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Smart grids and energy storage: Enabling RE deployment

4th Annual MENA Clean Energy Forum
8th December 2015

Renewables competitiveness

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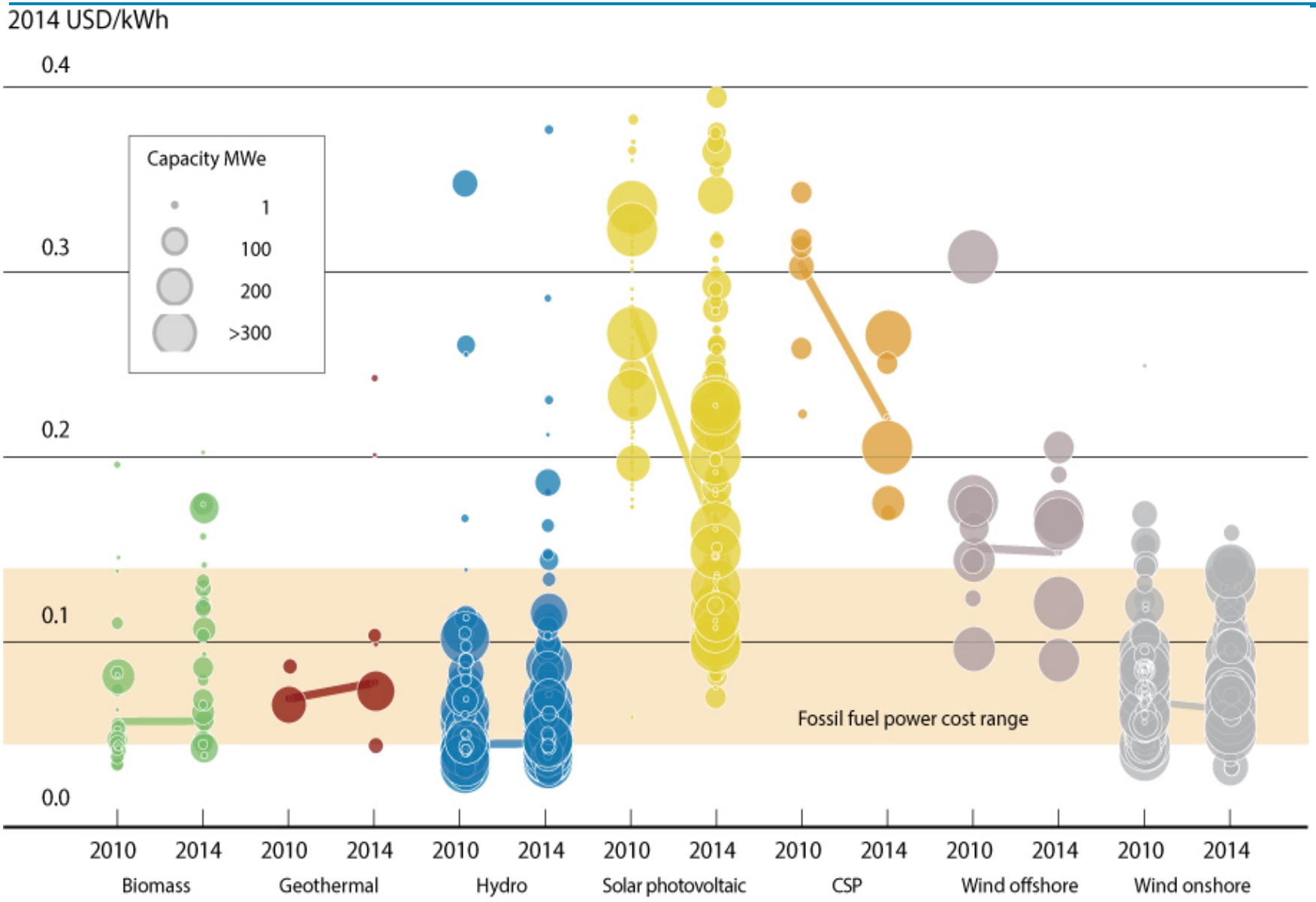

