Ancillary Services
Overview of Ancillary Services

• Regulation
• Load Following
• Energy Imbalance
• Operating Reserve – Spinning
• Operating Reserve – Supplemental
• Backup Supply
Overview of Ancillary Services

- System Control
- Dynamic Scheduling
- Reactive Power and Voltage Control from Generation Sources
- Real Power Transmission Losses
- Network Stability Services from Generation Sources
- System Blackstart Capability
Services Descriptions

Regulation

• Adequate generation response capability (under AGC)
• Continuously balance Control Area supply resources with minute-to-minute load variations

Load Following

• Generation and interchange capability to meet the hour-to-hour and daily load variations not covered by Regulation service.
Basic
Automatic Generation Control
Services Descriptions

Energy Imbalance

• Mismatch between the energy schedule(s) at the point of receipt (POR) or point of delivery (POD) and the actual metered energy flow at the POR or POD within a Control Area’s boundaries, over a given period of time.

• The Energy Imbalance service is the provision by the Control Area to supply the deficit energy or absorb the excess energy involved.
Gen A has a contract to supply power to load C but fails to deliver all the power called for in the contract. Gen B makes up the difference as imbalance service and is paid by the transmission operator.
Services Descriptions

Operating Reserve – Spinning

- Generation capacity synchronized to the system that is unloaded, is in excess of the quantity required to serve current and anticipated demand.

- Able to respond immediately to serve load, and is fully available within ten minutes.
Supplemental Reserve and Backup Supply
Necessity of Spinning Reserve
Services Descriptions

Operating Reserve – Supplemental

• The provision of
  (1) unsynchronized generation capacity
  (2) interruptible load

Backup Supply

• Generating capacity used:
  (1) to replace an outage of generation or the failure to deliver generation due to an outage of transmission sources;
  (2) to cover that portion of the customer’s load that exceeds its generation.
Services Descriptions

System Control
• Ensure the reliability of the Interconnection
• Minimize transmission constraints
• Coordinate restoration following a contingency or disturbance.

Dynamic Scheduling
• The service that provides for the real-time metering, telemetering, computer software, to electronically move a portion or all of the “watt type” services associated with generation or load out of the Control Area into a different Control Area.
Dynamic Scheduling

Control Area A

Control Area B
Services Descriptions

Reactive Power and Voltage Control from Generation Sources

The provision of reactive power from generation sources, to support transmission system operations, including the ability to continually adjust transmission system voltage in response to system changes.

Real Power Transmission Losses

Replacement of energy losses and the capacity to supply those losses on the Transmission Provider’s transmission system associated with transmission service.
Reactive Supply and Voltage Control
Transmission Losses

![Diagram showing transmission losses with LTC and step-up transformers.](image-url)
Services Descriptions

Network Stability Services from Generation Sources

Procurement, operation and maintenance of special equipment, at generating plants to enable the Transmission Provider to meet reliability requirements.

Examples include power system stabilizers (PSS) and dynamic braking resistors.

System Blackstart Capability

Generating equipment that, following a system blackout, can start without the availability of an outside electrical supply.
Ancillary Service Criteria

NERC Interconnected Operations Services working group report
Interconnected Operations Services

NERC Interconnected Operations Services working group report
Costing Ancillary Services

- COST BASED VS. MARKET BASED PRICES
  - COST BASED: When there is a natural monopoly - e.g., when it is impossible to buy MVARs from outside suppliers (price set by regulation)
  - MARKET BASED: When there are ample suppliers that are competing for your business (price set by the market)
Basic Quantification

- Regulation and Load Following: MW
- Energy Imbalance: MWh
- Operating Reserve - Spinning: MW capacity
- Operating Reserve - Supplemental: MW capacity
- Backup Supply: MW/minute
- System Control, Dynamic Scheduling: Hours
- Reactive Supply and Voltage Control from Generation: MVAR
- Real Power Transmission Losses: MWh
- Network Stability Services from Generation Sources: Hours
- System Blackstart Capability: MW capacity
Step 1 Determine the amount of each ancillary service needed to support a transaction

- **Transaction:**
  - MW
  - Start time
  - End Time
  - Source location
  - Delivery location

- **Examples of Ancillary Service Amounts**
  - Amount per MW of transaction
  - Amount per MWh of the transaction
  - Impact of the transaction on the transmission system
STEP 2 - Identify the equipment necessary to supply this service

- Regulation and Load Following
- Energy Imbalance
- Operating Reserve - Spinning
- Operating Reserve - Supplemental
- Backup Supply
- System Control, Dynamic Scheduling
- Reactive Supply and Voltage Control
- Real Power Transmission Losses
- Network Stability Services
- System Blackstart Capability

