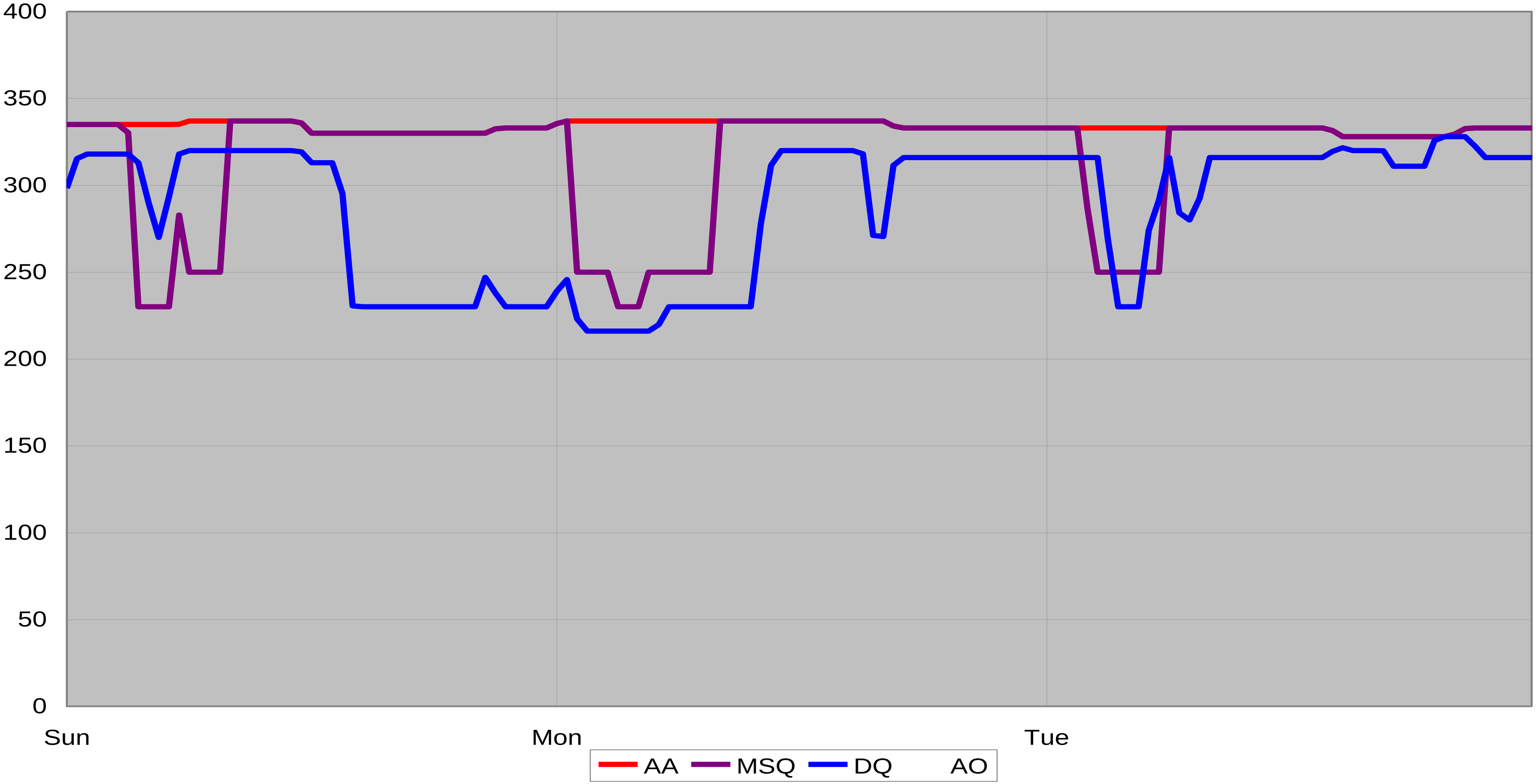
# Constraint Payments

- Constraint payments can be positive/negative
  - **If DQ > MSQ, Generator receives a payment**
  - **If DQ < MSQ, Generator makes a payment back**
- Production Cost includes:
  - incremental costs
  - start-up costs
  - idling costs
- TSOs determine dispatch

# Example



# Example

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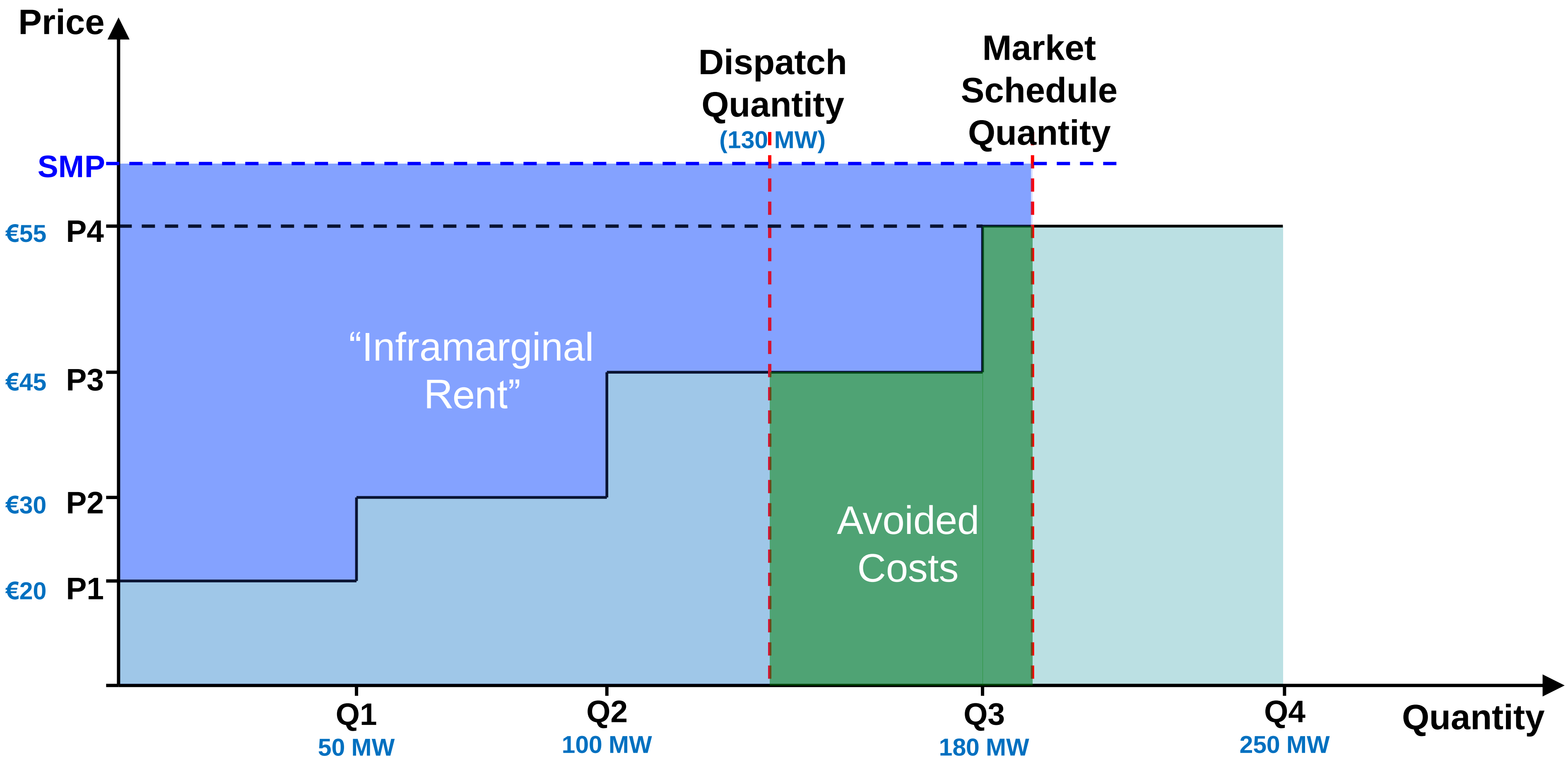
# Constraint Payments



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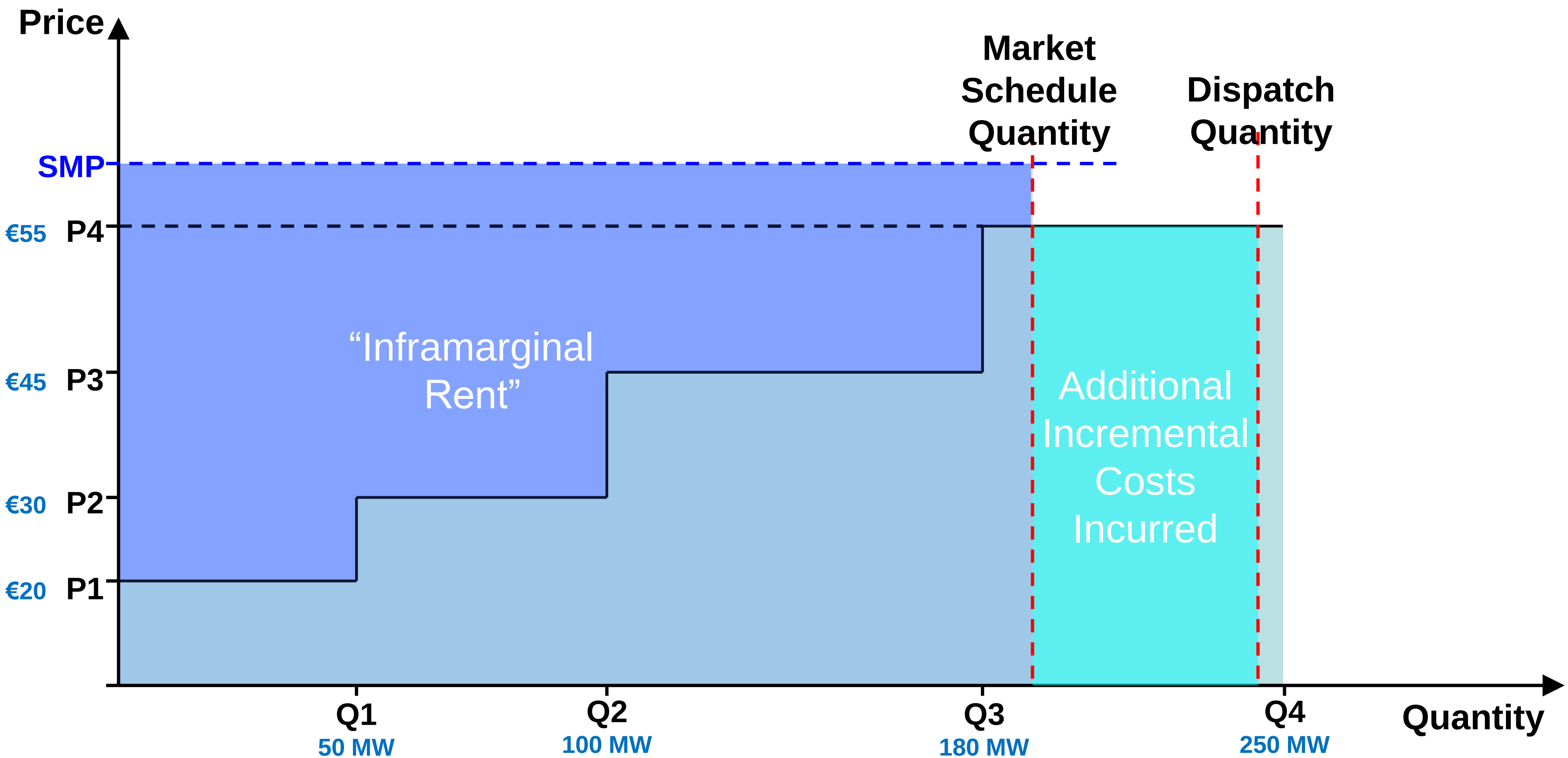


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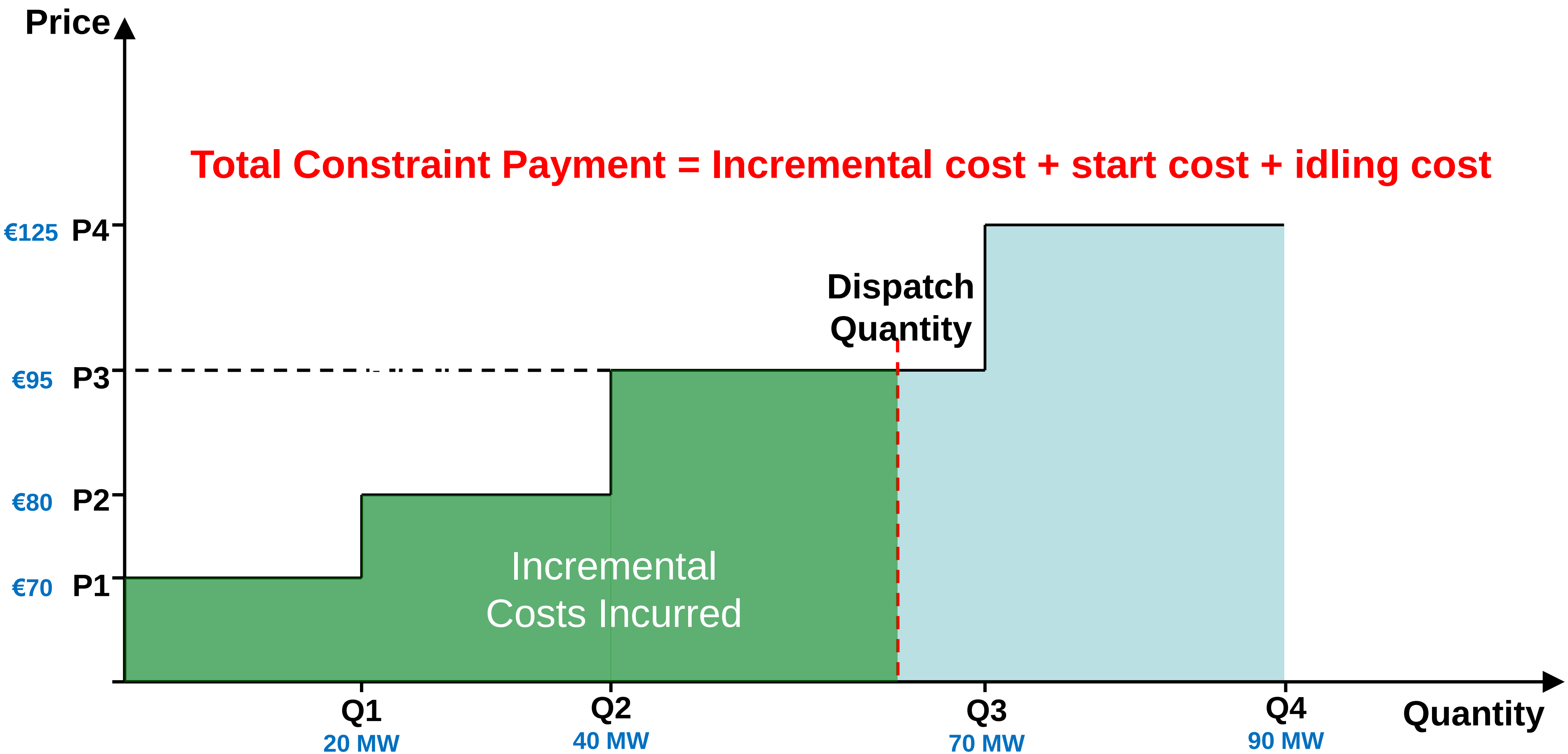
# Constraint Payments