Newly installed RE generation capacity

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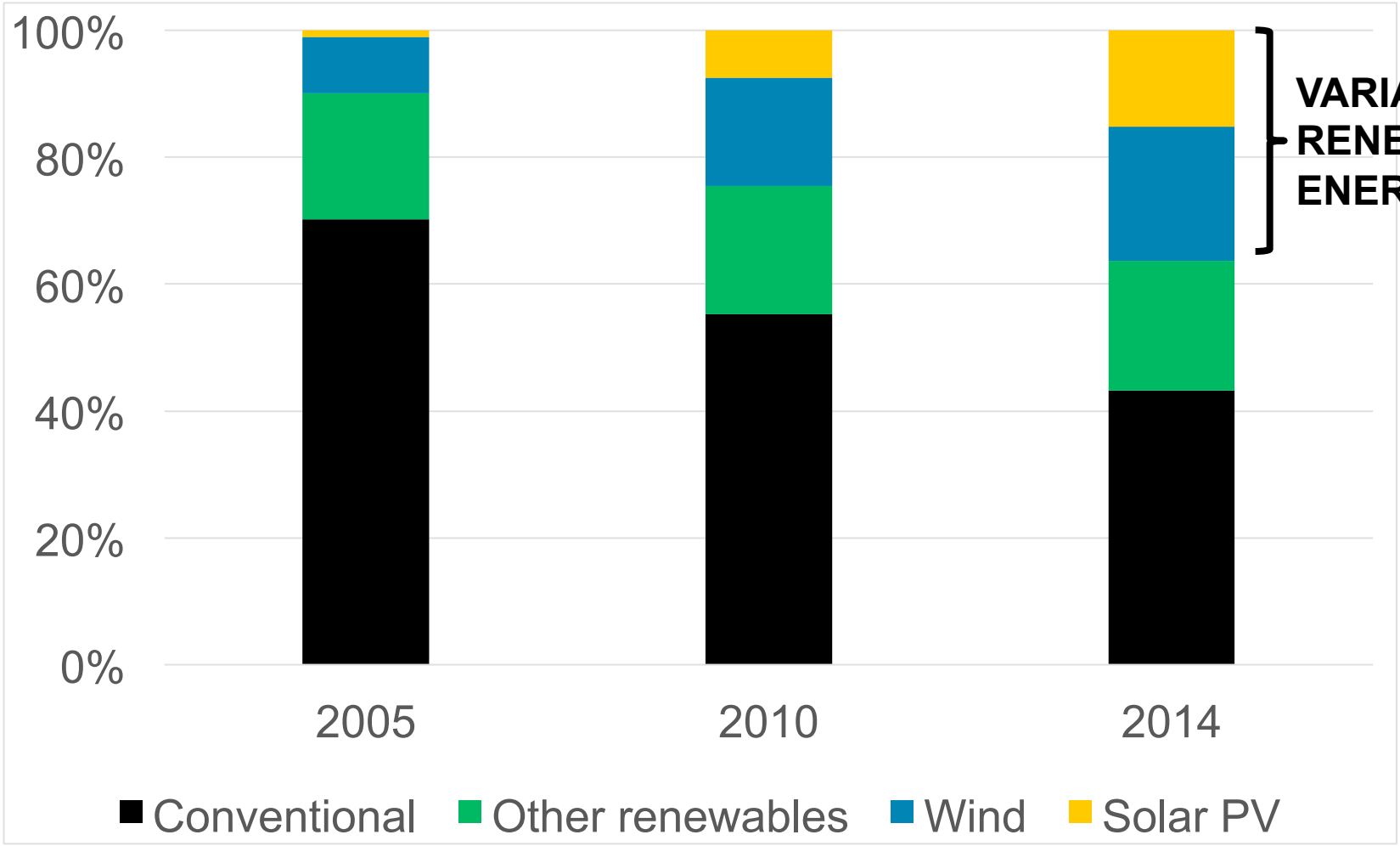
2015: 50-55 GW solar PV - >200 GW installed capacity worldwide
55-58 GW wind power - >400 GW installed capacity worldwide



