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The IRENA Electricity Storage Valuation Framework

Presenters:

- Heather Worley, Energy Storage Partnership, ESMAP, World Bank
- Emanuele Taibi, Power Sector Transformation Strategies team, IRENA

THURSDAY, 16 APRIL 2020 • 3:00PM – 3:30PM CET

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April 2020

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ESMAP

IMPROVING STORAGE KNOWLEDGE THROUGH COOPERATION

Energy Storage Partnership

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ESMAP Energy Sector Management Assistance Program

australian energy storage alliance

Alliance for Rural Electrification
Shining a Light for Progress

BERA Belgian Energy Research Alliance

BVES BUNDESVERBAND ENERGIESPEICHER

cigre For power system expertise

CNESA China Energy Storage Alliance

CSIR our future through science

Department for Business, Energy & Industrial Strategy

UKaid from the British people

DTU

中国化学与物理电源行业协会储能应用分会
Energy Storage Applications Branch of China Industrial Association of Power Sources

European Bank for Reconstruction and Development

EASE European Association for Storage of Energy

ESA Energy Storage Association

THE FARADAY INSTITUTION

GLOBAL BATTERY ALLIANCE

IDB

iea

IESA India Energy Storage Alliance

UKRI

Innovate UK

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IRESEN Institut de Recherche en Energie Solaire et en Energies Nouvelles

beyond leading technology KIAT Korea Institute for Advancement of Technology

KBIA Korea Battery Industry Association

Loughborough University

LCEDN

masen

NPL National Physical Laboratory

National Research Council Canada

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Electricity Storage Valuation Framework:

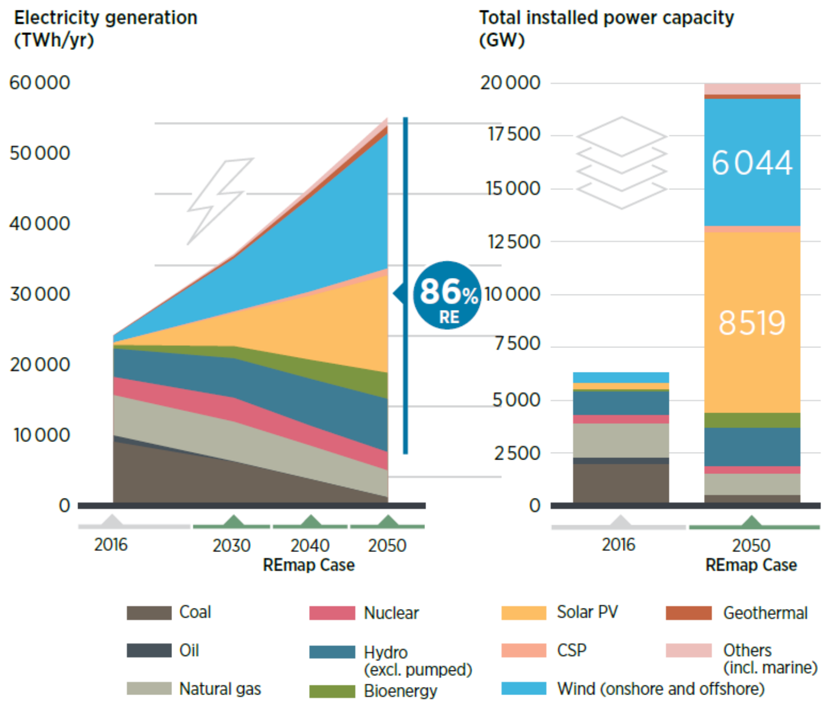
Assessing system value and ensuring project viability