<table>
<thead>
<tr>
<th>Equipment/Service</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>On Line Generation</td>
<td></td>
</tr>
<tr>
<td>Energy Imbalance Generators, fuel</td>
<td></td>
</tr>
<tr>
<td>On Line Gen capacity</td>
<td></td>
</tr>
<tr>
<td>On Line Gen capacity</td>
<td></td>
</tr>
<tr>
<td>Off Line Generation</td>
<td></td>
</tr>
<tr>
<td>Computers, Comm, facilities</td>
<td></td>
</tr>
<tr>
<td>On Line Generation</td>
<td></td>
</tr>
<tr>
<td>Generators, fuel</td>
<td></td>
</tr>
<tr>
<td>Stabilizers, braking resistor</td>
<td></td>
</tr>
<tr>
<td>Off Line Generation</td>
<td></td>
</tr>
</tbody>
</table>
STEP 3 - Calculate the annualized capital cost for the equipment identified for each ancillary service in STEP 2

STEP 4 - Identify the fixed O&M and labor costs for the equipment identified in STEP 2

STEP 5 - Calculate the incremental operating costs for the equipment identified in STEP 2

STEP 6 - Calculate the annualized cost of other equipment needed (e.g., to supply regulation, you need control computers, communications, etc.)

STEP 7 - Sum costs in STEP 3, 4, 5, AND 6
STEP 8 - Divide the amount from STEP 7 ($/yr) by the amount of each ancillary service required to support a transaction

- Regulation and Load Following $/MW
- Energy Imbalance $/MWh
- Operating Reserve - Spinning $/MW capacity
- Operating Reserve - Supplemental $/MW capacity
- Backup Supply $/MW/minute
- System Control, Dynamic Scheduling $/Hours
- Reactive Supply and Voltage Control from Generation $/MVAR
- Real Power Transmission Losses $/MWh
- Network Stability Services from Generation Sources $/Hours
- System Blackstart Capability $/MW capacity
Equipment to supply service

- Regulation and Load Following
  On Line Generation
- Energy Imbalance
  Generators, fuel
- Operating Reserve - Spinning
  On Line Gen capacity
- Operating Reserve - Supplemental
  On Line Gen capacity
- Backup Supply
  Off Line Generation
- System Control, Dynamic Scheduling
  Computers, Comm, facilities
- Reactive Supply and Voltage Control
  On Line Generation
- Real Power Transmission Losses
  Generators, fuel
- Network Stability Services
  Stabilizers, braking resistor
- System Blackstart Capability
  Off Line Generation
Service Costs

- Regulation and Load Following $/MW
- Energy Imbalance $/MWh
- Operating Reserve - Spinning $/MW capacity
- Operating Reserve - Supplemental $/MW capacity
- Backup Supply $/MW/minute
- System Control, Dynamic Scheduling $/Hours
- Reactive Supply and Voltage Control from Generation $/MVAR
- Real Power Transmission Losses $/MWh
- Network Stability Services from Generation Sources $/Hours
- System Blackstart Capability $/MW capacity
# Sample Costs

<table>
<thead>
<tr>
<th>Service</th>
<th>Costs (COMED)</th>
<th>Costs (Maine Electric)</th>
<th>Costs (ConEd NY)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Regulation and Load Following</td>
<td>$7.32 / MW - hr</td>
<td></td>
<td>$0.662 / MW - hr</td>
</tr>
<tr>
<td>Energy Imbalance Supply</td>
<td></td>
<td>Customer pays 150% of hourly marginal cost</td>
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</tr>
<tr>
<td>Energy Imbalance Purchase</td>
<td></td>
<td>Customer receives 50% of hourly marginal cost</td>
<td></td>
</tr>
<tr>
<td>Spinning reserve</td>
<td>$23.08 /MW - hr</td>
<td></td>
<td>$0.585 /MW - hr</td>
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<tr>
<td>Supplemental reserve</td>
<td>$6.52 /MW - hr</td>
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<td>$0.332 /MW - hr</td>
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<tr>
<td>Backup Supply</td>
<td></td>
<td></td>
<td>0.592 /MW - hr</td>
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<tr>
<td>System Scheduling, Dynamic Scheduling</td>
<td>NO CHARGE</td>
<td></td>
<td>$0.592 /MW - hr</td>
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<tr>
<td>Reactive Supply and Voltage Regulation</td>
<td>NO CHARGE</td>
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<td>$0.317 / MW - hr</td>
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<tr>
<td>Transmission Losses</td>
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<tr>
<td>Blackstart Capability</td>
<td></td>
<td></td>
<td>$0.089 / MW - hr</td>
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Metering Ancillary Services
# Metering Requirements

<table>
<thead>
<tr>
<th>SERVICE</th>
<th>METER</th>
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<tbody>
<tr>
<td>• Regulation and Load Following</td>
<td>Unit Response</td>
</tr>
<tr>
<td>• Energy Imbalance</td>
<td>MWh vs schedule</td>
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<tr>
<td>• Operating Reserve - Spinning</td>
<td>Unit status &amp; Capacity</td>
</tr>
<tr>
<td>• Operating Reserve - Supplemental</td>
<td>Unit Status</td>
</tr>
<tr>
<td>• Backup Supply</td>
<td>Unit Status</td>
</tr>
<tr>
<td>• System Control, Dynamic Scheduling</td>
<td>Integrated ACE</td>
</tr>
<tr>
<td>• Reactive Supply and Voltage Control from Generation</td>
<td>Measure Voltage</td>
</tr>
<tr>
<td>• Real Power Transmission Losses</td>
<td>MWh</td>
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