The Growth of Solar PV and Wind Power

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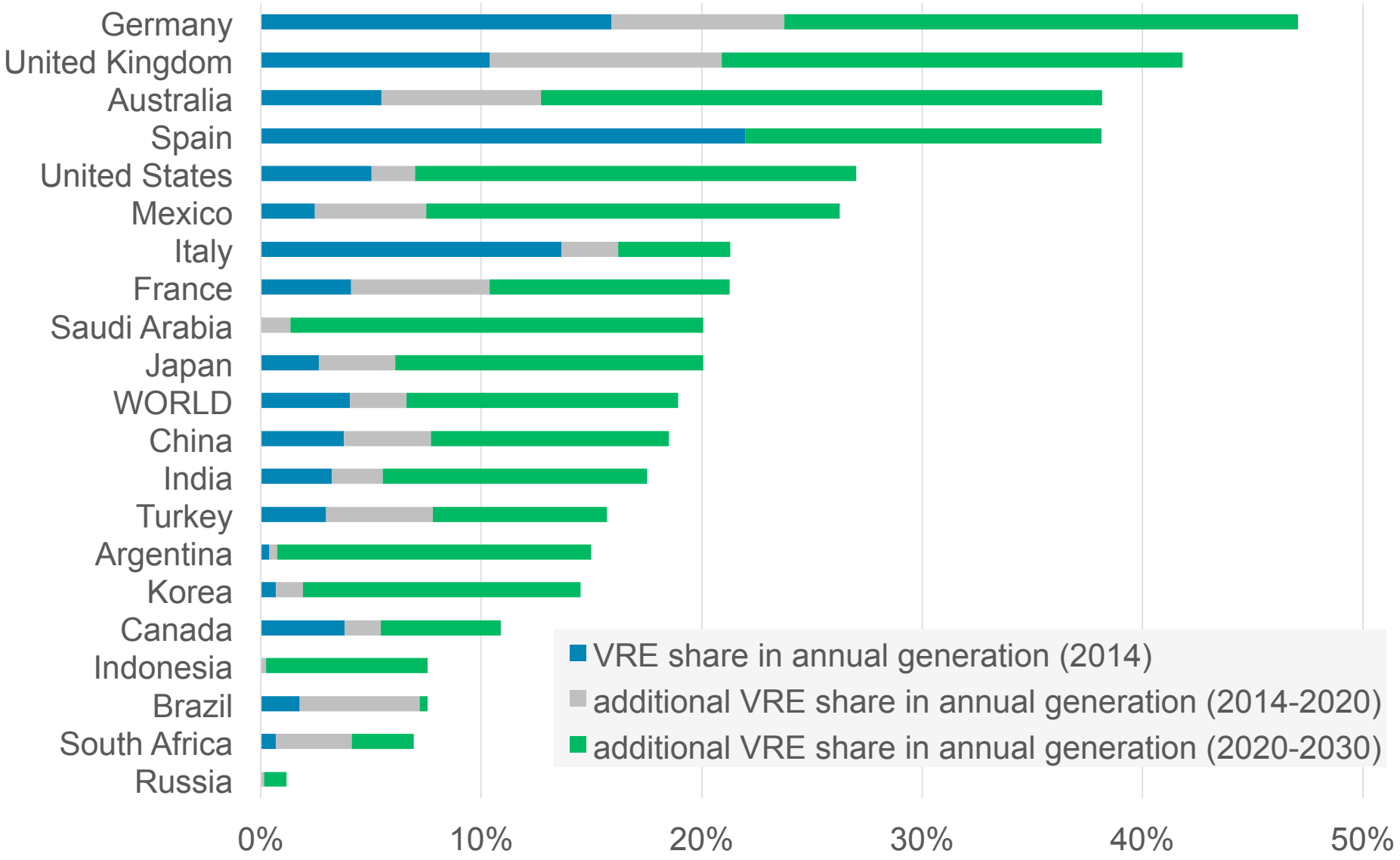