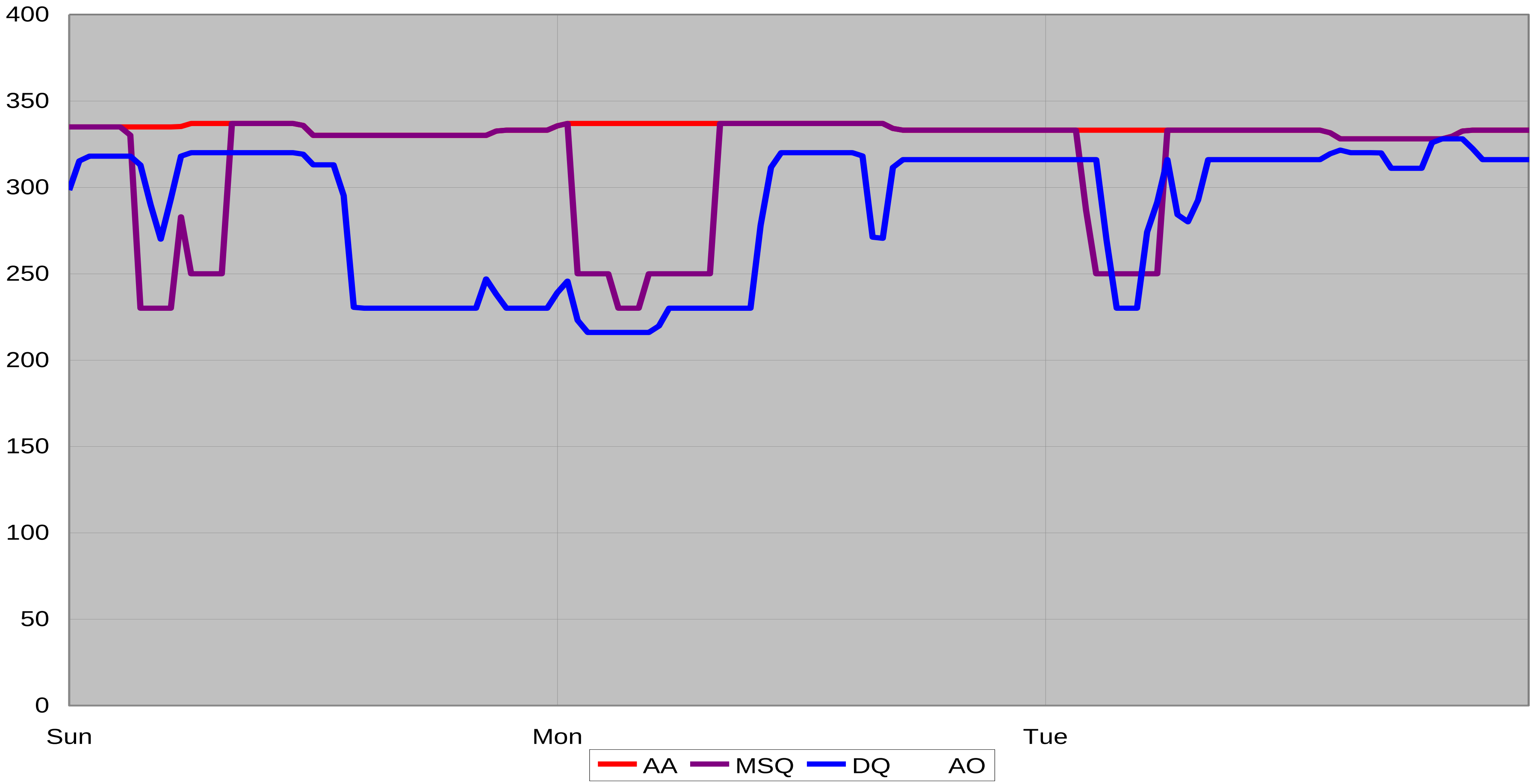


# Uninstructed Imbalance Payments

- Uninstructed Imbalance Payments apply if Actual Output differs from Dispatch Quantity

- Tolerance bands set annually
  - Take actual system frequency into account, thus allowing for regulation
  - Within tolerance band:
    - Uninstructed Imbalance Payments based on Imbalance amount
  - Outside tolerance band:
    - Uninstructed Imbalance Payments based on Imbalance amount with an additional factor included

# Example

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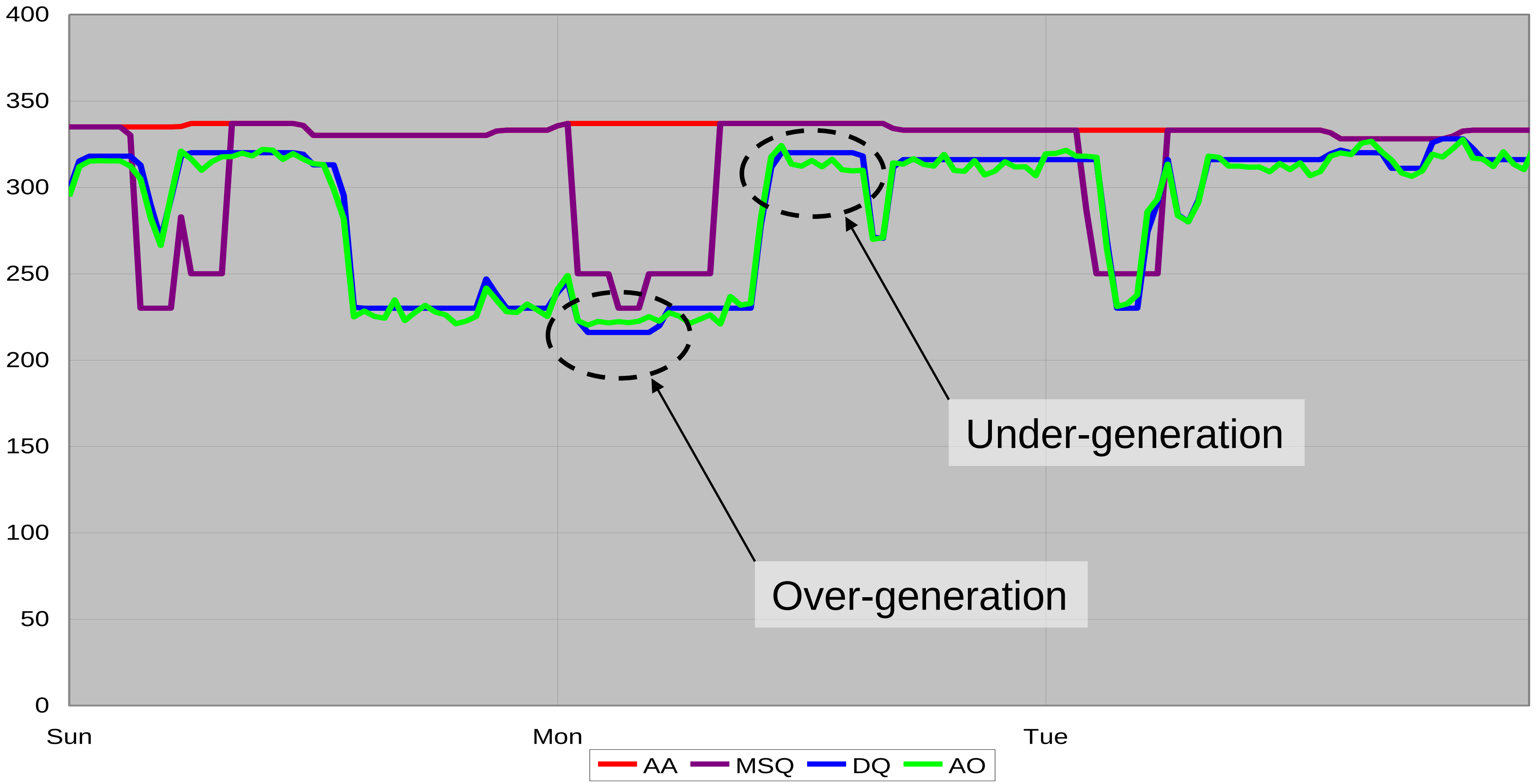
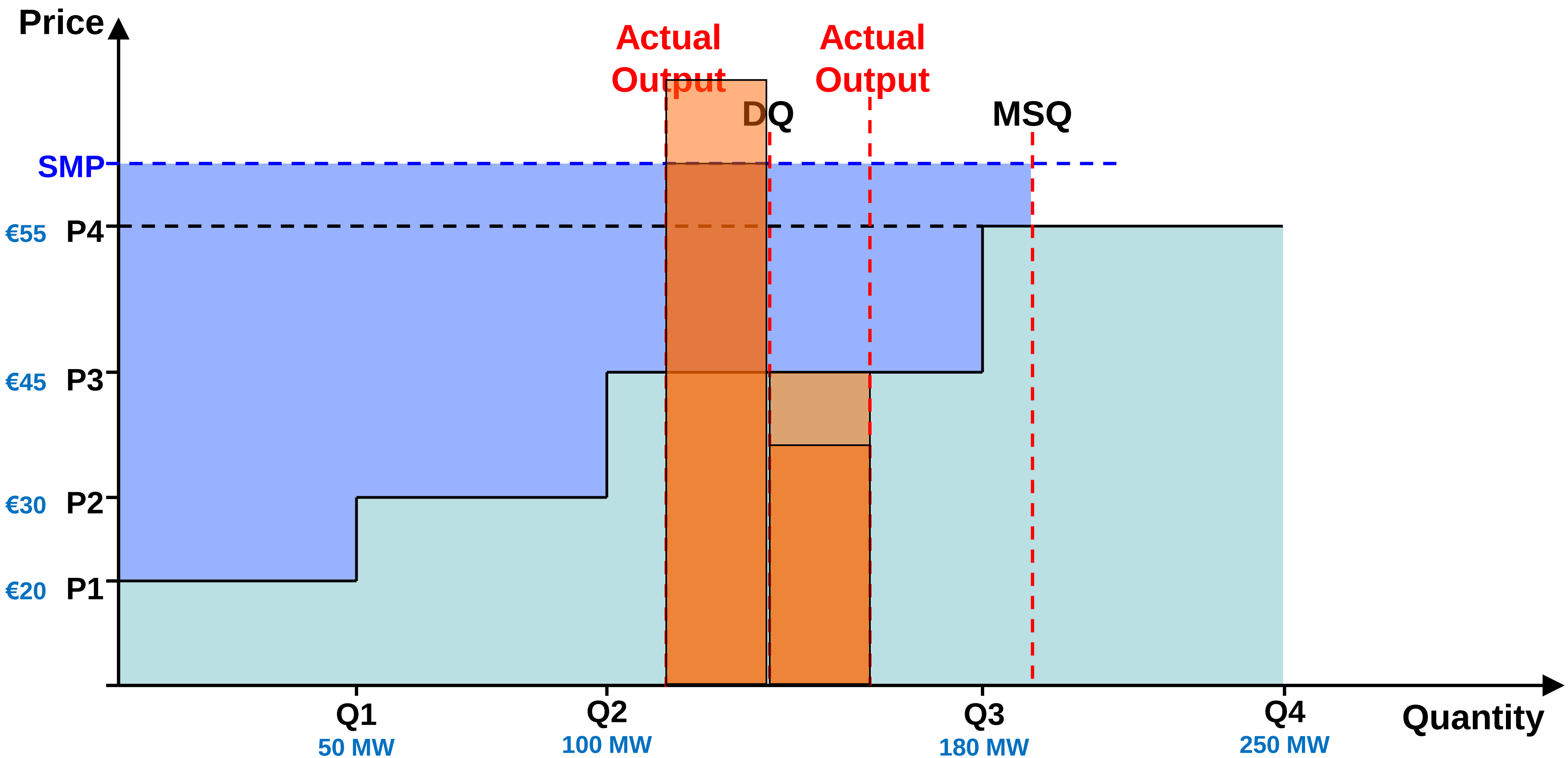
# Example


400
350
300
250
200
150
100
50
0
Sun
Mon
Tue
AA
MSQ
DQ
AO
Under-generation
Over-generation

# Uninstructed Imbalance Payments



# Testing Charges

- For a Generator Unit that is under test in SEM
- Testing Charges apply per MWh of output
- Testing Tariff is based on registered capacity

Testing Charge = Max (Metered Gen, 0) * Testing Tariff

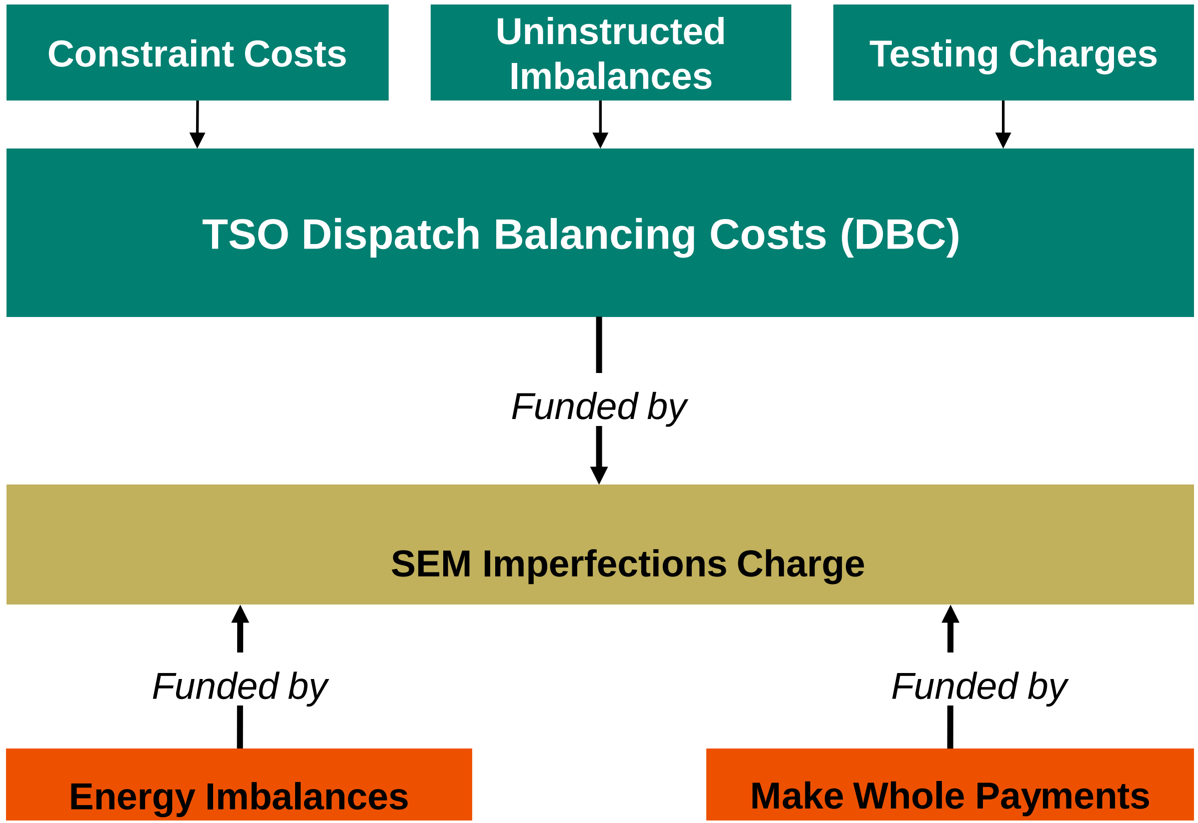
# Make Whole Payments

- Ensures that all Generator Unit Operating Costs are met
- If costs are *NOT* met through other market payments, make whole payments apply:

Make Whole Payment = Max (Operating Cost - Payments received, 0)

- Calculated on a Billing Period basis (1 week)
- Make Whole Payments only necessary in exceptional circumstances - SMP should generally cover all operating costs.

