



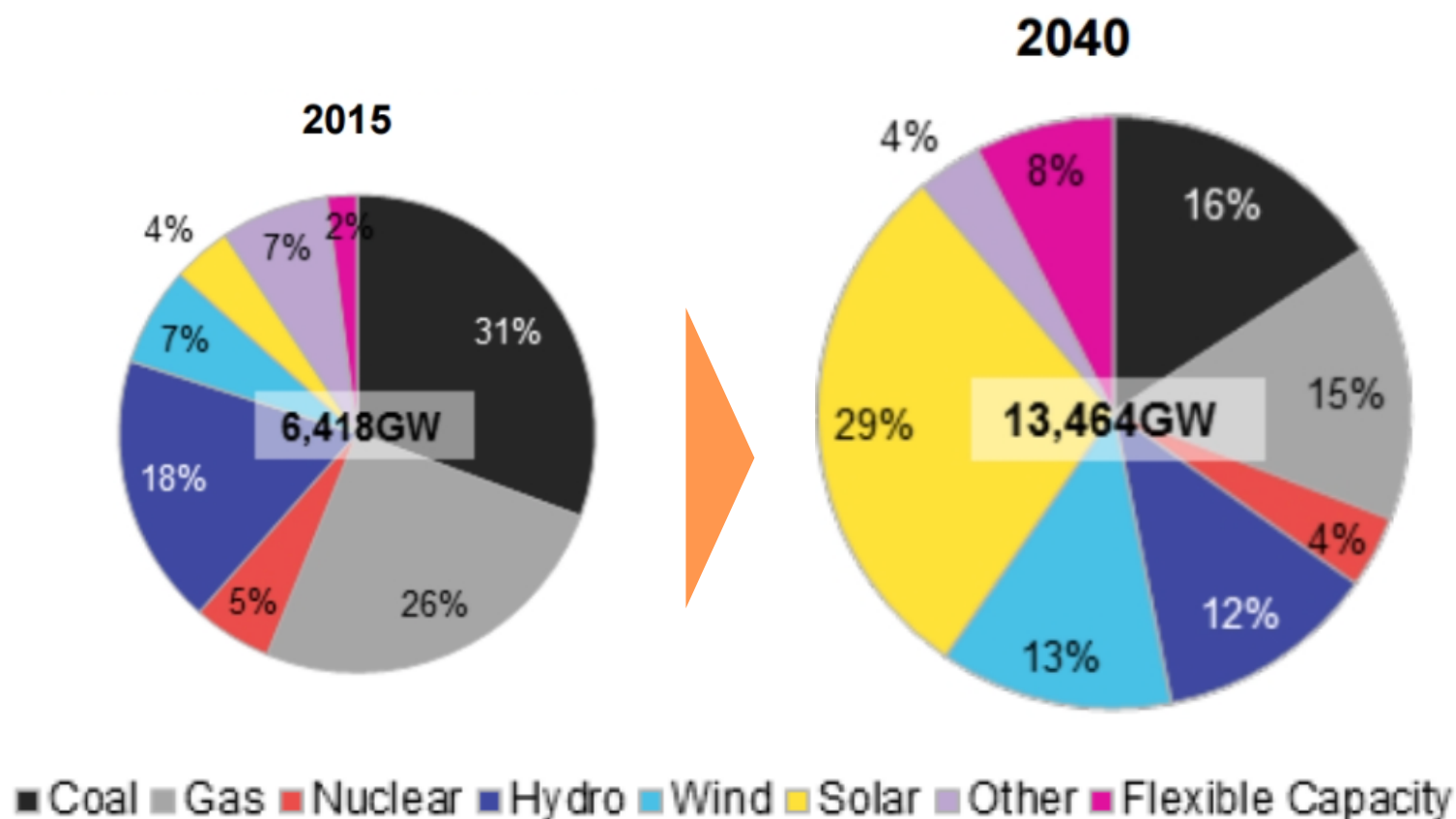
# Bulk Storage Solutions for RE Grid Integration & Mega Projects

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## Game-changing growth of RE in the global energy mix

Intermittent solar and wind energy will represent an increasing share of the global energy mix, driving an exponential growth in storage solutions...

