

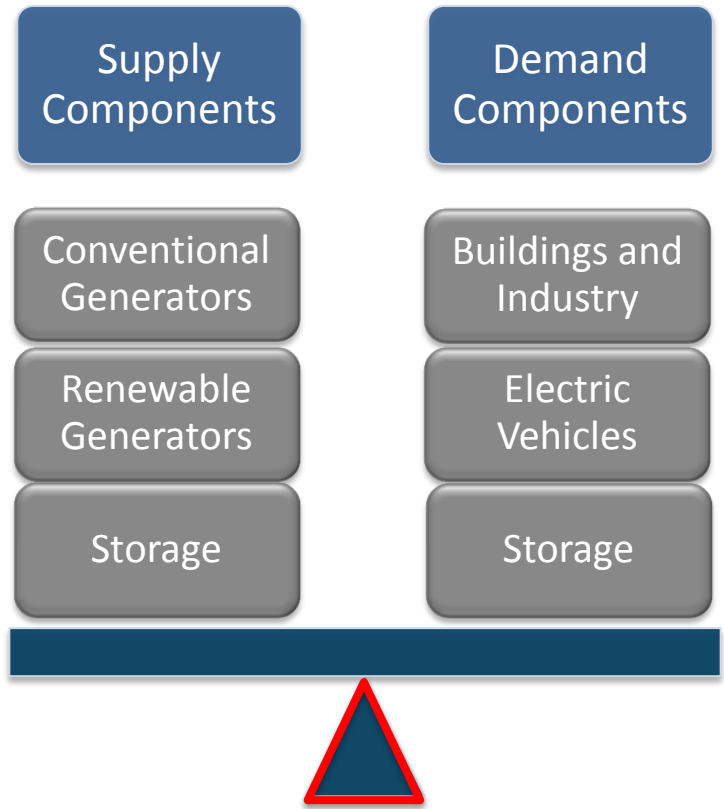
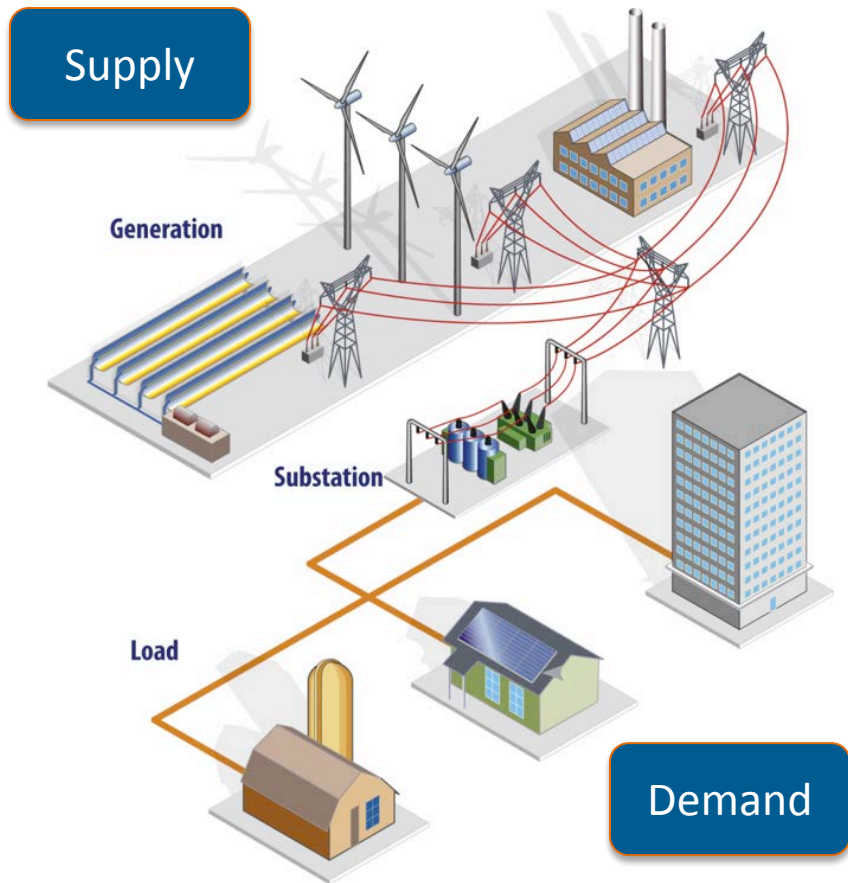