# Dispatch Balancing Costs

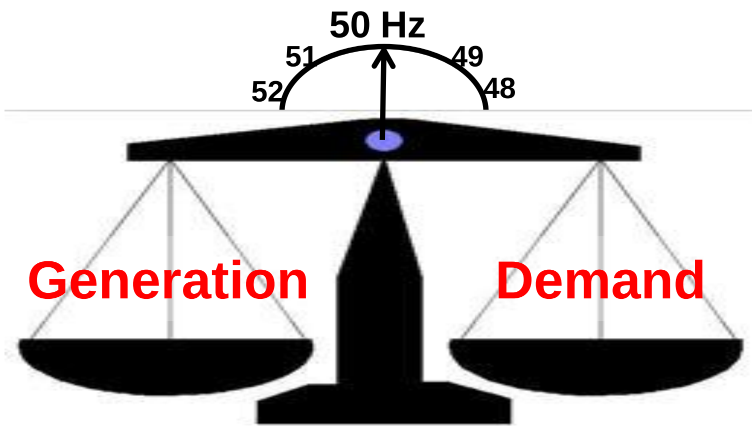


# What Causes Constraints?

- Generators receive constraint payments to keep them financially neutral for the difference between the market schedule and actual dispatch.

- The main drivers of constraints costs are:
  – Reserve
  – Transmission
  – Perfect foresight
  – Market modelling assumptions
  – System security constraints
  – SO Interconnector Trades

# 1: Reserve Constraints



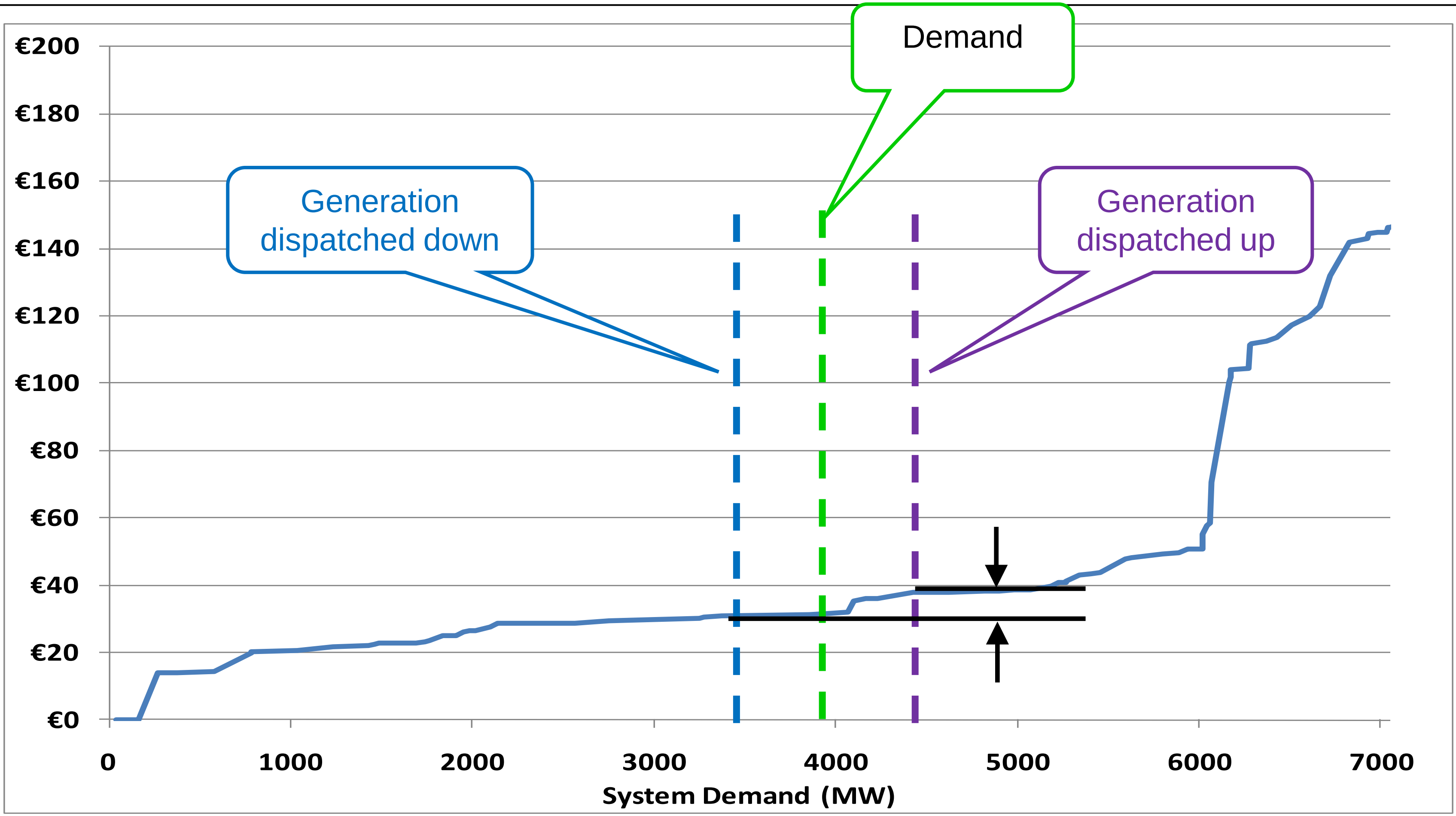

- Reserve: Additional power capacity available from generators or through reduction in load

# 1: Reserve Constraints

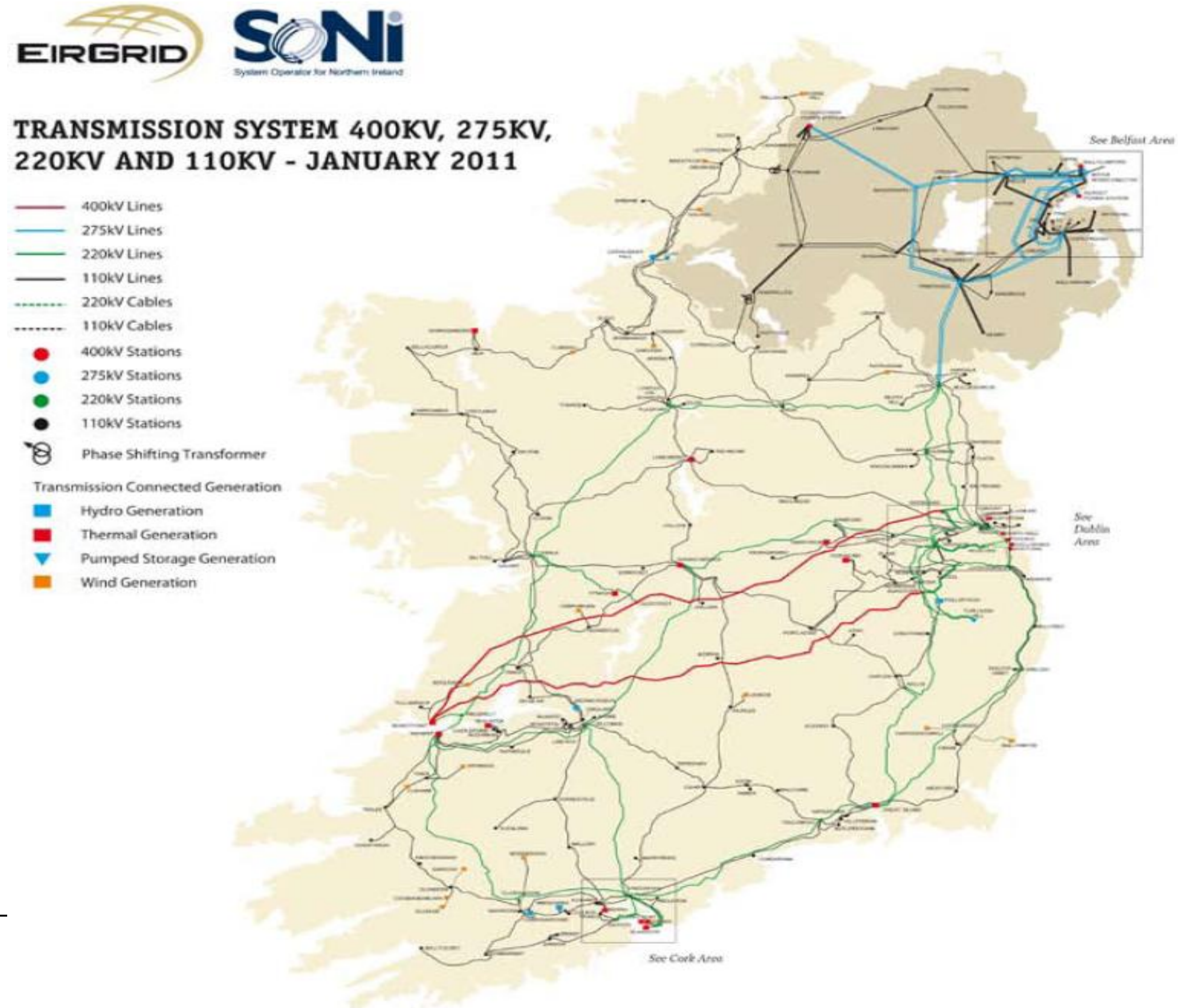
- Reserve required to ensure continuity of supply in the event of a generator/interconnector trip
- Part loading generators frees up spare capacity for quick response
- In-merit generators are constrained down

  ⇨ Additional generators constrained on
- The market schedule does not account for reserve requirements

# Merit order illustration



# 2: Transmission Constraints

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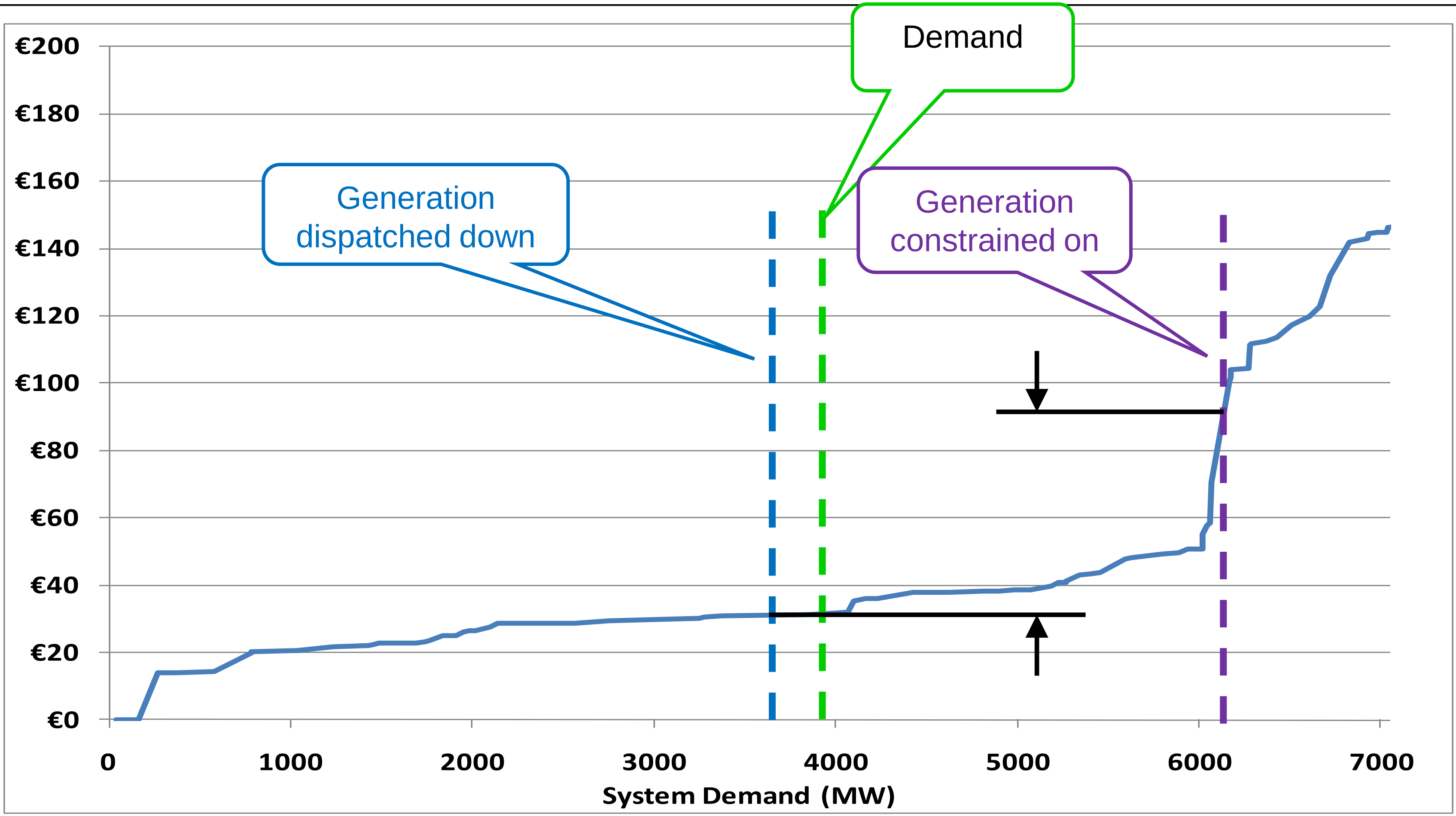
# 2: Transmission Constraints