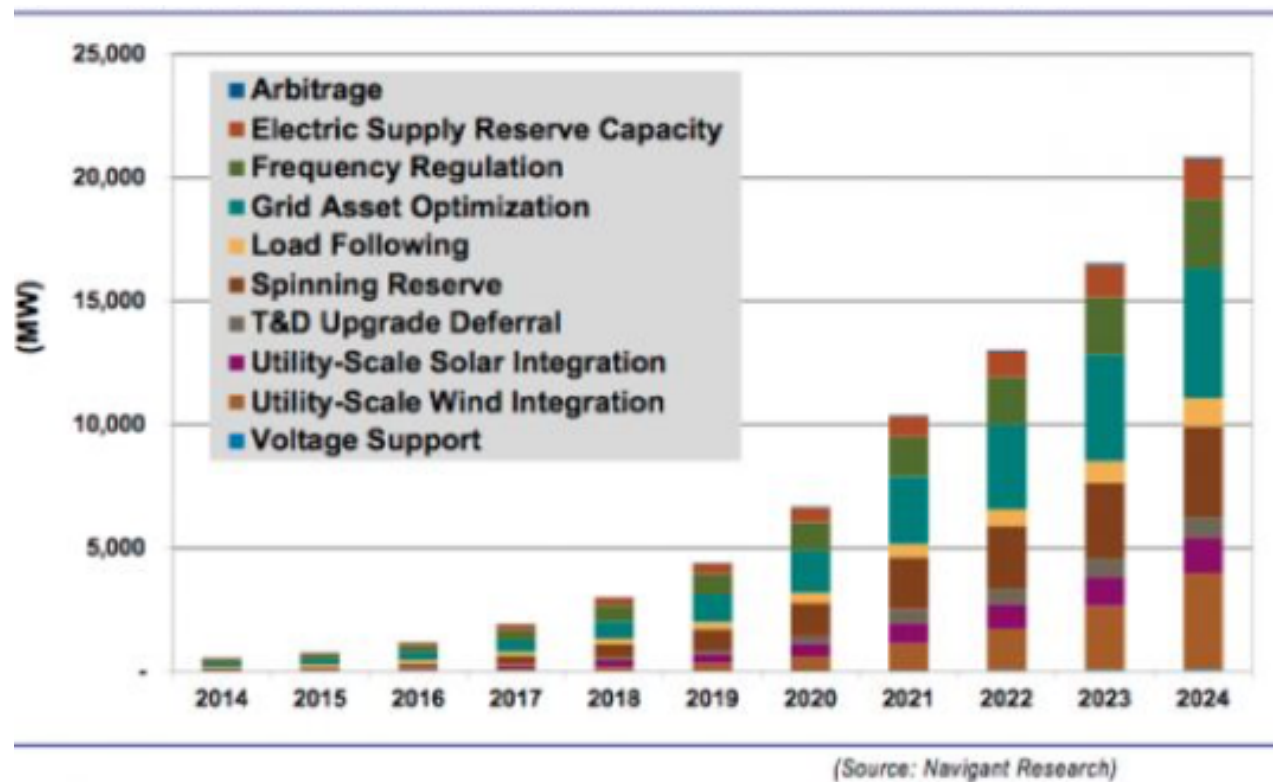


Source: BNEF, 2016

# Exponential rise of the global storage market

High RE penetration, grid integration and balancing and the rise of Mega solar & wind projects will drive the need for **Bulk storage solutions**

## Annual Global Growth of Storage Applications



20 GW/year  
post-2025

### Growth drivers

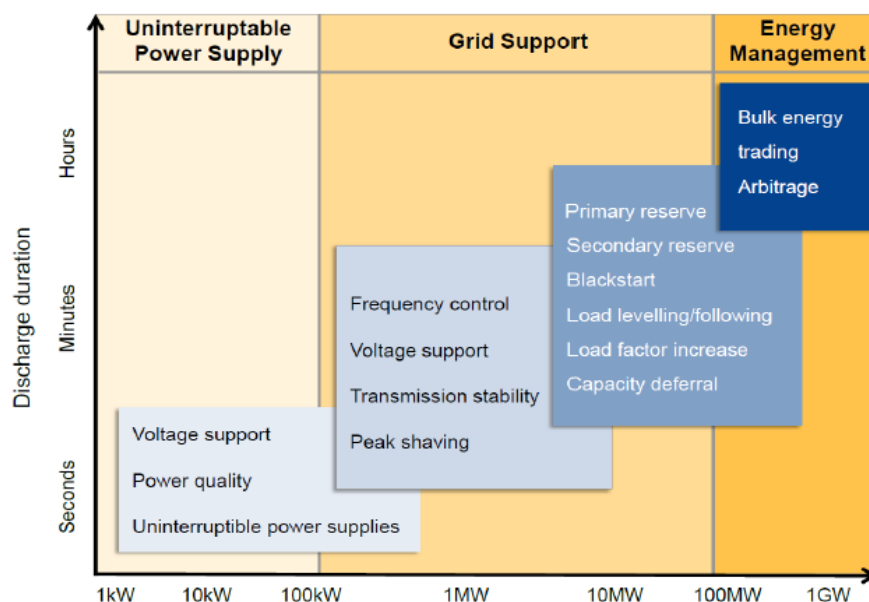
- ✧ Rapidly falling costs
- ✧ RE integration
- ✧ Island & remote grids
- ✧ Mega-scale plants

# The role of Bulk storage in grid management

A limited number of Bulk storage technologies match the need for grid-level *Energy Management* for RE's integration, balancing power and arbitrage