Integration of Variable RE: Enabling Technologies

Ilya Chernyakhovskiy

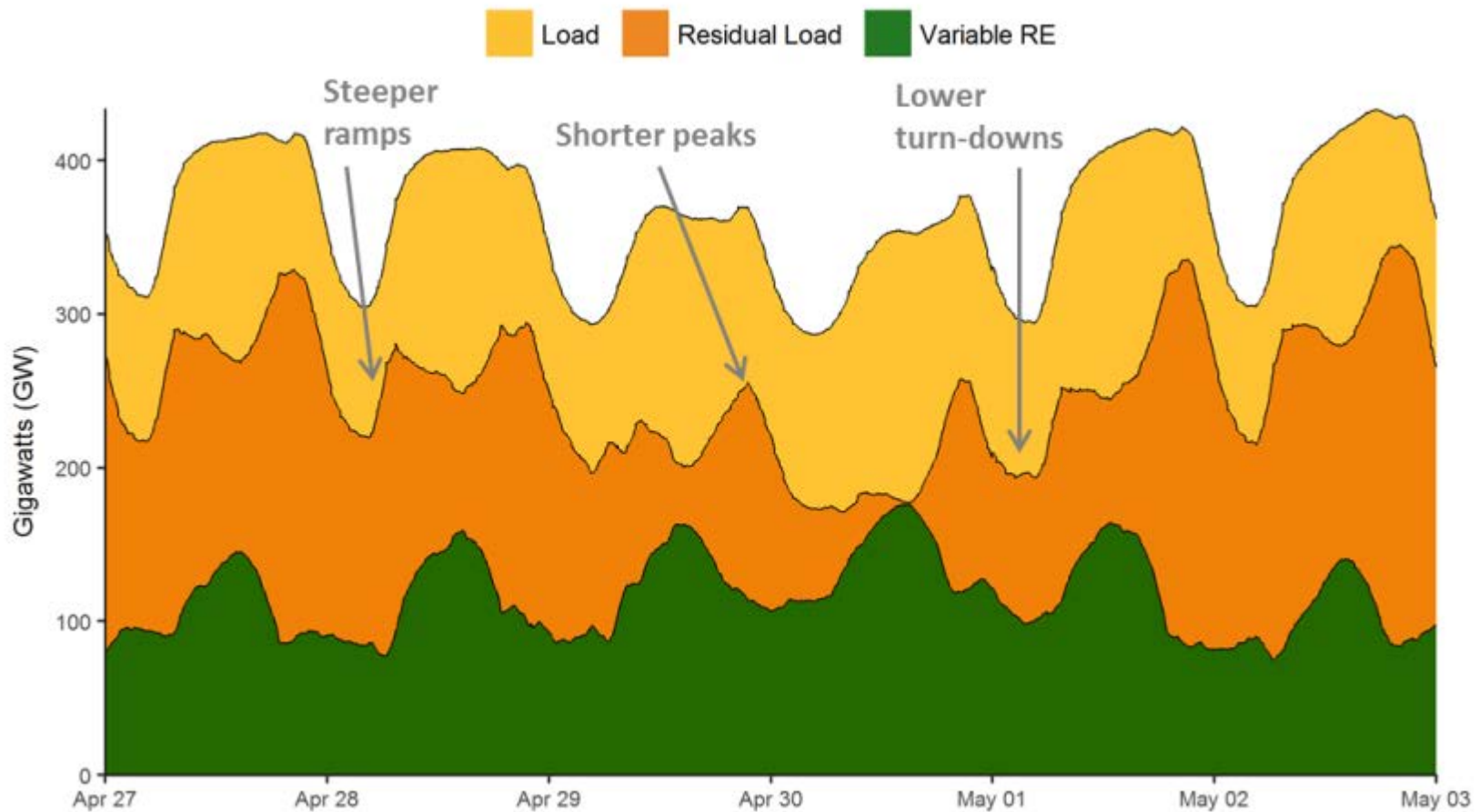
15 June 2017

Grid Operations—A Matter of Balance