- Required for safe and secure operation of the transmission network
  - power flows on transmission circuits and system voltages must remain within limits
- Generators constrained on/up
  - E.g. to support voltages in weaker parts of the network
- Generators constrained off/down
  - E.g. when a line outage means that there is insufficient capacity to export all available power
- Market schedule does not account for these physical limitations on the transmission system

# Merit order illustration



# 3: Market Modelling Assumptions

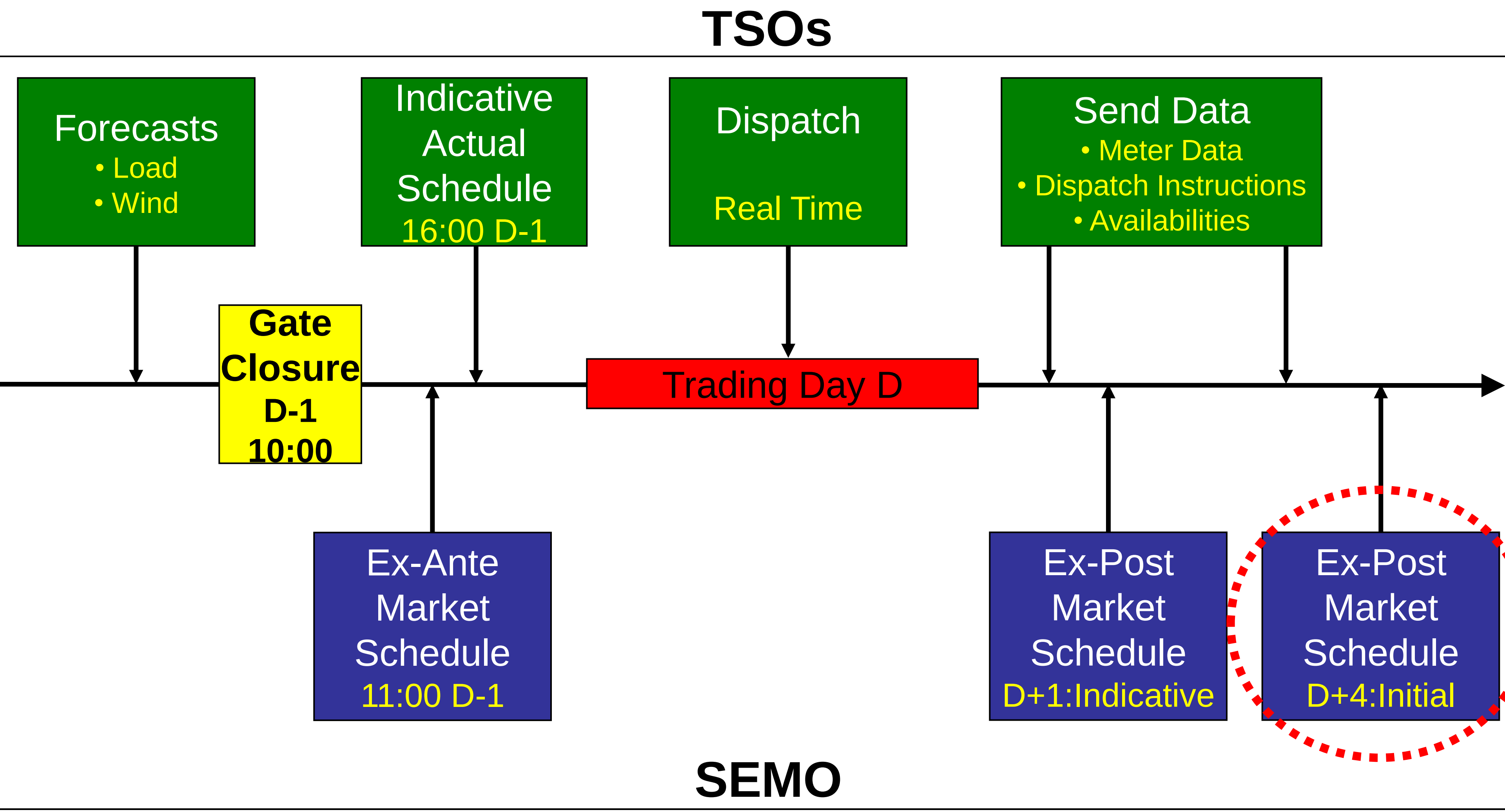
- Due to limitations of market software
  - approximations and assumptions made in the MSP software
  - market schedule will not always be physically feasible

- TSOs and generators: bound by the technical realities of operation

- Actual dispatch will differ from the market schedule regardless of any transmission and security constraints

# 4: Perfect Foresight

- The market schedule is calculated ex-post by MSP Software


TSOs
Forecasts
• Load
• Wind
Indicative Actual Schedule
16:00 D-1
Dispatch
Real Time
Send Data
• Meter Data
• Dispatch Instructions
• Availabilities
Gate Closure D-1 10:00
Trading Day D
Ex-Ante Market Schedule
11:00 D-1
Ex-Post Market Schedule
D+1:Indicative
Ex-Post Market Schedule
D+4:Initial
SEMO

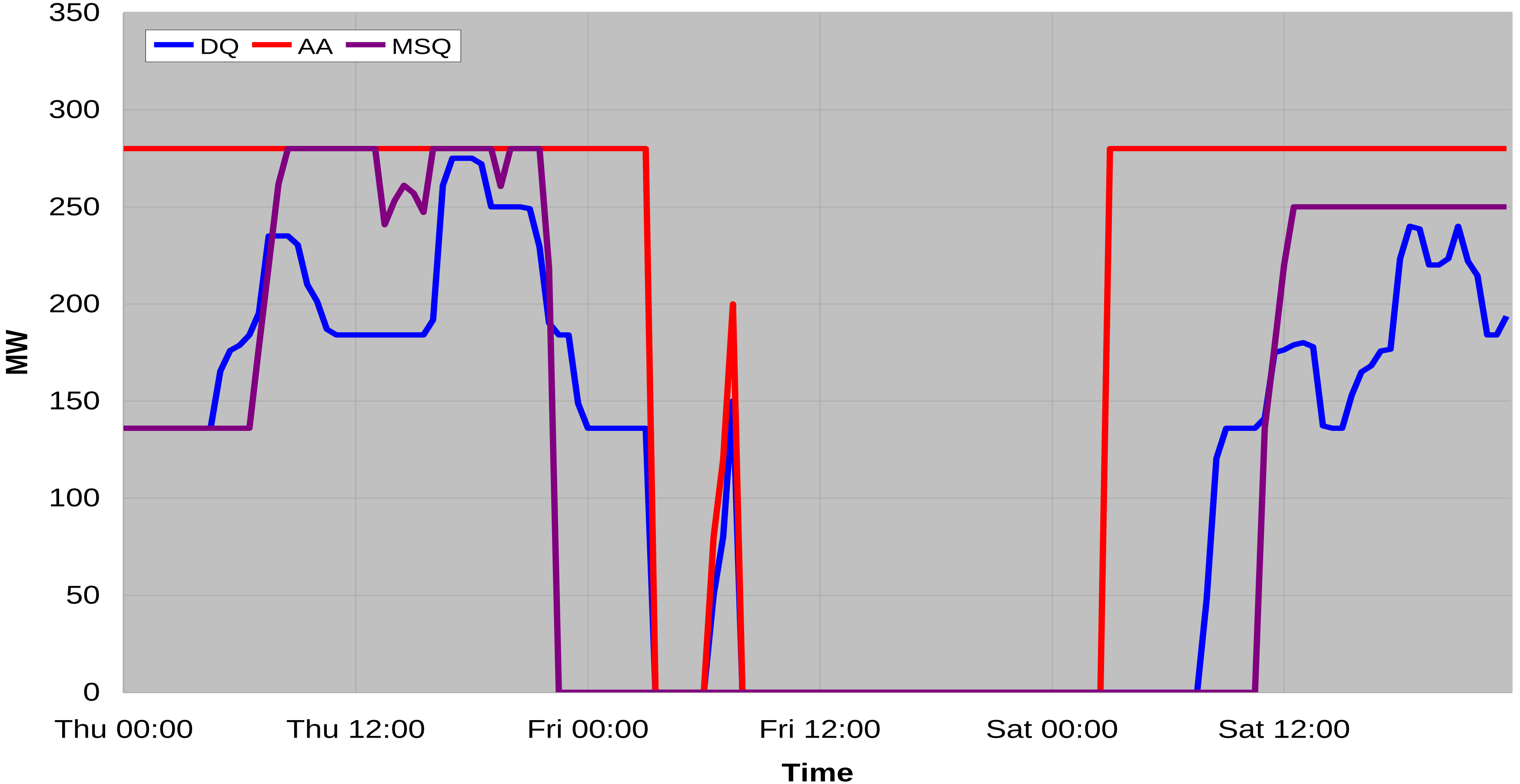
# 4: Perfect Foresight

- MSP Software has 'perfect foresight' of changes to:
  - Demand
  - Generator availability
  - Unforecast wind variability

- TSOs do not have the advantage of this 'perfect foresight'
  - Must plan and operate the system to account for possible variations in these parameters.
  - Must react instantly to changes.

- Actual dispatch will be less economically efficient

# Perfect Foresight Example

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# 5: Other Constraints

- System Security Constraints:
  - Capacity tests for system security
    - Verify availability of generators
  - Grid Code Testing and Performance Monitoring
    - Verify compliance with Grid Code
    - E.g. secondary fuel testing

- SO Interconnector Trades
  - Moyle Low/High Frequency Service

# What Causes Constraints?

- Reserve
- Transmission
- Perfect foresight
- Market modelling assumptions
- System security constraints
- SO Interconnector Trades

# 3: Ongoing Management of Dispatch Balancing Costs

# DBC: TSO & SEMO Roles

- SEMO:
  - Settlement for SEM, including all DBC
  - All payments/charges
  - Collect the Imperfections Charge which funds DBC

- TSOs:
  - Dispatch Generation in real time
  - Manage DBC on an ongoing basis
  - Forecast DBC for setting the Imperfections Charge

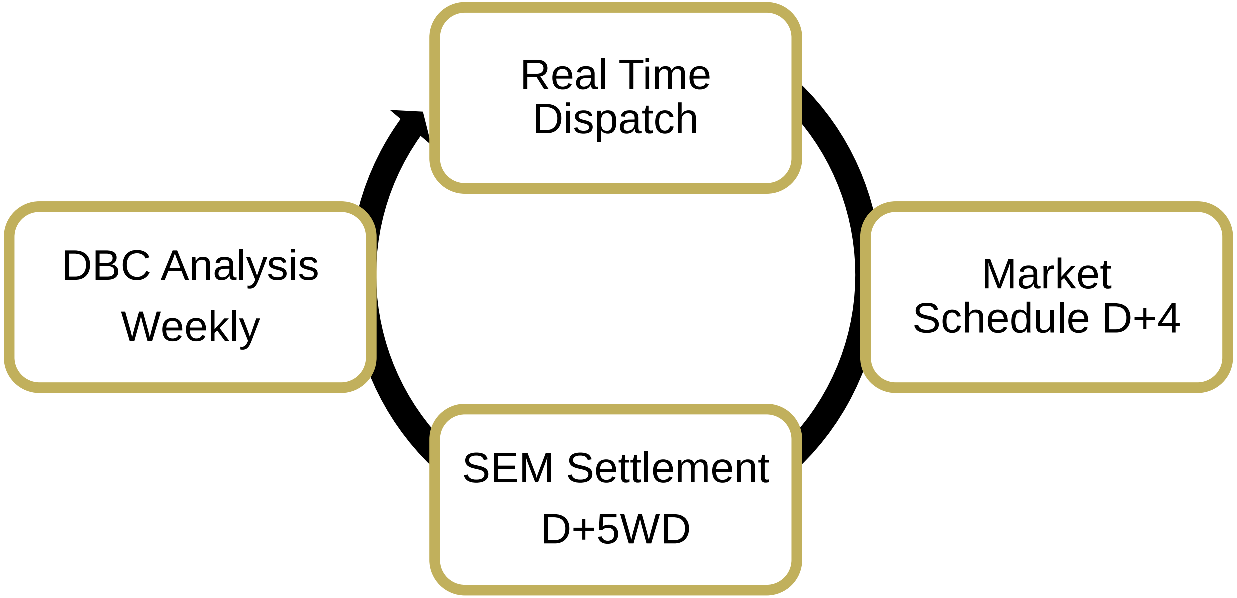
# DBC Analysis

- Purpose of DBC Analysis
- Timeframe for Analysis
- Cross-functional involvement
- Data and Tools
- Managing DBC across the Tariff Year

# Purpose of DBC Analysis

- Review of actual out-turn Dispatch Balancing Costs against forecast for current year
  - Determine position versus forecast
- Identify trends and drivers
- Analyse issues affecting DBC
- Provide information for teams carrying out operational planning and dispatch
- Assist SEMO and EirGrid Finance to manage cashflow across the year versus Imperfections recovery

# DBC Analysis Timeline




- DBC Analysis is carried out in weekly blocks after SEM invoicing has been completed so that all relevant data is available from the market database

# Cross-Functional Input

- Analysis carried out by EirGrid (OSP) and SONI (Near-Time) teams on a weekly basis

- Input from other teams across the EirGrid group
  - Operations departments in SONI and EirGrid

# DBC Analysis – Data Tools

- EDIL
  - unit availability changes, trips, within-day testing
- Control Centre Logs
  - information on dispatch, prevailing transmission conditions, impact of forecast changes, wind dispatch
- Reserve Provision
  - reports on unit response to frequency changes on the system
- Performance Monitoring Data
- Modelling software
  - PLEXOS for Power Systems