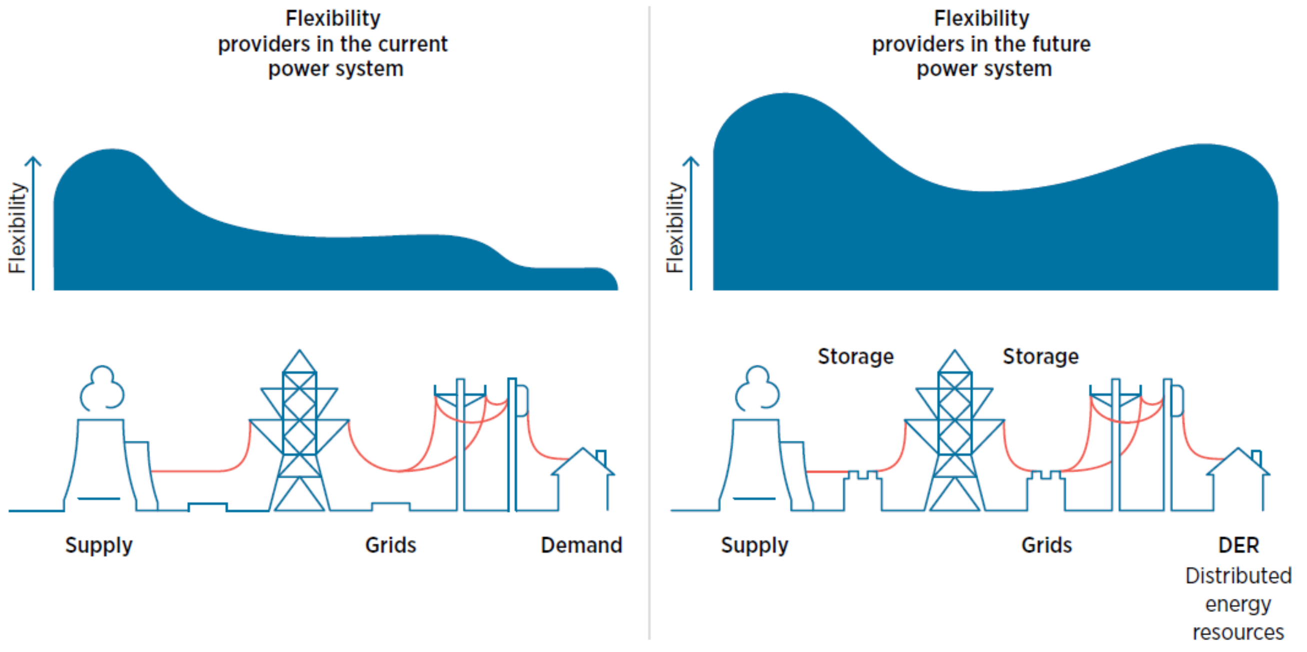
Emanuele Taibi

#IRENAinsights webinar
16 April 2020

System flexibility is key to achieving the goals of the energy transition

- Solar and wind power could contribute more than 85% of total electricity demand by 2050
- Integrating high shares of VRE requires enhancing system flexibility at all parts of the energy system
- Electricity storage together with other flexibility measures (i.e. more flexible demand, flexible generation and smart transmission and distribution networks) could enable integration of VRE at very large shares





Part 1:

Overview for Policy Makers

The role of electricity storage for VRE integration

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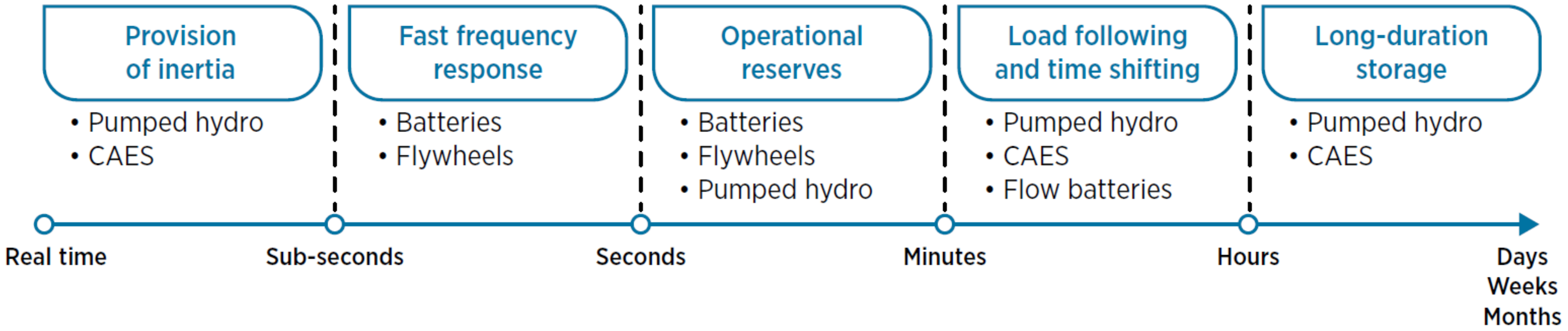
- Solar and wind power are variable and have limited predictability, affecting system operations at various time scales: need to increase system flexibility