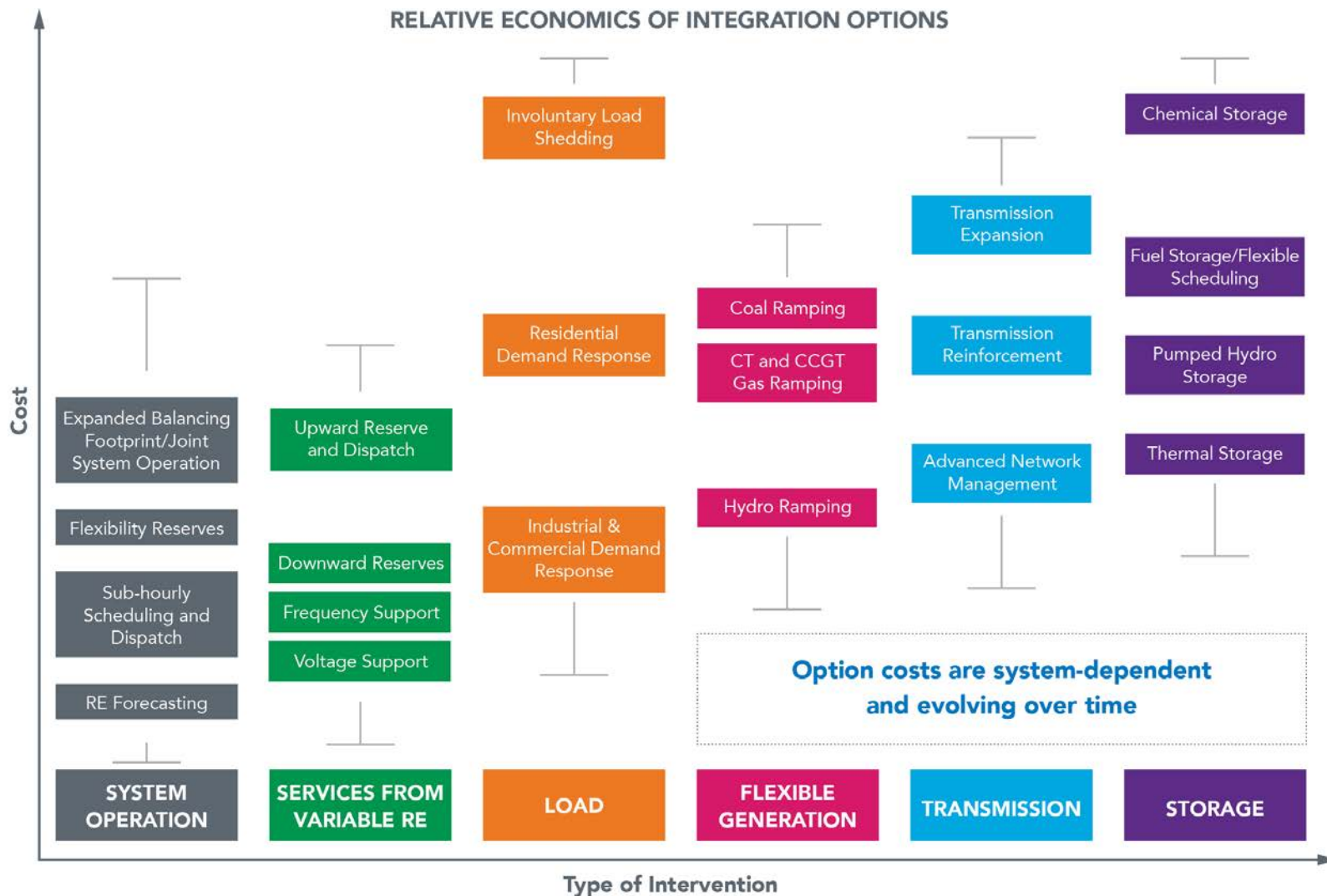
Supply and demand are both variable. The power system keeps these in balance at all times.