# Data Sources and Tools

National Control Centre

Castlereagh House Control Centre

Control Centre Log

Power System Control Office

Near-Time Operations

RCUC Operators

System Studies

Power System Operational Planning

Near-Time Operations

Generation Outages

Transmission Outages

Other Sources

AS Contracted Values

Testing Programme

Performance Reports

# SEM Market Database

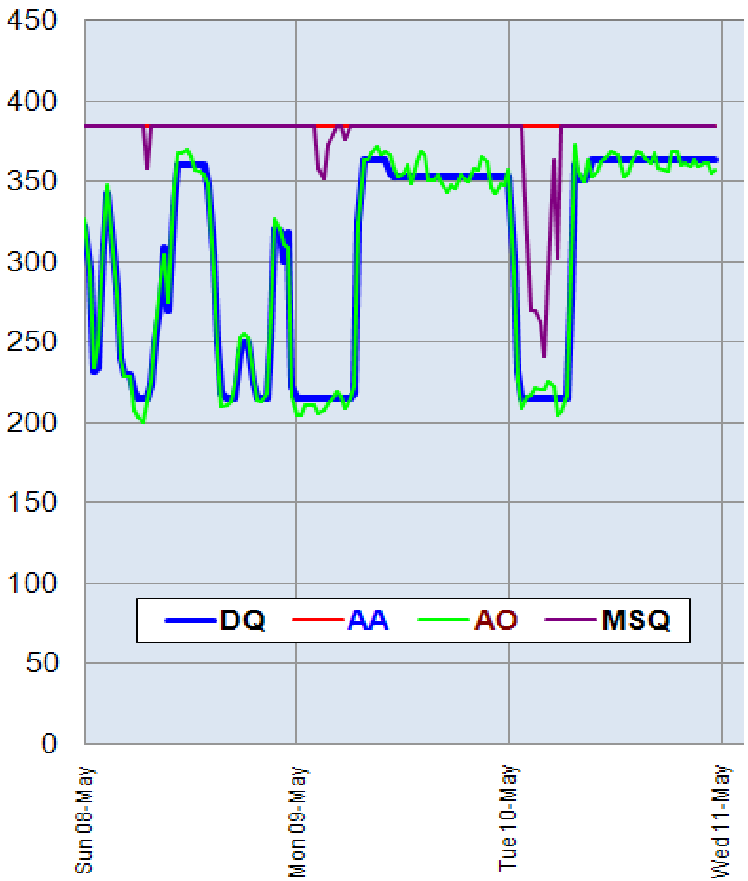
**SEM Database**

- Unit Availability
- Metering
- Dispatch Instructions
- SO Interconnector Trades
- Market Schedule
- Commercial Offer Data
- Forecast System Demand
- Dispatch Quantities
- Technical Offer Data
- Forecast Wind Generation
- System Demand
- Wind Generation
- I/C flows

# Weekly Analysis

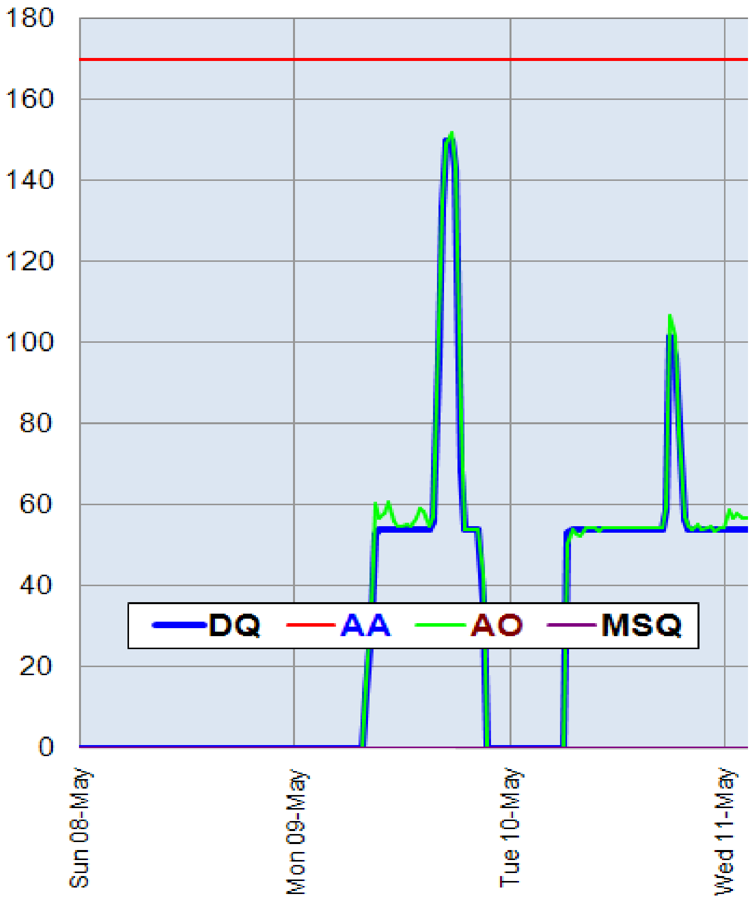
- Analyse half-hour data from SEM database in weekly blocks
- Compare unit availability, market schedule, unit dispatch and actual output
- Identify instances where large or unexpected costs arise
- Understand reasons
- Analyse impacts of system events on DBC

# Analysis – Unit Constrained Down



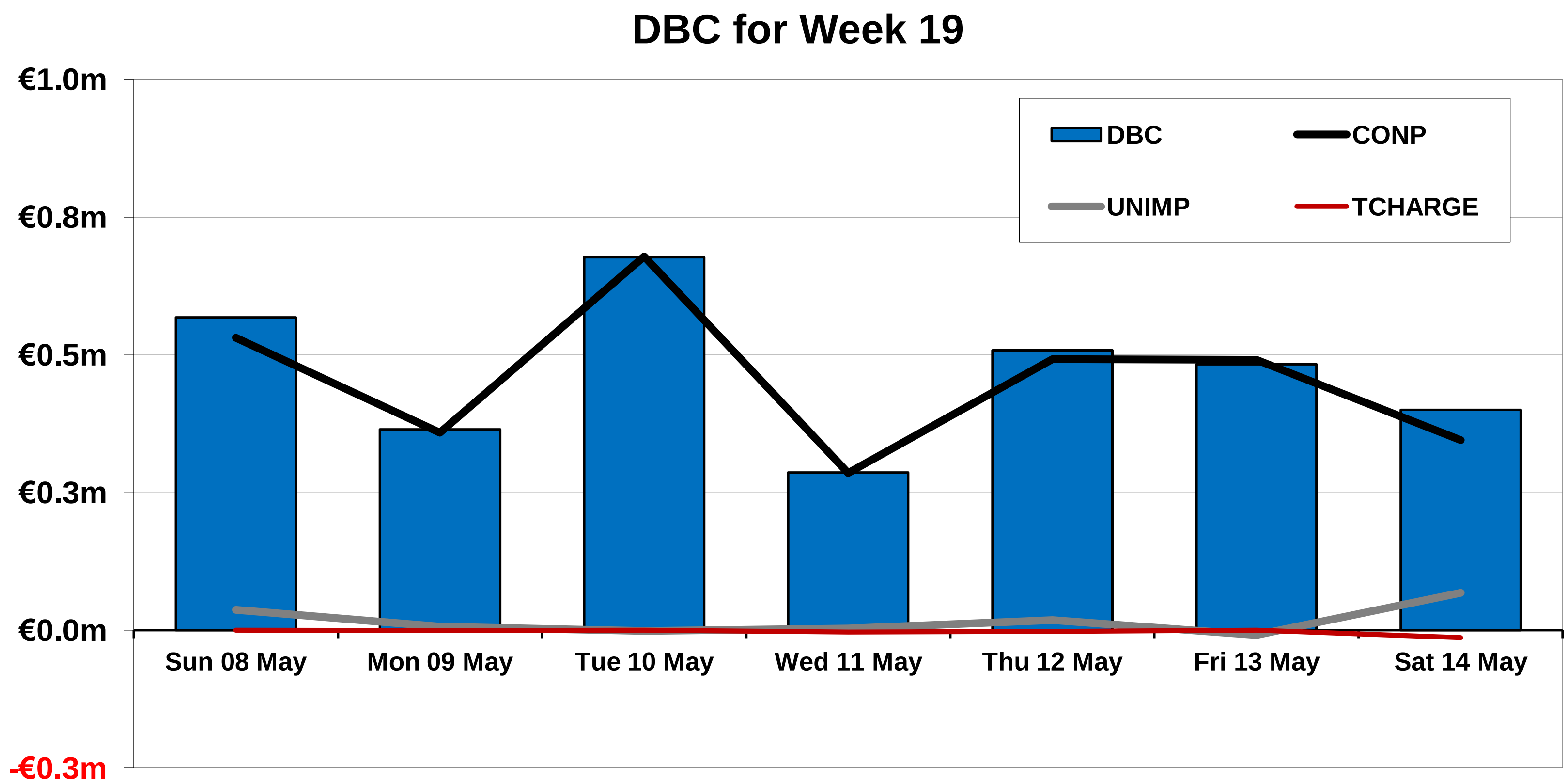

- Typically in-merit plant
  - Constrained down to provide reserve
  - Dispatched down at times of lower load and / or high wind generation

# Analysis – Unit Constrained On/Up

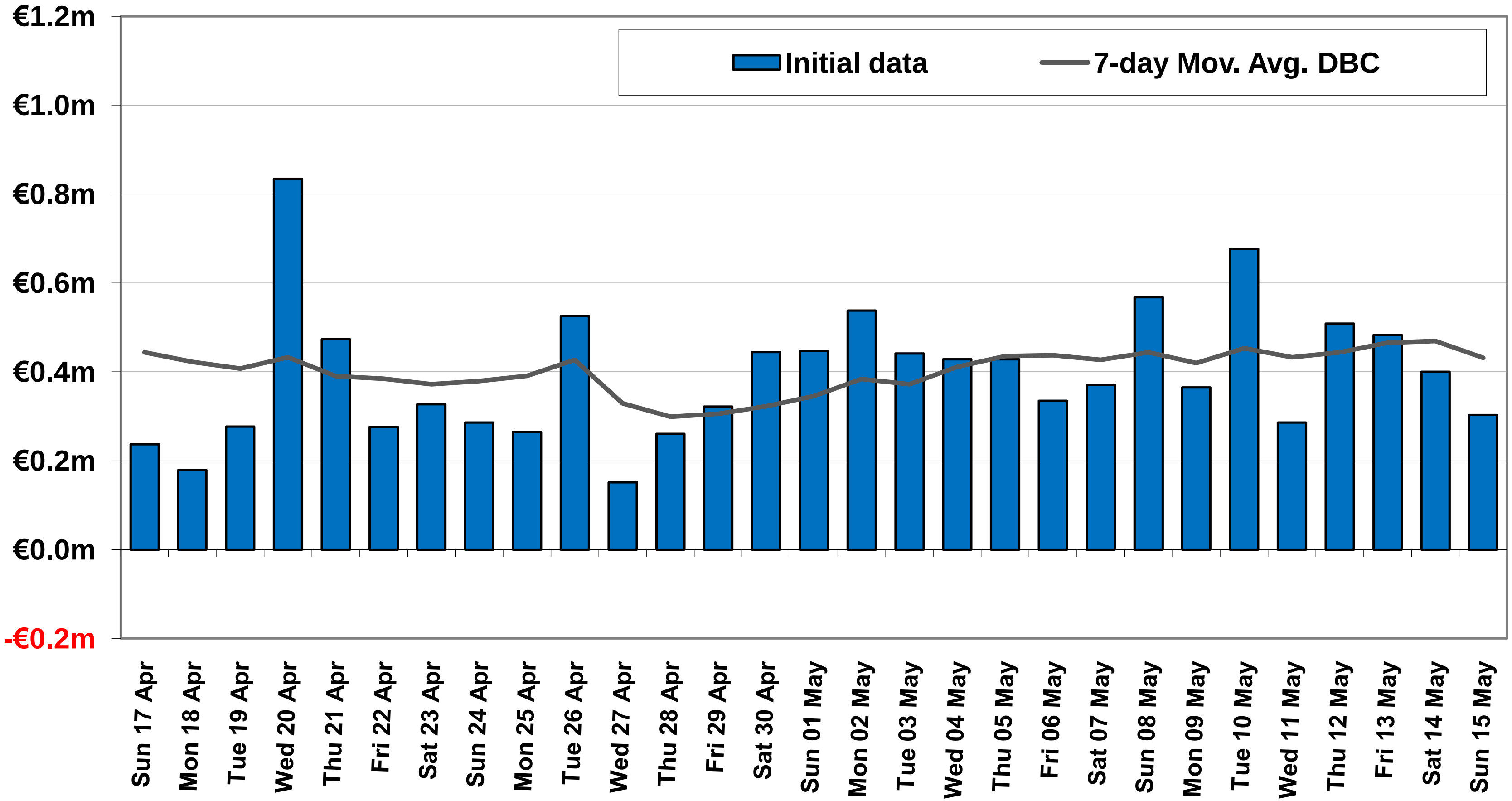



- Units may be required to:
  - Provide Reserve
  - Alleviate a Transmission Constraint
  - Provide local voltage support
  - Replace MW from constrained down generation

# Weekly Analysis



# Analysing Recent Trends

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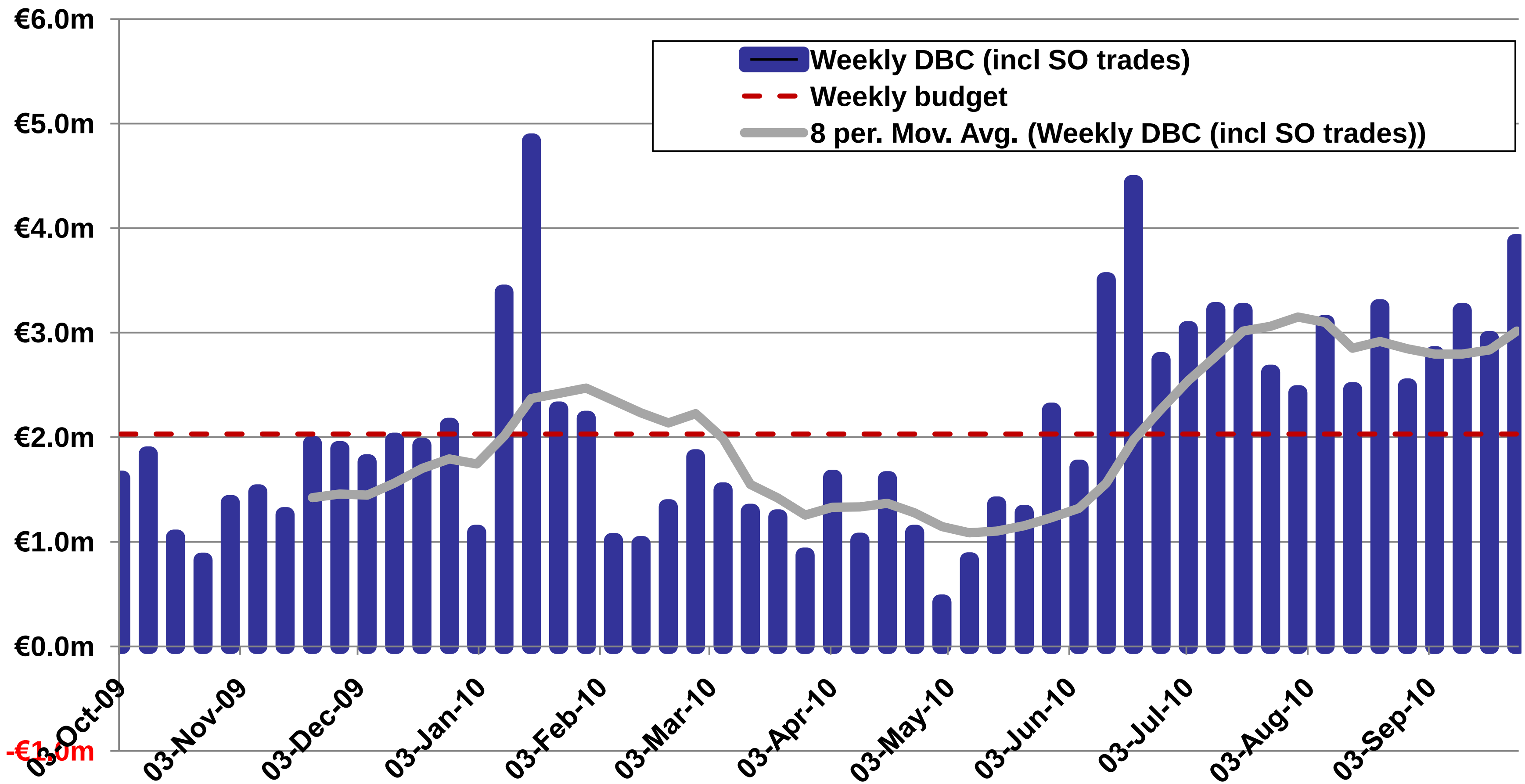
# 2009/10 Tariff Year