Smart grid options for RE support

Technology	Maturity	Availability / Market penetration	Capital and O&M costs	Typical payback	Risks/ Disadvantage
Advanced metering					
Advanced electricity pricing					
Demand response (DR)					
Distribution automation (DA)					
Renewable resource forecasting					
Smart inverters					
Distributed storage					
Virtual power plants (VPPs)					
Microgrids					
Flexible AC transmission					
Direct current (DC) links, incl. HVDC transmission					
Bulk storage					
Dynamic line ratings (DLR)					
Synchrophasors (PMUs)					

generally positive	generally neutral	generally negative

Smart grid for RE integration

1. Engage with grid operators from the start
2. Enable better collaboration between transmission grid and distribution grid operators
3. Engage consumers to provide balancing and metering solutions
4. Consider the total system cost
5. Find the right level of embedding ICT
6. Support learning on linkages between different energy carriers
7. Support learning on role of electric vehicles

Smart grid projects starting from 2002 and ending up to 2006.

Smart grid projects starting from 2011 and ending up to 2015.

Data: JRC

Cost-benefit for smart grids and renewables

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- Step-by-step guide to assess the costs and benefits of smart grids technologies in **developing** countries
- Two methods:
  - Set RE target
  - Additional RE deployment
- Quantitative assessment of smart grid benefits for:
  - Reduced ancillary service costs
  - Deferred distribution investments
  - Reduced equipment failures
  - Reduced distribution operations costs
  - Reduced electricity losses
  - Reduced major outages
  - Reduceds sags and swells

Jamaica: Demand response programme
(Costs for utility: USD 5,400k)

Benefit	NPV (USD)	Primary beneficiary
Optimized generator operation	1,300k	Utility
Reduced generation capacity investments	15,000k	Utility
Reduced electricity losses	450k	Utility
Reduced sustained outages	13,000k	Customers
Reduced CO_2 emissions	120k	Society
Reduced SO_x, NO_x, and PM-10 emissions	70k	Society