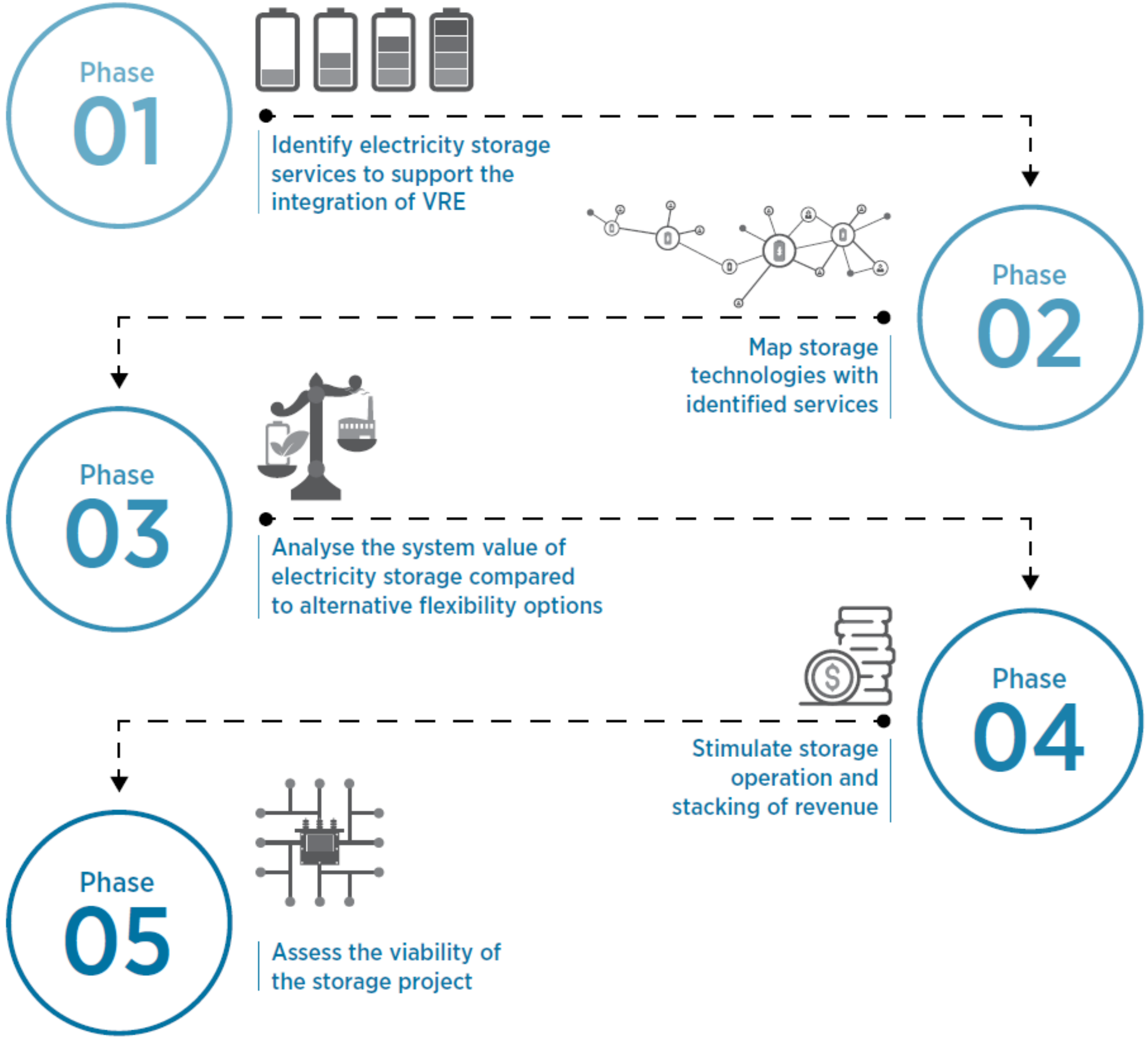
- **Electricity storage can support system operations at all time scales**



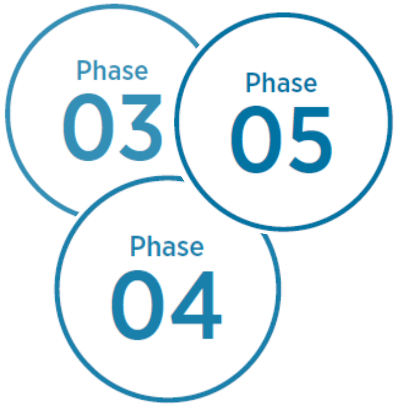
- **Storage co-located with VRE: Direct benefits to VRE**
  - ✓ Increases firm capacity (participation in capacity markets)
  - ✓ Reduces variability and uncertainty (participation in grid services markets)
  - ✓ Increases capture price