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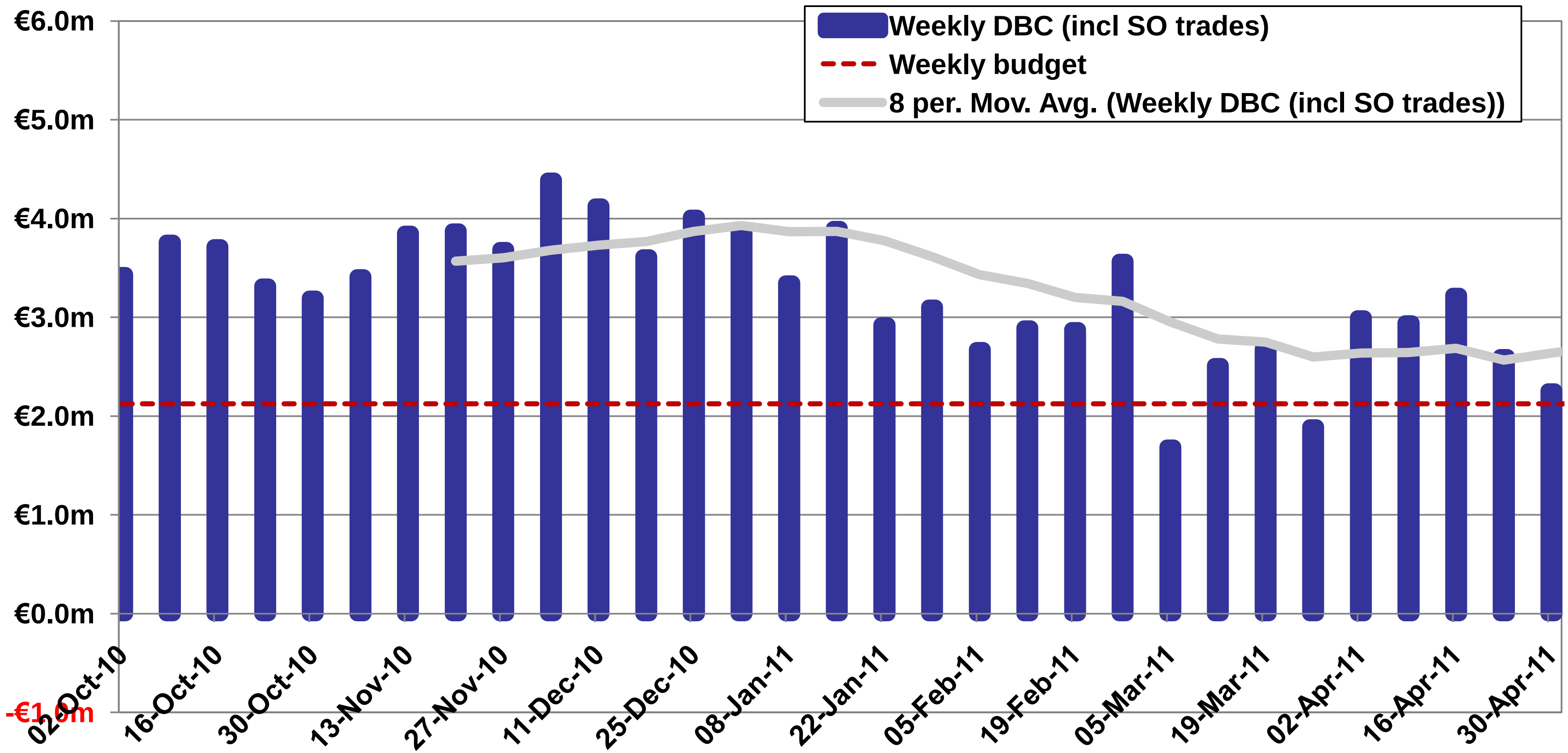
# 2010/11 Year to Date

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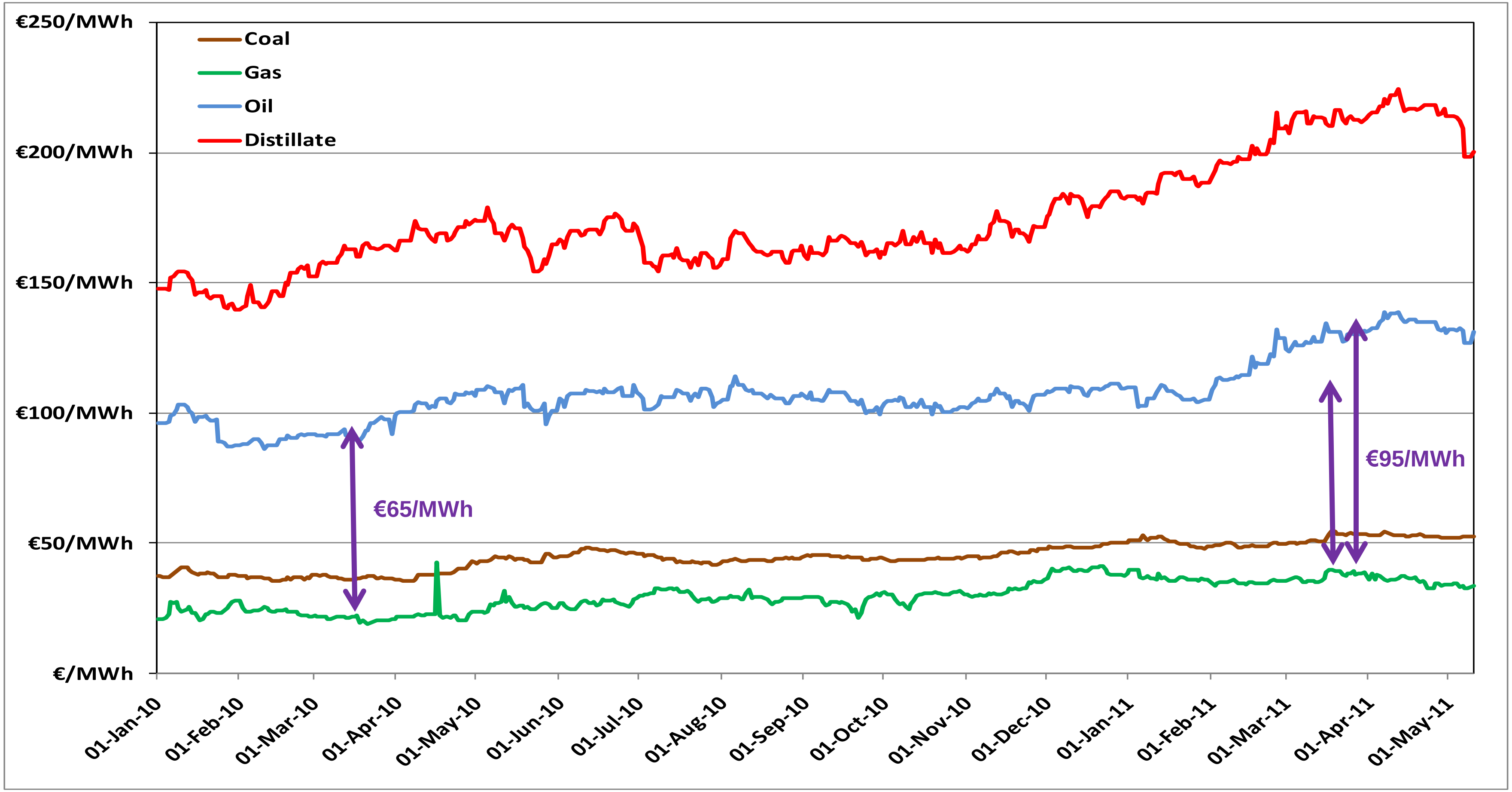
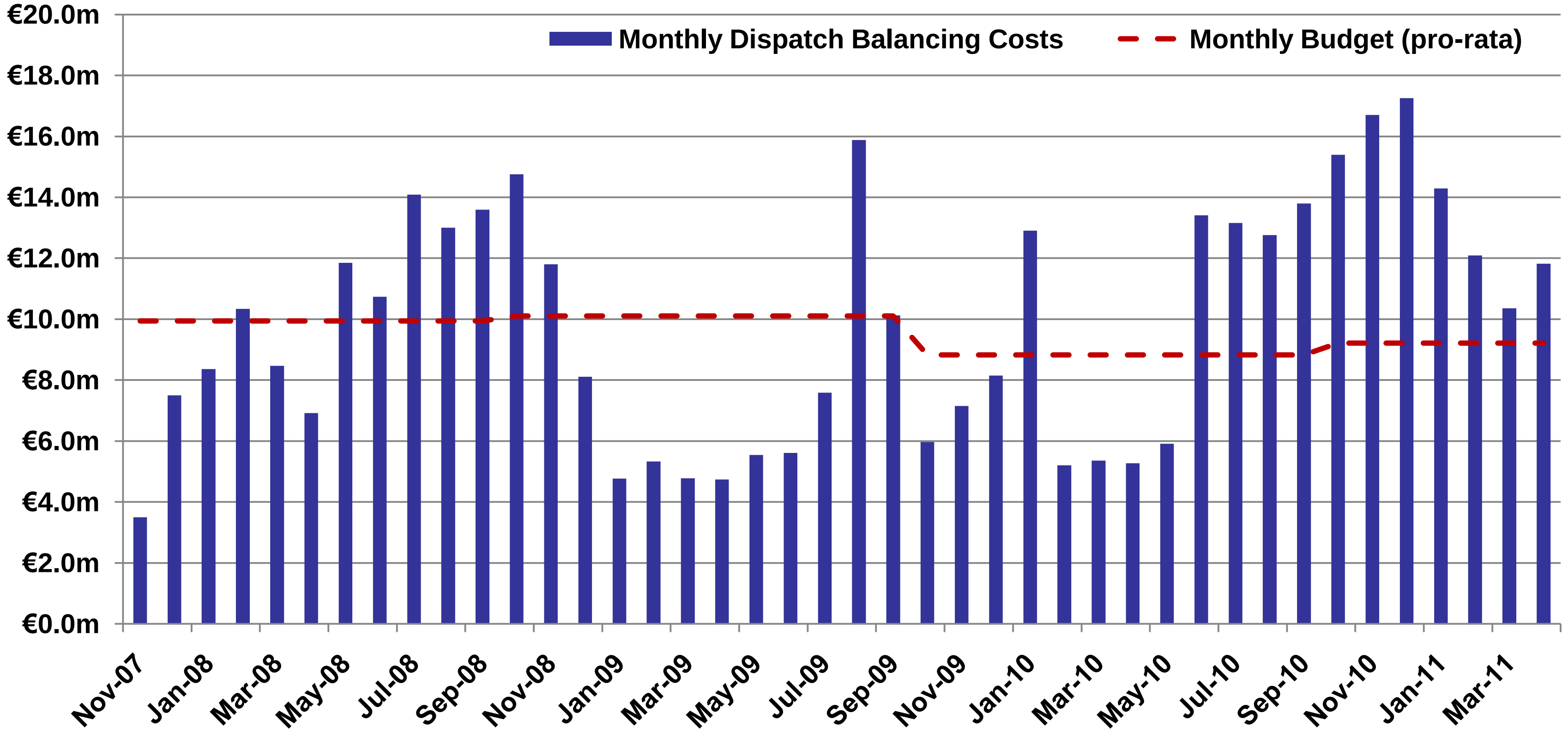
# Sample Incremental Costs (as bid)



# Since Market Start in 2007

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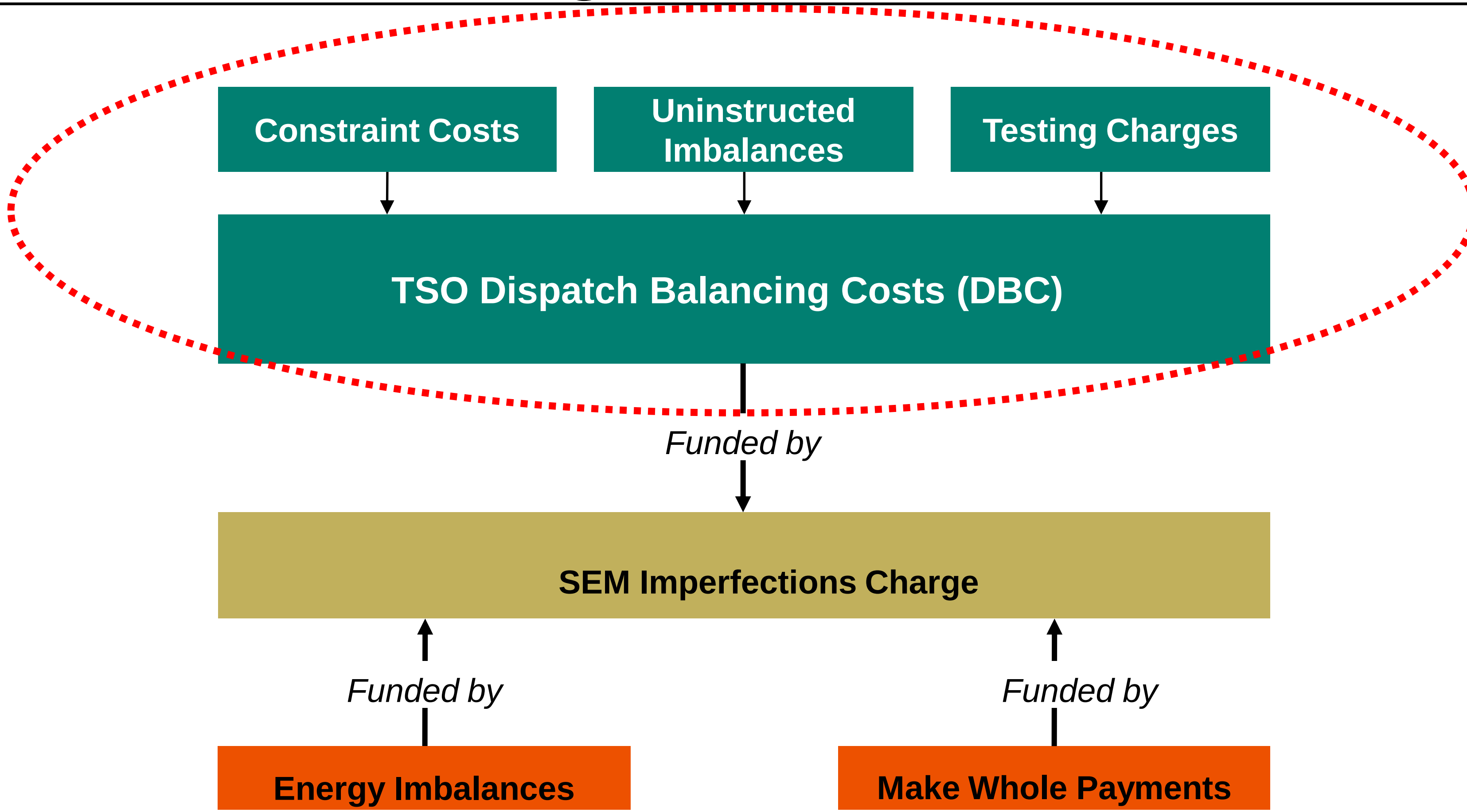
# Longer-term Analysis