## Bulk storage for Grid Support & Energy Management

### Range of Storage Applications



### Bulk storage technologies

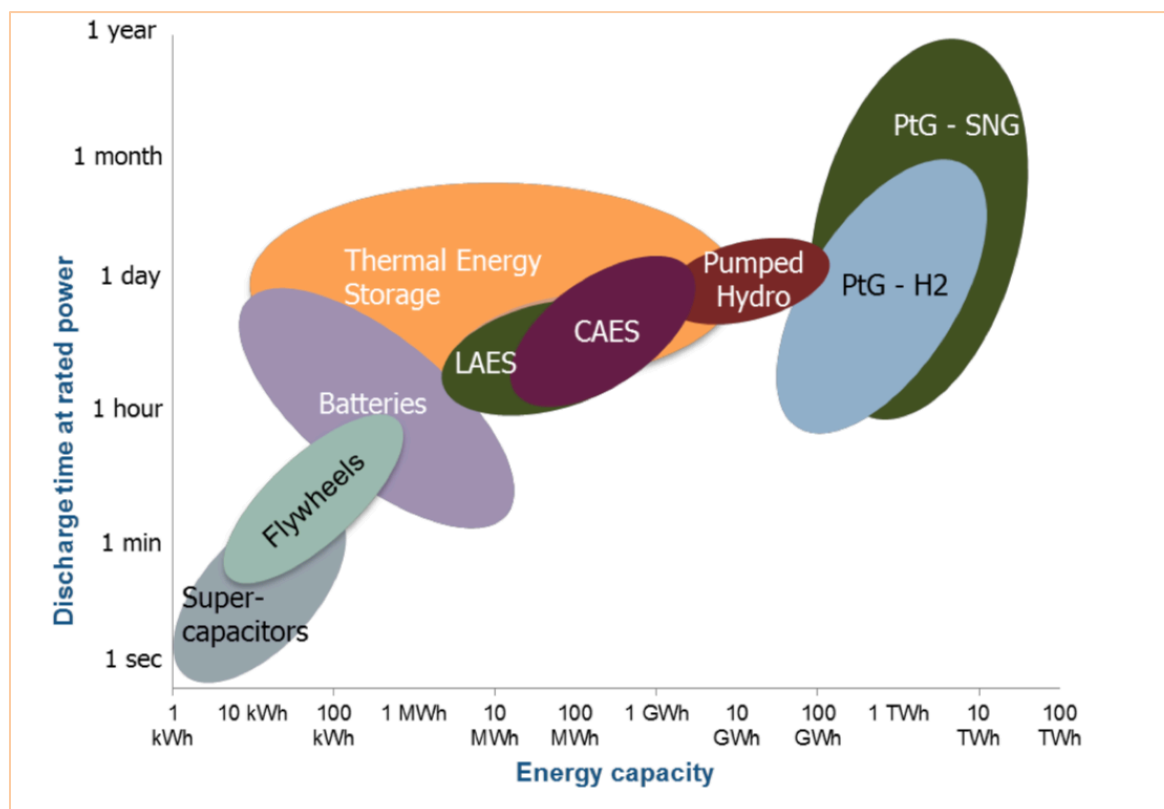
- ✧ PHS – Mature, Mass deployment
- ✧ CAES – Mature, Limited deployment
- ✧ LAES – Commercial Pilot
- ✧ Gravity – Concept

Source: 2016

## Competing Bulk storage solutions

Gravity storage solutions will compete with PHS, CAES and LAES storage technologies in the range from 100's of MWh to multi GWh

### Storage technologies by *Energy Capacity* and *Discharge Time*



Source: Sterner, 2014



# Bulk storage for Multi-GW RE projects

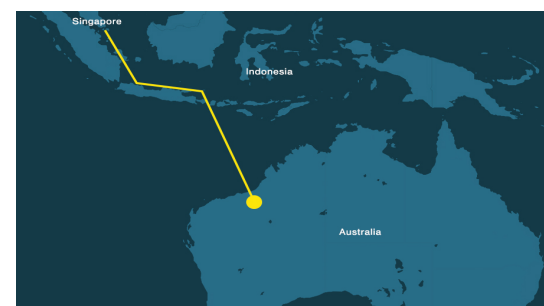
Multi-GW solar & wind projects will represent a key element in the global growth of RE and drive the demand for **flexible Bulk storage solutions**

## The Newsroom



## A Case Study

### Asian Renewable Energy Hub - \$13 B



- ✧ 4GW of wind and 2GW of solar generation
- ✧ Two subsea power cables from Australia to Jakarta and Singapore
- ✧ Over 15 TWh of electricity esported every year
- ✧ A design life of 60 years

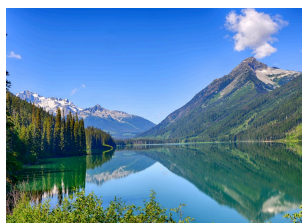
## Bulk storage for multi-GW “Mega” RE projects

Although PHS is already being deployed to support multi-GW solar & wind projects, it is often not suitable due to its unique characteristics & constraints



**Al Hattawi  
PHS  
(UAE)**

- 250 MW @ Rashid Al Maktoum solar park
- 1 GW of solar power by 2020, 5 GW by 2030



**Duffey Lake  
PHS  
(USA)**

- 1150 MW @ Washington State
- Intergation of high wind power penetration

### Limitations to PHS

- ✧ Topographical
- ✧ Hydrological
- ✧ Licensing



### New Bulk storage technologies

- ✧ Co-located at generation site
- ✧ Widely deployable
- ✧ Cost-competitive