Intro to Energy Storage

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Energy storage technologies

**Chemical**
- Hydrogen
- Synthetic Natural Gas
- Hydrocarbons

**Electrochemical**
- Classic Batteries
  - Lead Acid
  - Li-Polymer
  - Metal Air
  - Na-NiCl₂
  - Ni-Cd
- Flow Batteries
  - Li-Ion
  - Li-S
  - Na-Ion
  - Na-S
  - Ni-MH
  - Vanadium Red-Ox
  - Zn-Br

**Electrical**
- Supercapacitors
- SMES

**Mechanical**
- Flywheels
- Adiabatic Compressed Air
- Pumped Hydro
- Diabatic Compressed Air
- Pumped Heat Electrical Storage
- Cryogenic Energy Storage

**Thermal**
- Sensible Heat Storage
- Latent Heat Storage
- Thermochemical Heat Storage

Ways to use Energy Storage to Support Power Systems

<table>
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<tr>
<th>Generation/Bulk Services</th>
<th>Ancillary Services</th>
<th>Transmission Infrastructure Services</th>
<th>Distribution Infrastructure Services</th>
<th>Customer Energy Management Services</th>
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<tbody>
<tr>
<td>Arbitrage</td>
<td>Primary frequency control</td>
<td>Transmission investment deferral</td>
<td>Capacity support</td>
<td>End-user peak shaving</td>
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<td>Electric supply capacity</td>
<td>Secondary frequency control</td>
<td>Angular stability</td>
<td>Contingency grid support</td>
<td>Time-of-use energy cost management</td>
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<td>Support to conventional generation</td>
<td>Tertiary frequency control</td>
<td>Transmission support</td>
<td>Distribution investment deferral</td>
<td>Particular requirements in power quality</td>
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<td>Ancillary services RES support</td>
<td>Frequency stability of weak grids</td>
<td>Distribution power quality</td>
<td>Maximising self-production &amp; self-consumption of electricity</td>
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<td>Capacity firming</td>
<td>Black start</td>
<td>Dynamic, local voltage control</td>
<td>Demand charge management</td>
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<td>Curtailment minimisation</td>
<td>Voltage support</td>
<td>Intentional islanding</td>
<td>Continuity of energy supply</td>
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<td>Limitation of upstream disturbances</td>
<td>New ancillary services</td>
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<td>Reactive power compensation</td>
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