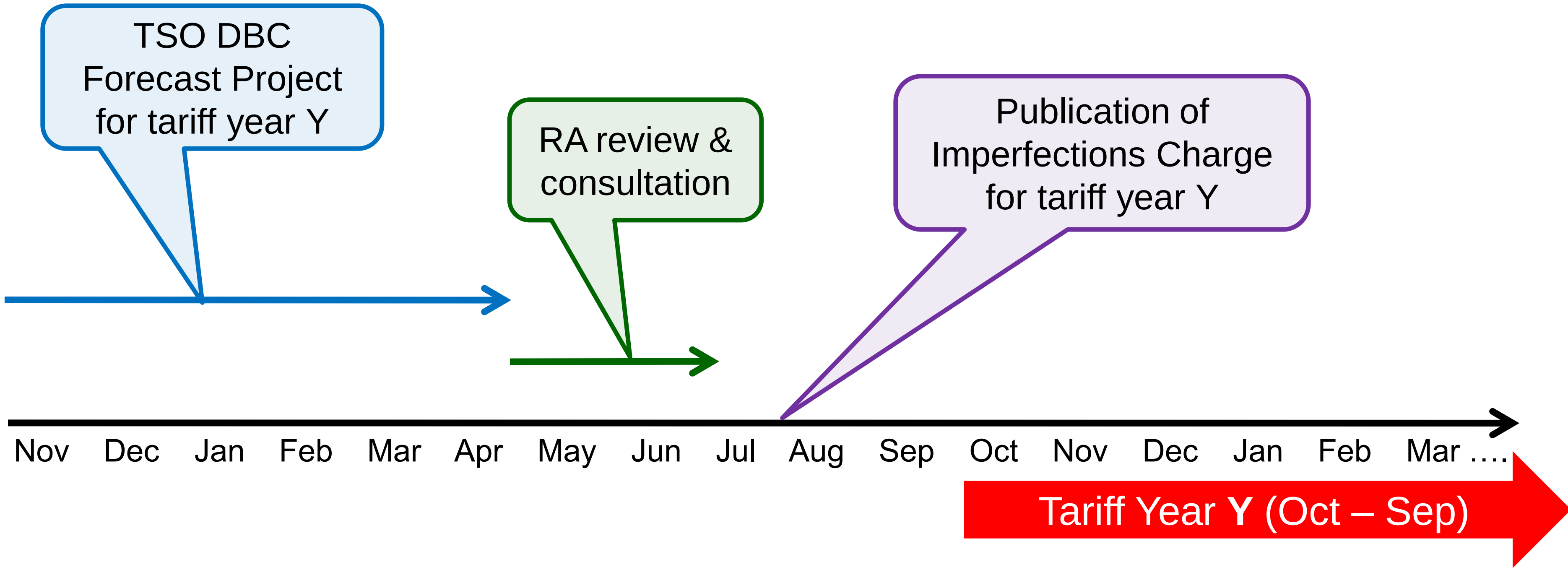

- Changes to Unit Availability
  - Forced outages
- Impacts of Outage Season
  - Transmission
  - Generation
- Timing of Units Commissioning
- Fuel costs and trends
- Unforeseen Events  e.g. weather
- Looking forward
- Forecasting

# 4: Forecasting Dispatch Balancing Costs

# DBC Forecasting



# DBC & Imperfections Timelines



# DBC Forecasting

- Objective: Produce forecast of DBC for future tariff year for the setting of the Imperfections Charge

- Annual Project
  - 6 months: Runs from November to April
  - DBC Forecast submitted to CER & NIAUR in April

- Joint project between SONI and EirGrid

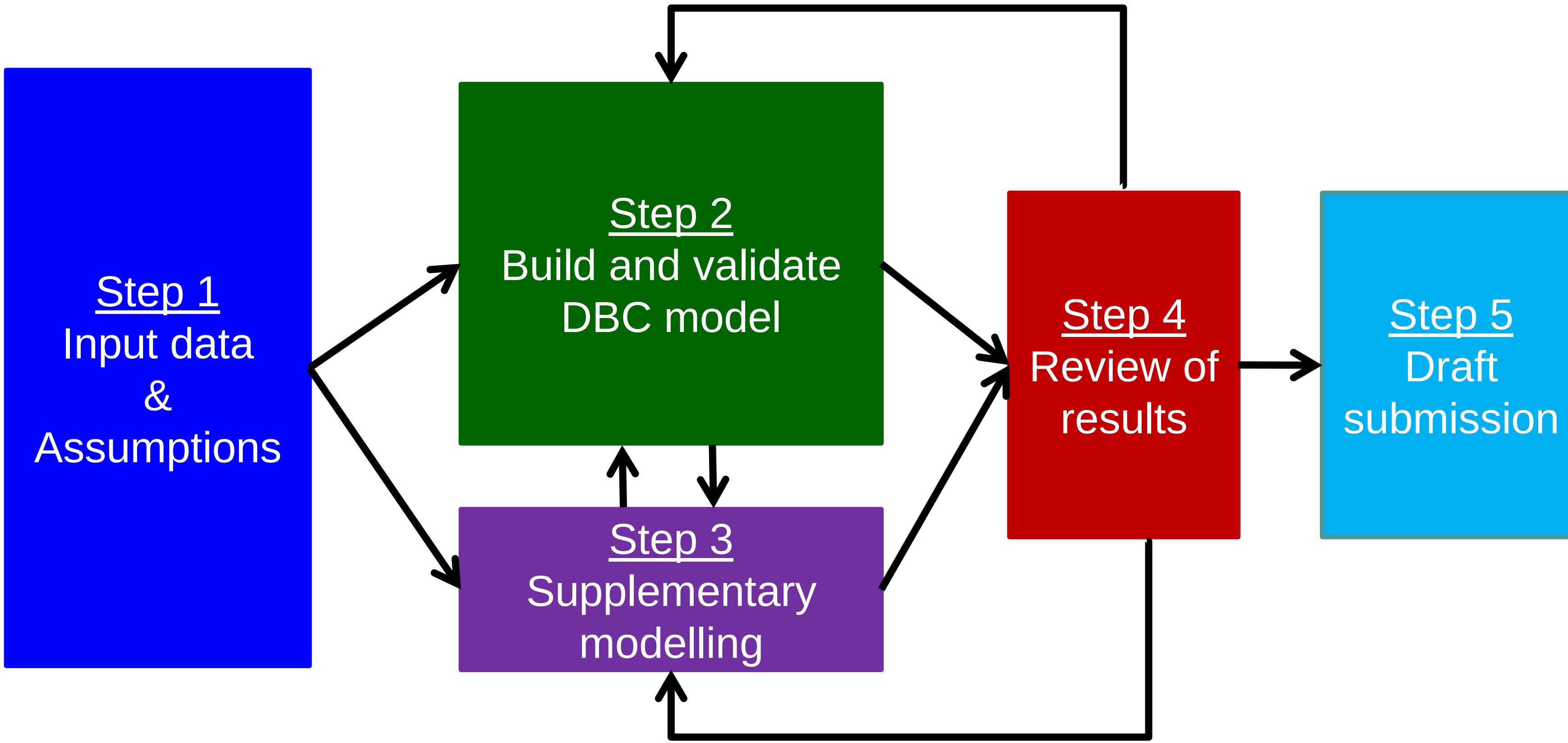
- Cross-departmental: Planning and Operations

# DBC Forecasting

Steps in the TSO DBC Forecasting process

1. Input data and assumptions
2. Build and validate DBC model
3. Development of supplementary modelling
4. Review of results
5. Drafting of submission

# DBC Forecasting



# Step 1: Input data & Assumptions

Step 1
Input data
&
Assumptions

- Forecast Generator Information
- Forecast System Demand
- Forecast Fuel Costs
- Exchange rates
- Forecast dispatch policies
- Forecast system security constraints

# Forecast Generation Information

- New generation commissioning
- Generator closures
- Planned outages
- Forced outages
- Technical & commercial parameters e.g.
  - Max/Min Generation Levels, ramp rates
  - Heat rates
- Renewable generation profiles
- Interconnector profiles

# Sources of Input data & Assumptions

- Trading & Settlement Code
- All-island Generation Capacity Statement
- Transmission Forecast Statement
- RA published data sets
- SEM data
- Ancillary Services data
- Transmission & Generator Outage Plans
- Long term fuel forecasts
- TSO Experience

Step 1
Input data
&
Assumptions

# DBC Forecasting

**Step 1**
Input data
&
Assumptions

→

**Step 2**
Build and validate
DBC model

# Step 2: Build and validate DBC model

- The DBC model is developed by the Generation Analysis group

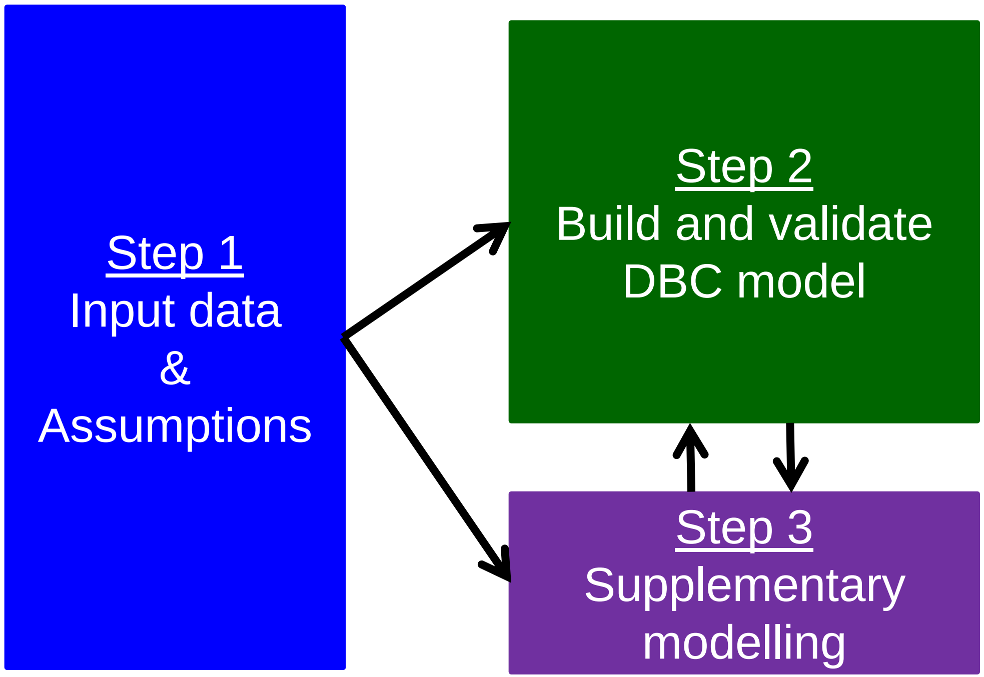
- Use PLEXOS software
  - production cost and market modelling tool

- 2 models are developed:
  - Unconstrained model
  - Constrained model

# 2: Build and validate DBC model

- Unconstrained model:
  - Models SEM
  - No transmission or reserve constraints
- Constrained model:
  - Model of the transmission and generation systems across the whole island
  - Key reserve and transmission constraints included
- Constraint cost = difference in production costs between unconstrained & constrained model

# DBC Forecasting



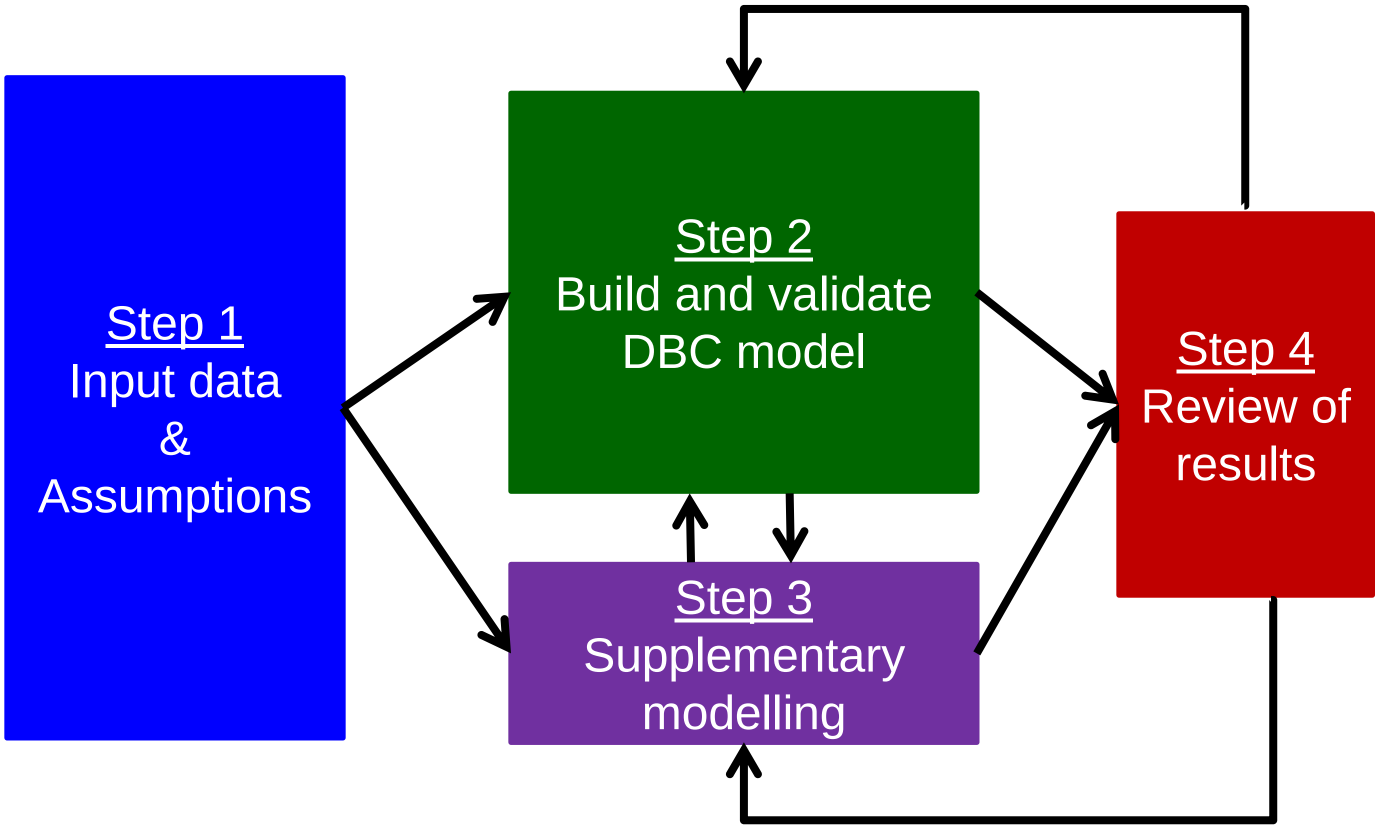
# Step 3: Supplementary modelling

- Certain causes of constraint costs are NOT captured by the plexos model:
  - Perfect foresight
    - Changes in forecast demand or wind
    - Changes in generator availabilities
  - Market modelling effects
  - System security constraints
  - SO Interconnector Trades