- **Stand alone storage: Indirect benefits to VRE by increasing system flexibility**
  - ✓ Reduces operational impacts of VRE
  - ✓ Defers need for other investments (e.g. peak capacity, T&D capacity)
  - ✓ Increases efficiency and reduces costs of grid services provision

The Electricity Storage Valuation Framework



Based on data gathering and application of a straightforward methodology



Based on different types of optimization models to carry out the analysis

Recommendations for different stakeholders

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For electricity storage developers

Get familiar with existing business models and collaborate closer with regulators and utilities to highlight system benefits of ES.

For vertically integrated utilities

Update planning tools to include ES and update procurement processes for services required, rather than specific technologies.

For regulators

Eliminate barriers for ES participation in different markets, create new markets and products able to capture the value of ES, make explicit provisions for all sources of flexibility – incl. ES – in IRPs.

For the research community

Support further development of tools and methodologies to perform ES valuation, develop scenarios to study benefits of ES.

Part 2:

Using power system models to assess value and viability

Phase 03 - System Value Analysis

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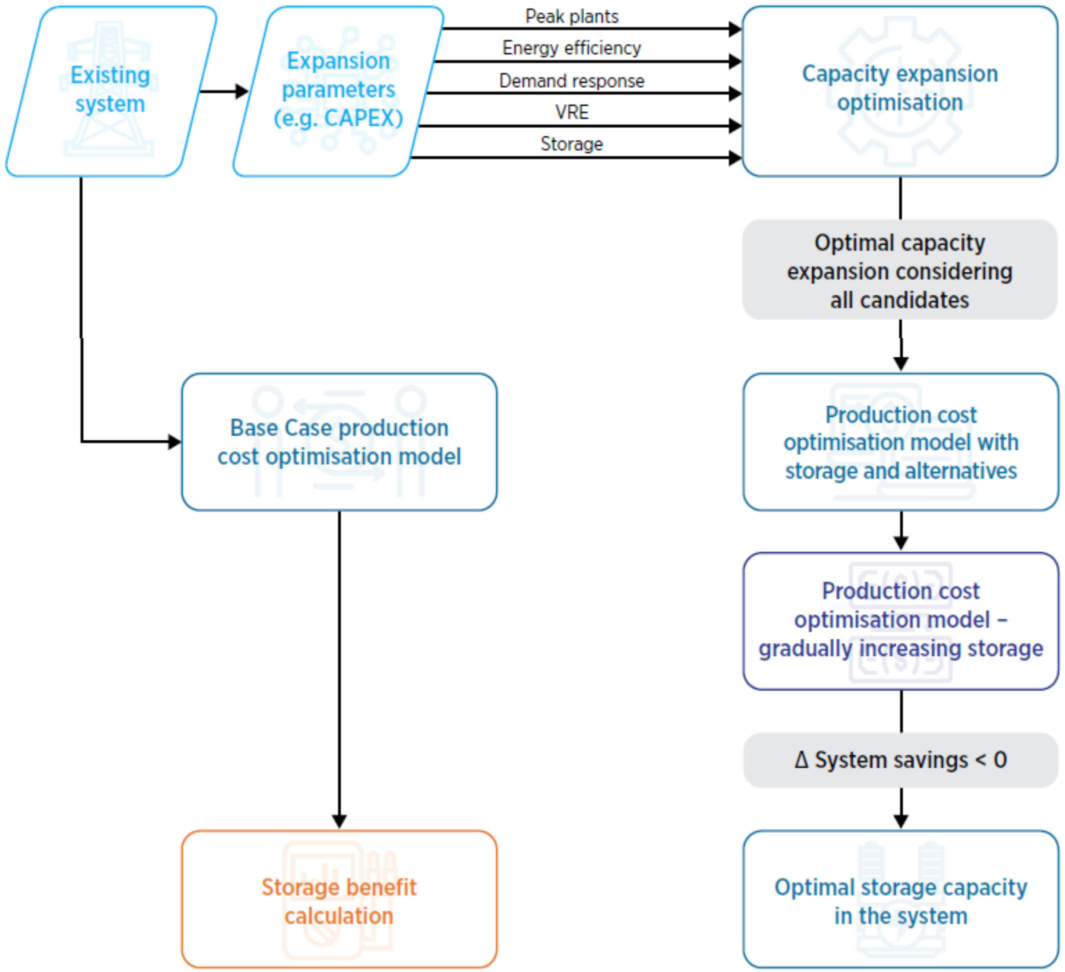


