Energy Storage Technologies in Electricity Sector – An Overview

Suresh Shrestha
Senior Divisional Engineer
What is Energy Storage?
Why Energy Storage?
Benefits of EST
Types
Applications
What is Energy Storage?

Conversion of electricity into a different form of energy which can be reconverted into electricity when needed.
Why Energy Storage?

- Varying Demand
- Demand Supply Imbalance
- Quality and Stability affected

- Power Grid
- Congestion/ Power interruptions
- Mobile Applications (Eg. Electric Vehicles)

- Consumption at the time of Generation

- Characteristics of Electricity

- Generation Site far from Consumption Site
Why Energy Storage?

The biggest chunk of GHG from Energy
The biggest chunk of energy --electricity
The biggest chunk of electricity from fossil fuels (60%)

SE4ALL
SDGs
Paris Agreement
INDC
More RE for electricity generation
Electric Vehicles
Energy Storage
The share of renewable energy in global power generation rising to over 26% by 2020 from 22% in 2013 – a remarkable shift in a very limited period of time (IEA).

<table>
<thead>
<tr>
<th>Country</th>
<th>Objective Description</th>
</tr>
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<tbody>
<tr>
<td>Afghanistan</td>
<td>Aims to cut emissions by 13.6% from business-as-usual levels by 2030, conditional on international support.</td>
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<tr>
<td>Bangladesh</td>
<td>Plans to cut GHG emissions by 5% by 2030 compared with business-as-usual levels in the power, transport and industry sectors;</td>
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<tr>
<td>Bhutan</td>
<td>Bhutan Plans to remain carbon neutral as set out in 2009. Repeats commitment to keep 60% of territory forested.</td>
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<tr>
<td>India</td>
<td>Aims to cut GHG emissions by 33% - 35% of the 2005 levels by 2030. Targets 40% of electricity from non-fossil fuel sources by that date.</td>
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<tr>
<td>Maldives</td>
<td>Aims for 10% emission cuts from business-as-usual levels by 2030, raising to 24% with international support.</td>
</tr>
<tr>
<td>Nepal</td>
<td>Aims to reduce dependency on fossil fuels by 50% by 2050 and achieve 80% electrification through renewable energy sources. Plans to maintain 40% of the total area under forest cover.</td>
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<tr>
<td>Pakistan</td>
<td>Intends to reduce up to 20% of its 2030 projected GHG emissions subject to availability of international grants. Estimated to about USD 40 billion.</td>
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<tr>
<td>Sri Lanka</td>
<td>Aims for a reduction in GHG emissions of 7% from business-as-usual levels by 2030, or up to 23% with international support. Estimated cost USD 420 million.</td>
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</tbody>
</table>

**Global e-cars, (IEA)**

![Graph showing the growth of global e-cars sales from 2010 to 2016](image)

- E-buses sales in China (Clean Technia)
- CAGR of battery electric buses: 52%

**E-buses sales in China (Clean Technia)**

<table>
<thead>
<tr>
<th>Year</th>
<th>Battery Electric Buses</th>
<th>Plug-in Hybrid Electric/ Hybrid Electric Buses</th>
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</thead>
<tbody>
<tr>
<td>2011</td>
<td>1,356</td>
<td></td>
</tr>
<tr>
<td>2012</td>
<td>4,303</td>
<td></td>
</tr>
<tr>
<td>2013</td>
<td>4,303</td>
<td></td>
</tr>
<tr>
<td>2014</td>
<td>6,138</td>
<td></td>
</tr>
<tr>
<td>2015</td>
<td>8,748</td>
<td></td>
</tr>
<tr>
<td>2016</td>
<td>12,760</td>
<td></td>
</tr>
<tr>
<td>2017</td>
<td>17,297</td>
<td></td>
</tr>
<tr>
<td>2018</td>
<td>23,051</td>
<td></td>
</tr>
<tr>
<td>2019</td>
<td>28,700</td>
<td></td>
</tr>
<tr>
<td>2020</td>
<td>34,200</td>
<td></td>
</tr>
<tr>
<td>2021</td>
<td>41,700</td>
<td></td>
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</tbody>
</table>

**E-buses sales in China (Clean Technia)**

- Battery Electric Buses
- Plug-in Hybrid Electric/ Hybrid Electric Buses

**Note:**

- **INDC, SMS**
Why Energy Storage?

Stored

Low Demand

Low generation cost

Intermittent sources

Used

High generation Cost

High Demand

Generation means not available
Increasing Energy Storage Adoption

- Increasing intermittency in Power Generation
- Increasing Customer Expectation
- Technology Advancement
- Cost Reduction
- Policy Initiatives

Demand for ES → Enabling Factors
Environmental Benefits: Decreased CO2 emissions
Improved power quality/reliability
Alleviating intermittency of RE-source generated power
Meeting mobile appliances and vehicle load needs
Management of standby power generation
Increase in economic value of wind and solar energy
Income generation (Consumers)
Cost Saving (Suppliers)
Battery
Electrical energy is stored in chemical form for later use. Battery technologies are being improved, and new battery technologies are becoming developed.

Ice Storage
Refrigeration creates ice at night, when power rates are low which then runs a cooling system during the afternoon, when power costs are high and the power grid is most stressed.

Pumped Hydro
Excess electricity is used to pump water uphill into a reservoir. When power is needed, the water can run down through turbines, much like a traditional hydroelectric dam. More than 20,000 MW of pumped storage capacity exists in the United States.

Flywheel
Flywheels convert electrical energy to kinetic energy, then back again very rapidly. Flywheels are ideal for power conditioning and short-term storage.

Compressed Air
Electricity is used to compress air into small or large modular storage tanks or a large underground cavern. The compressed air is used to spin turbines when electricity is needed.
Estimated Global Installed Capacity of Energy Storage

- **Pumped Hydro, 123,390 MW**
- **Batteries, 14,296 MW**
- **Molten Salt, 142 MW**
- **Flywheels, 42 MW**
- **Compressed Air, 740 MW**
- **Thermal Storage, 1,002 MW**
- **Capacitors, 0.5 MW**
- **Solar Thermal, 72 MW**
- **Other, 16,295 MW**

Global Total: 138,683 MW

Source: Strategen Consulting, LLC
Thank you!!