Wind and Solar Add Variability to the Supply Side

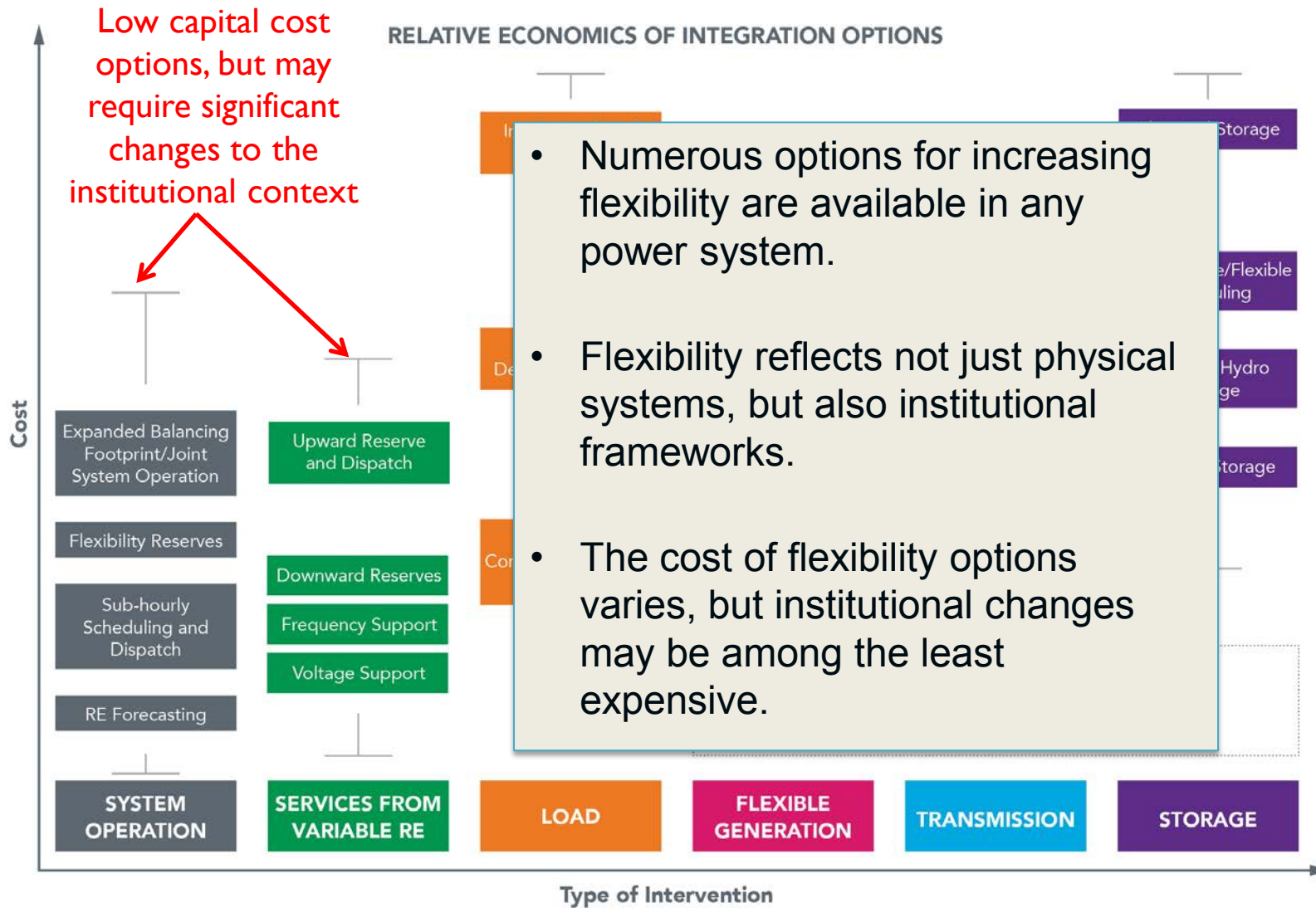


Flexibility: The ability of a power system to respond to change in demand and supply

