Operating Reserves
Operating Reserve

- **Operating Reserve** refers to spare generating capacity that is available at very short notice to deal with unforeseen demand variations or supply disruptions. The Irish Transmission System Operator Eirgrid identifies three types of operating reserve based on response time: Primary, secondary and tertiary.

- **Primary Operating Reserve (POR)** is available within 15 seconds – this is provided by inertial response and by automatic governor control.

- **Secondary Operating Reserve (SOR)** is available within a 15 to 90 second window. This may be provided by part loaded plant and pumped storage.

- Primary and secondary reserves together are sometimes referred to as **spinning reserve** – they must be provided by generators that are currently spinning and synchronised to the grid.

- **Note**: that the role of operating reserve is provide immediate response to unexpected events. Ensuring that overall generation capacity is sufficient to meet expected demand is catered for by **Generation Adequacy** studies.
Tertiary Response

- Tertiary reserves respond after 90 seconds and may be provided by fast responding offline plant that can be brought into operation quickly.

- **Tertiary operating Reserve 1 (TOR1):** 90 seconds to 5 minutes

- **Tertiary Operating Reserve 2 (TOR2):** 5 minutes to 20 minutes

- **Replacement reserve:** Fully available and sustainable over the period from 20 minutes to 4 hours after an event.

*Eirgrid 2009 Grid Code v3.4*
Reserve Response

Figure 2.1 – Role of Primary and Secondary operating reserve in managing frequency excursions.

SEI 2004 Operating Reserve Requirements as Wind Power Increases in the Irish Electricity System.
What Level of Reserves are Required

• Historically TSOs tried to ensure that enough reserves were available to cover the loss of one or more of the largest generators on the grid.

• From the 1960’s probabilistic methods have been used to determine the level of reserves required to meet desired reliability targets.

• The advent of deregulated electricity regimes has led to the development of markets to set the price of operating reserve.

• If an economic value can be set on the loss of load (Value of ‘lost load VOLL) then markets can also be used to determine the optimum quantity of reserves as well as the price.

(De Silva and Alvarez 2007 Operating reserve capacity requirements and pricing in deregulated markets using probabilistic techniques IET Journal of Generation Transmission and Distribution)
How Does Eirgrid Determine Reserve Requirement?

• Grid Code 3.4 lists the following factors
  – The magnitude and number of the largest in feeds to the system (single contingency)
  – Simulations of loss of largest in feed
  – Ambient Weather Conditions
  – The extent to which customer disconnections are allowed
  – The cost of providing operating reserve
  – Other factors include TSO policy, National Events, Agreements with externally connected parties.
The impact of Wind Power

• The variability of wind adds an additional uncertainty to the power system and at high levels of penetration this will impact on reserve requirements.

• The 2004 SEI sponsored study “Operating Reserve Requirement as Wind Power Penetration Increases on the Irish Electricity System” suggests that the costs of additional reserve could be minimised if wind forecasting is incorporated in the operational planning time frame.
Generator Requirements

• Grid Code 3.4 requires all generators to provide the following operating reserve:

POR: 5%
SOR: 5%
TOR1: 8%
TOR2: 10%

In every case the requirement only applies if the generator is providing more than 50% registered MW capacity. The reserve requirement also ramps down to zero as MW output approaches 100% registered capacity.
Reserve as a Service

- In addition to the reserve requirement placed on generators Eirgrid sources additional reserves and pays for them.
- Remember this is payment for energy that is available but not actually used.
- The faster the response the more valuable the reserve.

<table>
<thead>
<tr>
<th>Operating Reserve Category</th>
<th>Operating Reserve Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>POR</td>
<td>€2.08/MWh</td>
</tr>
<tr>
<td>SOR</td>
<td>€1.89/MWh</td>
</tr>
<tr>
<td>TOR1</td>
<td>€1.73/MWh</td>
</tr>
<tr>
<td>TOR2</td>
<td>€1.73/MWh</td>
</tr>
<tr>
<td>RR</td>
<td>€1.30/MWh</td>
</tr>
</tbody>
</table>

Eirgrid Payment Schedule for Operating Reserve: January 2010