Comparing technologies

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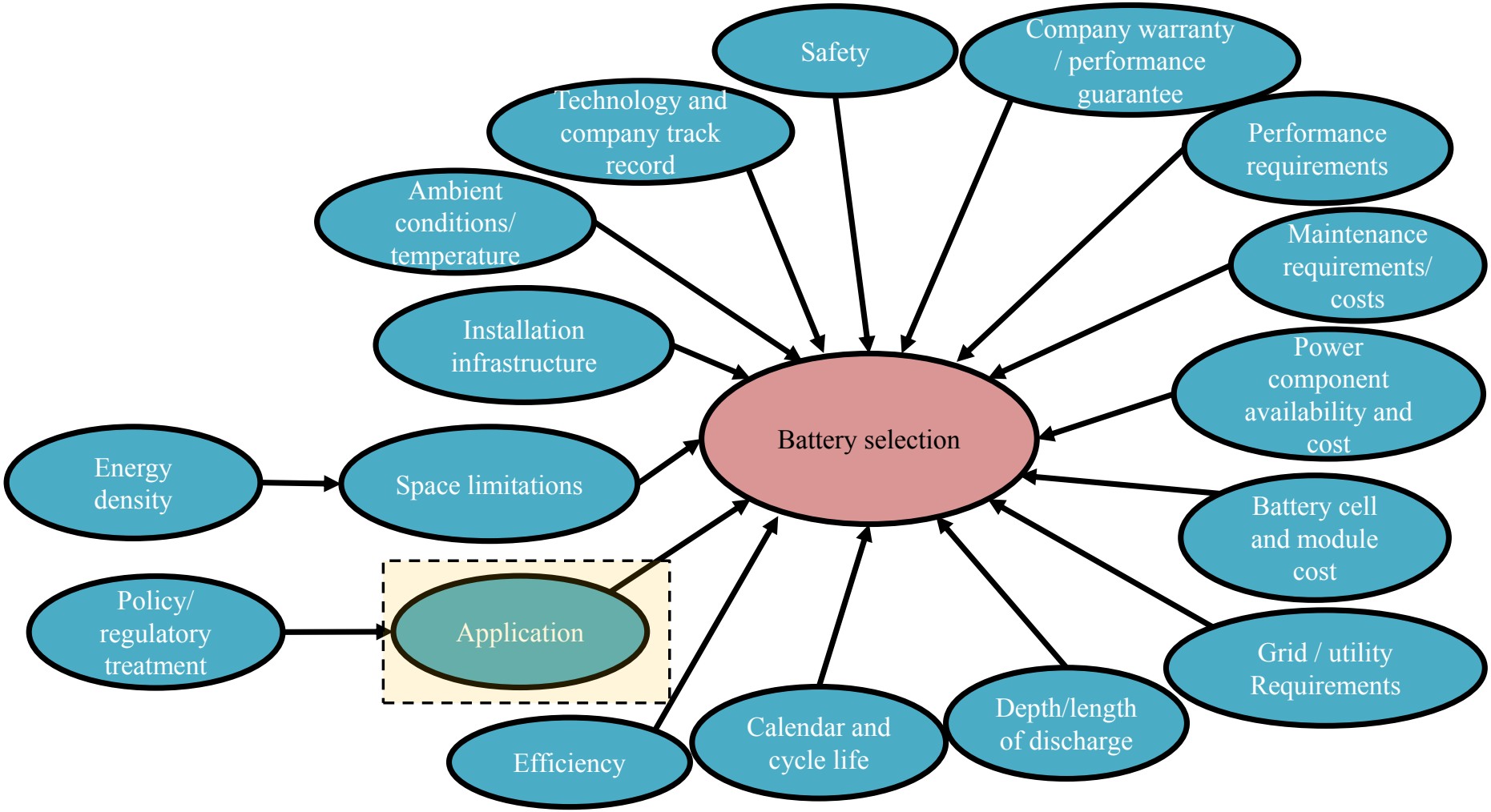
	Pumped hydro	Lead-acid	Li-ion	Flow battery	Molten salt	Fly-wheel	Super-capacitor	CAES	Hydro-gen
Output (MW)	250 – 1000	0.01 - 10	0.01 - 30	0.01 – 30	1 – 200	0.01 – 10	0.1 – 10	110; 290	10 – 100
Depth of discharge %	100	50	80	70 – 90	90	90	90	90	100
Discharge time	Hrs	Min – Hrs	Min - Hrs	Hrs	Hrs	Sec – Min	Sec -	Min - Hrs	Hrs
Efficiency (%) - DC	70 – 80	70 – 80	90	75 – 80	75 – 85	90	95	40 - 70 (A)	70 – 80
Cycles	>50 000	300 - > 800	1000 - > 5000	> 10000	> 10000	> 50000	> 50000	> 50000	> 50000
Lifetime	30+	3 – 10	8 – 15	10 – 20	10 – 20	10 – 20	10 – 20	30+	10 – 20
Investment (USD/kW)	2000 – 4000	500 - 1500	1500 - 5000	2000 - 4000	4000	300 – 1000	1500 – 2500	850 - 2000	650 - 2300
Storage costs (USD/kWh)	50 – 150	150 – 600	600 - 2000	500 – 850	500	4000 - 6000		100 - 1000	
Cycle costs (USD/kWh/C)	0.05 – 0.15	0.2 – 0.5	0.15 – 0.50	0.1 – 0.25	0.0[illegible] – 0.12	0.05 – 0.11			

Comparing storage options



Roadmap action agenda

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SYSTEM ANALYSIS FOR STORAGE

- Engage and guide policy makers
- Provide systemic economic assessment models
- Support system analysis of electricity/ heat/fuel/ productive uses as storage options

STORAGE IN ISLANDS AND REMOTE AREAS

- Facilitate financing
- Create local value chains
- Develop a global database with practical example
- Guide policy makers to the required tools

CONSUMER-LOCATED STORAGE

- Comparative information sheets and labelling
- Accelerate standards on safety and recycling
- (Data) ownership and liability regulation

GENERATOR-LOCATED STORAGE

- Support the development of innovative regulation
- Support for localised/distributed systems

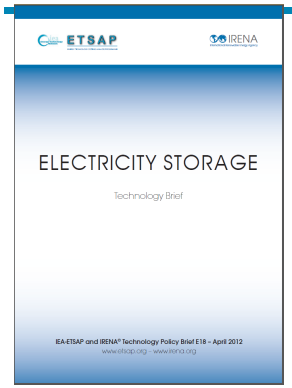
GRID-LOCATED STORAGE (TRANSM. & DISTR.)