Different Sources of Flexibility Help to Address Variability and Uncertainty



Different Sources of Flexibility Help to Address Variability and Uncertainty



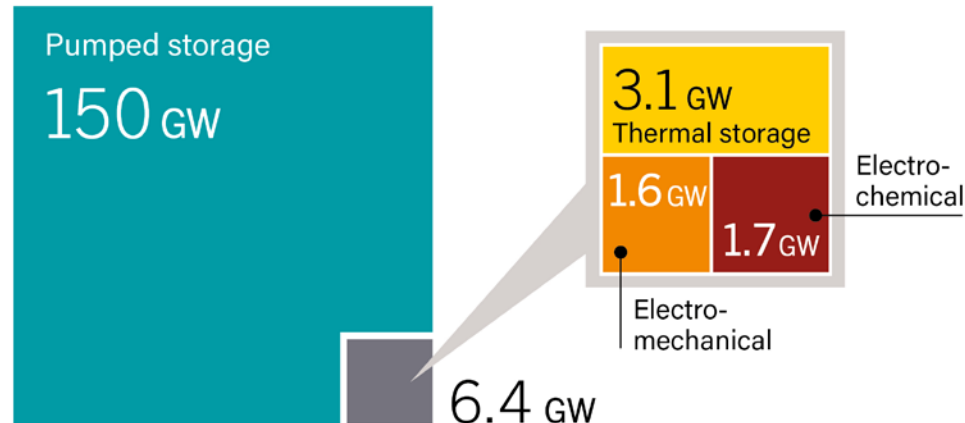
Enabling Technologies and Energy Systems Integration

Storage can provide **system benefits** and **flexibility** to customers, system managers and utilities

Global grid-connected and stationary energy storage capacity in 2016 : **156 GW**

Can be applied from the **household level** to **utility-scale**

Global Grid-Connected Energy Storage Capacity, by Technology, 2016



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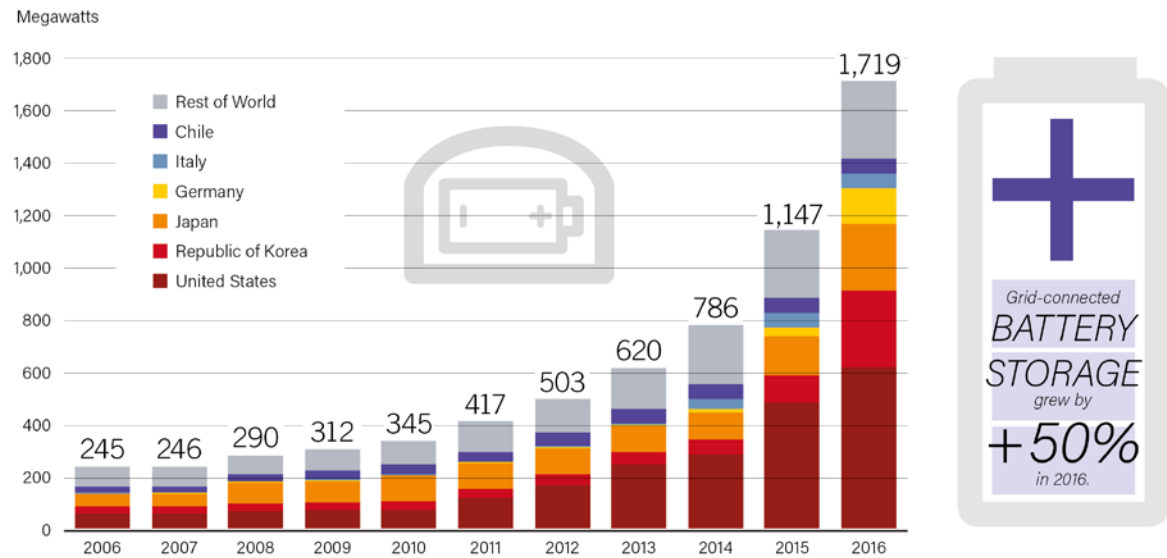


Enabling Technologies and Energy Systems Integration

Grid-connected battery storage grew by **50%** in 2016.