# Step 3: Supplementary modelling

- Separate provisions developed to account for these components
  - Based on further analysis
  - Historical information
  - Operational experience
  - Uses inputs from the plexos model

# DBC Forecasting



# Step 4: Review of results

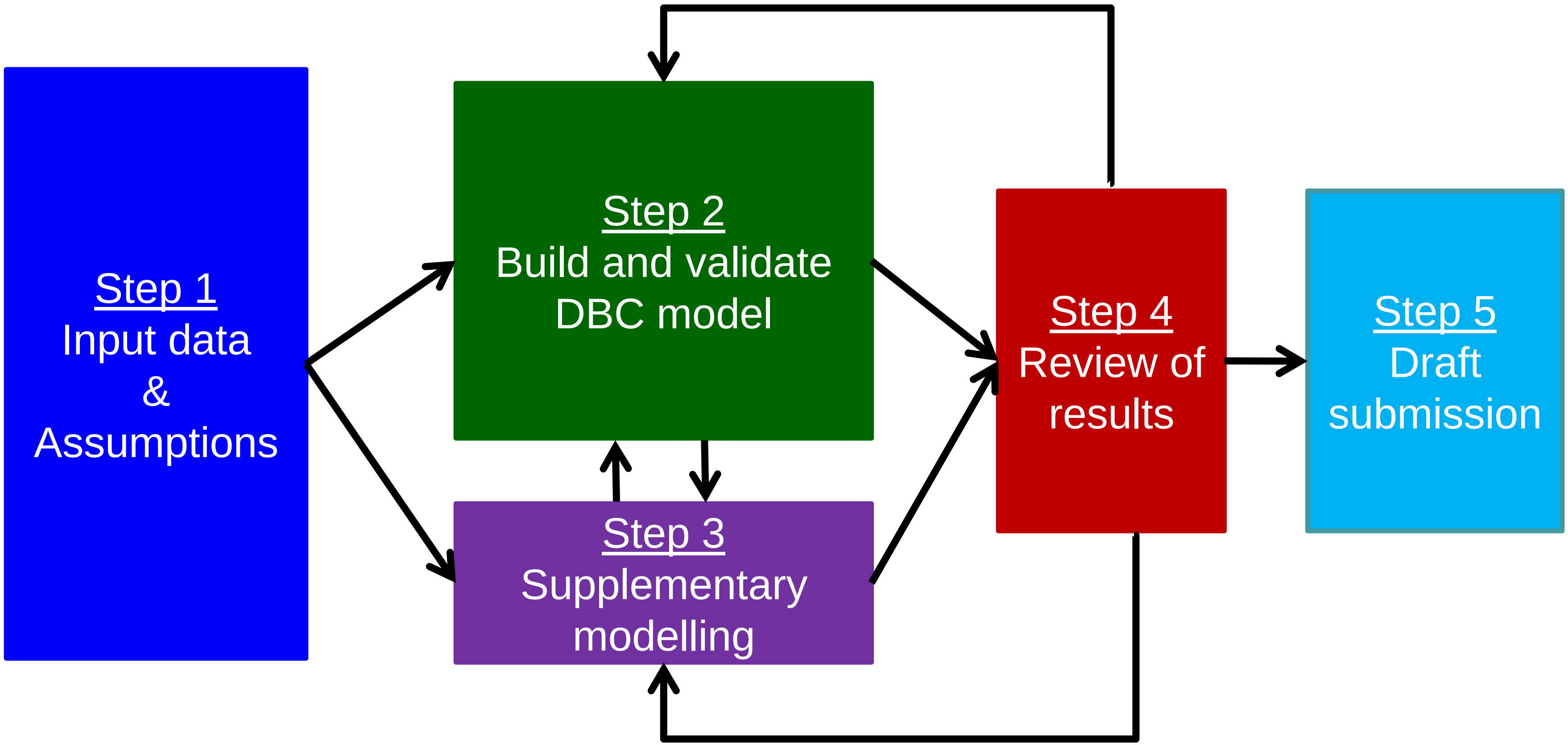
- Review of outputs of plexos model & supplementary modelling

- Review against
  - Historical power flows and dispatches
  - Operational experience

- Sensitivity studies

- Internal workshops to review and debate issues

# DBC Forecasting



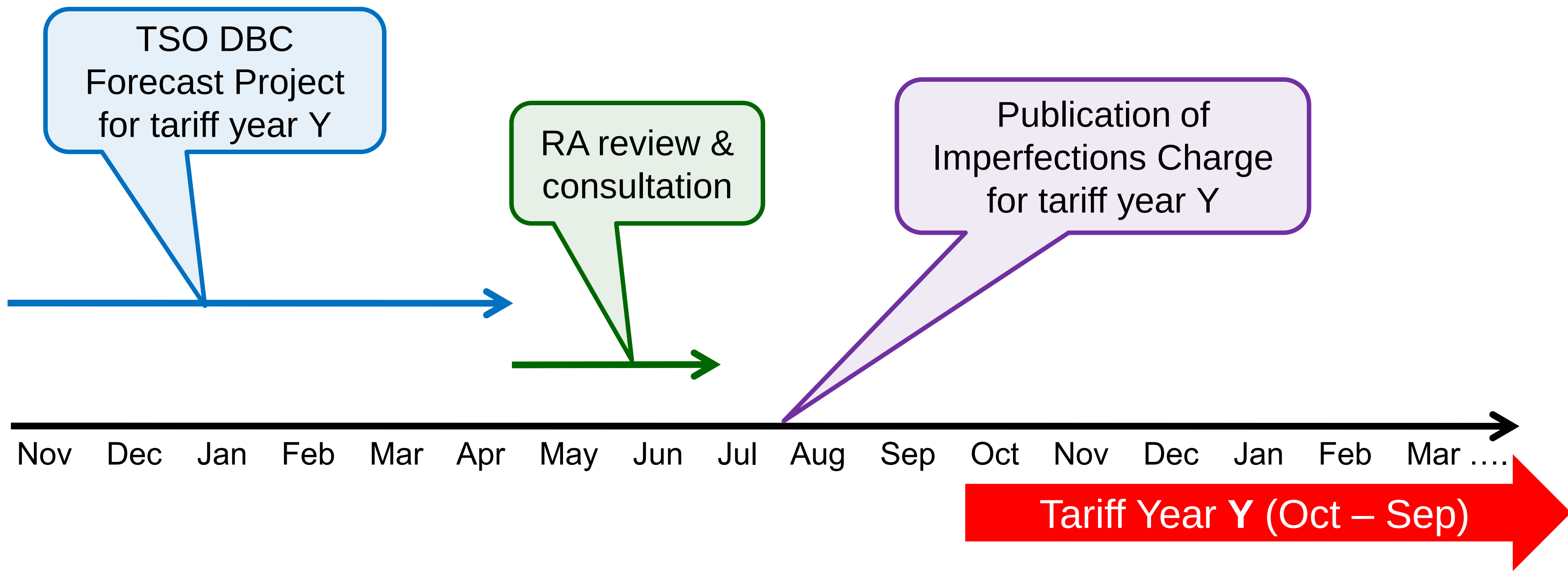
# Step 5: Draft Submission

- Subject to internal review and sign off

- Submitted to the RAs by 30th April each year

- Subsequent meetings with RAs
  - Present the forecast
  - Answer any questions
  - Sensitivity studies

# DBC & Imperfections Timelines



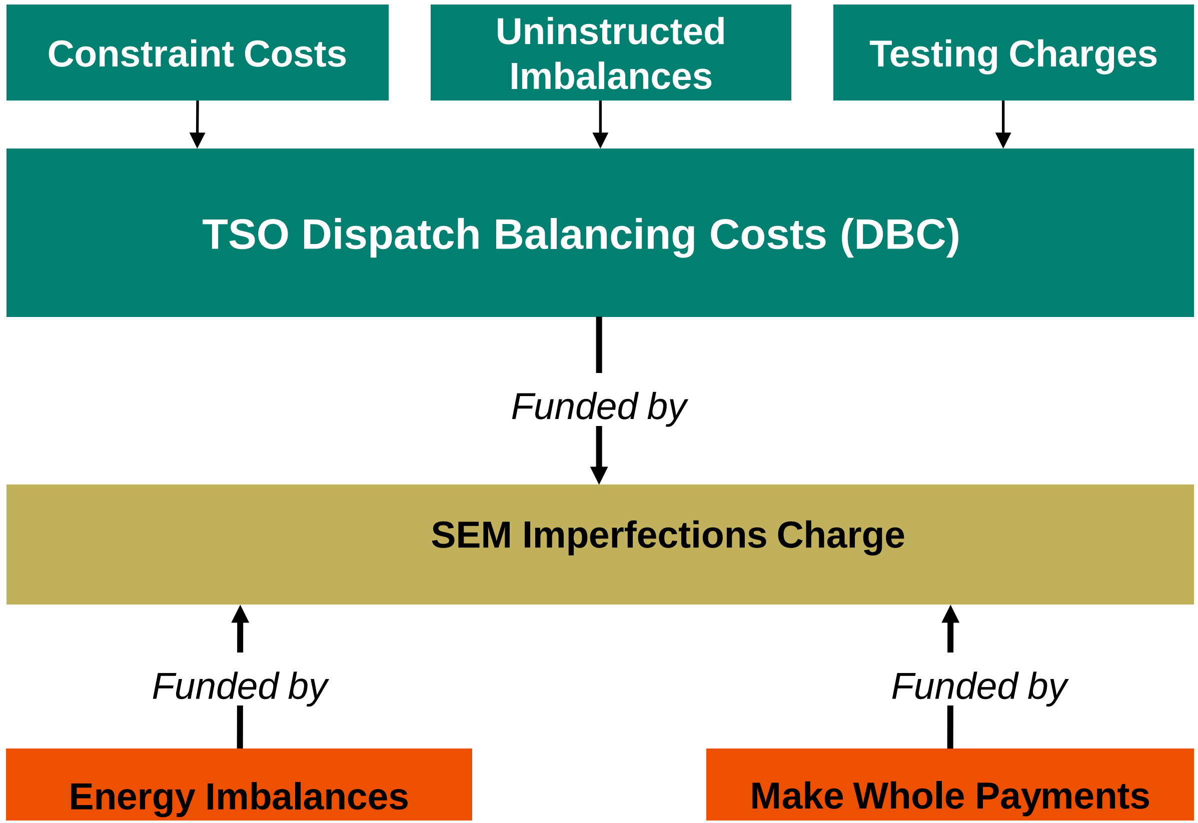
# Setting the Imperfections Charge

- Major component is the DBC Forecast

- Other key inputs:
  - Forecast Make Whole Payments
  - Forecast Energy Imbalances
  - Forecast system demand from TSOs
  - K factor from SEM: Imperfections over/under recovery

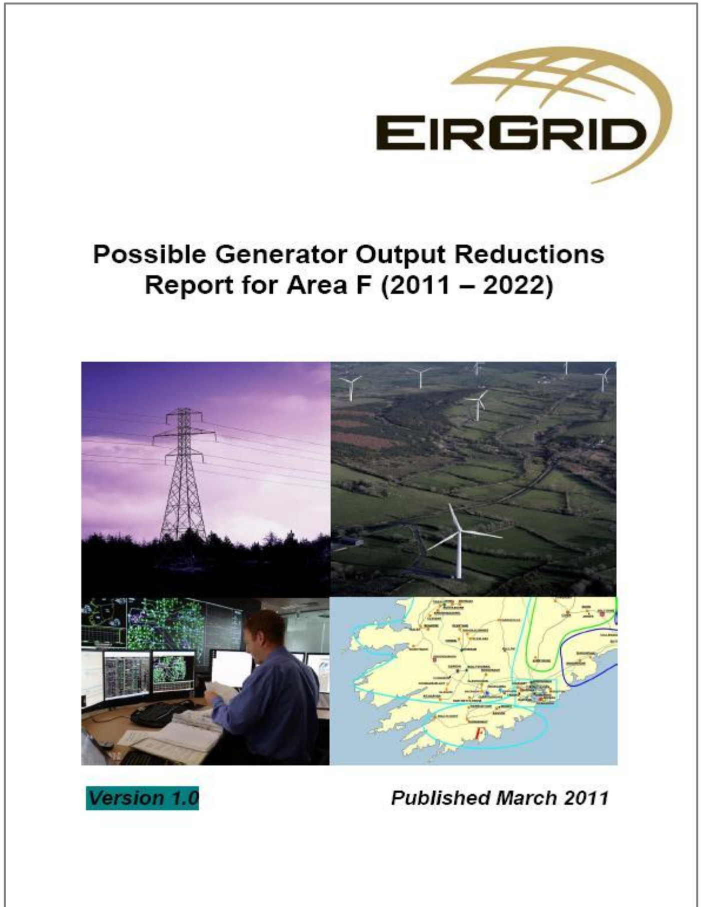
- Imperfections Charge is a per MWh charge.
  - Published prior to the start of the tariff year

# Imperfections



# Q & A

# Gate 3 – PGOR & Constraint Reports




- Reports assess the ‘physical’ levels of curtailment and constraint that generators might expect to experience in the period from 2011 through 2022
- Useful for generators thinking of connecting on a non-firm basis
- Whether a generator is compensated for this curtailment/constraint and the amount of any such compensation is not examined in the reports.