- Pumped hydro and compressed air energy storage (CAES) analysis
- Demonstration projects for new business models

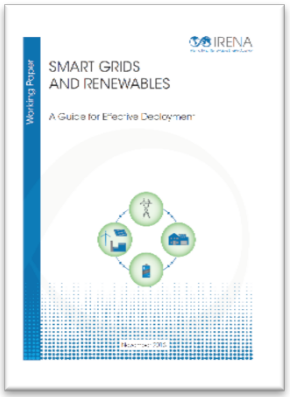
Supporting power sector transformation

Selected measures:	What technologies are available?
Grid Codes	Smart inverters
Forecasting	Forecasting / nowcasting tools; Control systems
Performance reporting	Smart inverters; Distribution automation; Communication protocols
Nodal pricing for congestion Management	FACTS; Synchrophasors; Distribution automation; Dynamic line rating
Public engagement	Advanced metering; Advanced electricity pricing
Reliability reporting	Smart inverters;
New models for self-consumption	Distributed battery & EV management; virtual power plants; Distributed heat/cold storage; Advanced metering
Demand side management	Advanced metering; Advanced electricity pricing
Subhourly scheduling and power markets	Flexibility upgrades; Virtual power plants; controllable VRE
Control power markets and procurement	Controllable VRE; Flexibility upgrades; Virtual power plants; Pumped hydro; Distributed battery; Forecasting; Direct load control
Ensuring capacity adequacy	Controllable VRE; Reserve Capacity; Pumped hydro; Distributed battery;
Market integration and cooperation	HV AC/DC lines; Interconnectors
Data ownership rights	Smart meters; Distribution automation; Distributed battery and EV management; Virtual power plants; Direct load control

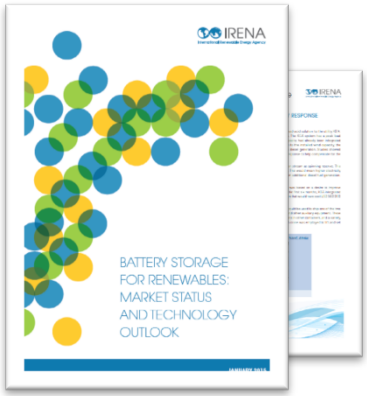
Background documents



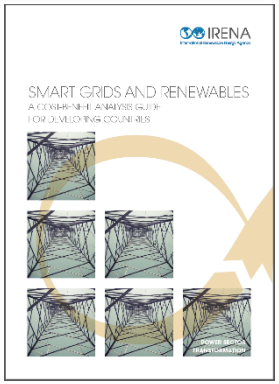
Technology overview on electricity storage



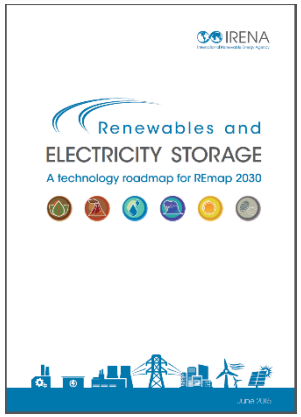
Overview of smart grid technologies for renewbles



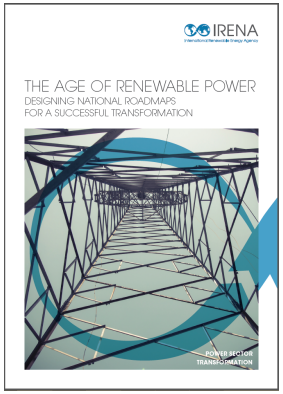
Battery storage: technology status and market outlook



Cost-benefit analysis for smart grids supporting renewables integration



Action agenda for renewables and electricity storage



Role of smart grid technologies and storage in national power sector transformation

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