Leading countries:
US, Republic of Korea, Japan, Germany, Italy, and Chile
(excluding off-grid renewables for energy access)

Global Grid-Connected Stationary Battery Storage Capacity, by Country, 2006-2016



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REN21 Renewable Energy Policy Network for the 21st Century

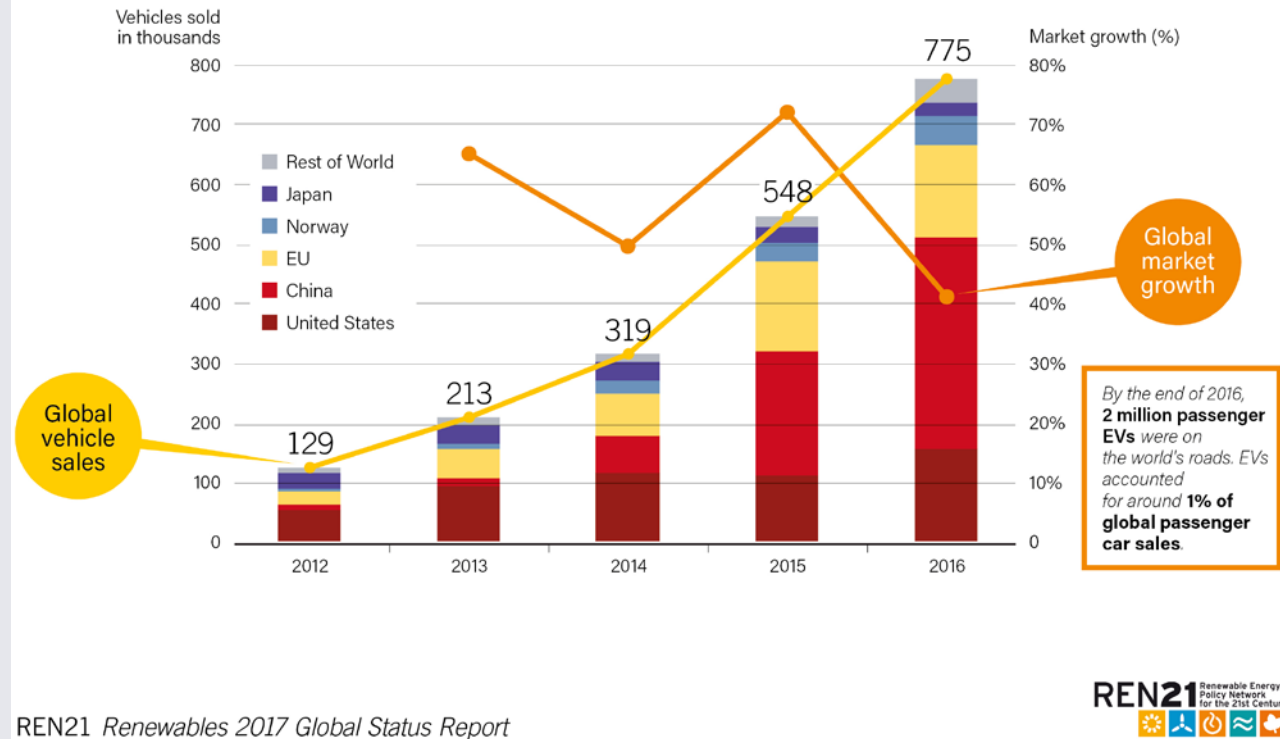
Enabling Technologies and Energy Systems Integration

Global sales of EVs reached **775,000 units**

More than **2 million passenger EVs** were on the world's roads by year's end (1% of the light vehicle market)

To date, limited linkage of renewable energy and electric mobility

Global Passenger Electric Vehicle Market (Including PHEVs), 2012-2016



REN21 Renewables 2017 Global Status Report