Capacity expansion model

- Compare electricity storage against alternatives
- Main outputs:
  - First estimate of electricity storage needed
  - Estimation of CAPEX benefits of electricity storage

Production cost model

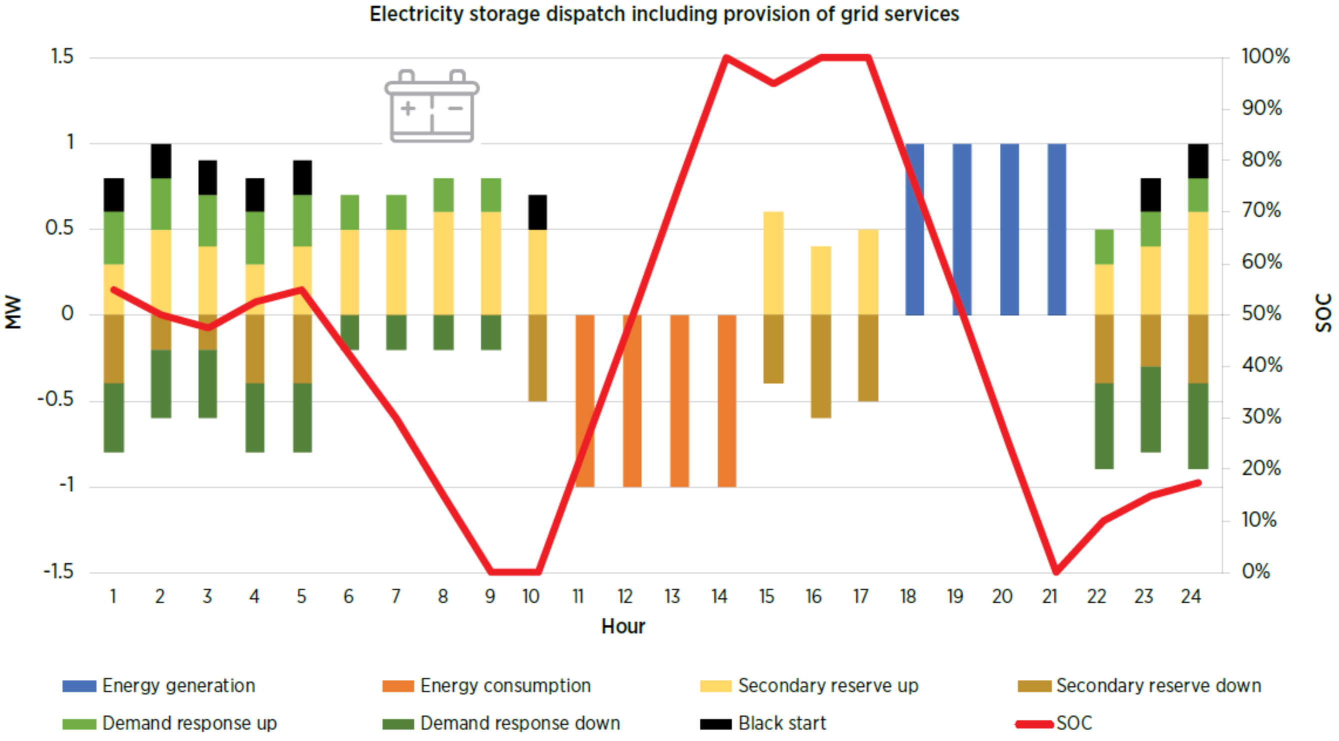
- Simulate the short term operation of electricity storage
- Main outputs:
  - Optimal capacity of electricity storage
  - Estimation of OPEX benefits of electricity storage

They key is to use a capacity expansion model for a first estimation but use an incremental production cost model to optimize electricity storage capacity

Phase 04 - Simulated Storage Operation

- Project level feasibility is assessed with a price taker dispatch optimization model
- **Inputs** for the price-taker storage dispatch model:
  - **From system value analysis**: energy prices, reserve prices, load, renewable generation
  - **From the user**: storage parameters, product durations, reserve utilization ratio
  - User selects services to be provided/markets to participate in

- The price taker model optimizes the dispatch of one selected storage project/pool
  - Gives insights for a marginal project (i.e. one small enough that does not change system-level variables like electricity price by changing its dispatch)
  - It is **important to consider future effect of storage deployment on system prices**



Phase 05

- Storage Project Viability Analysis

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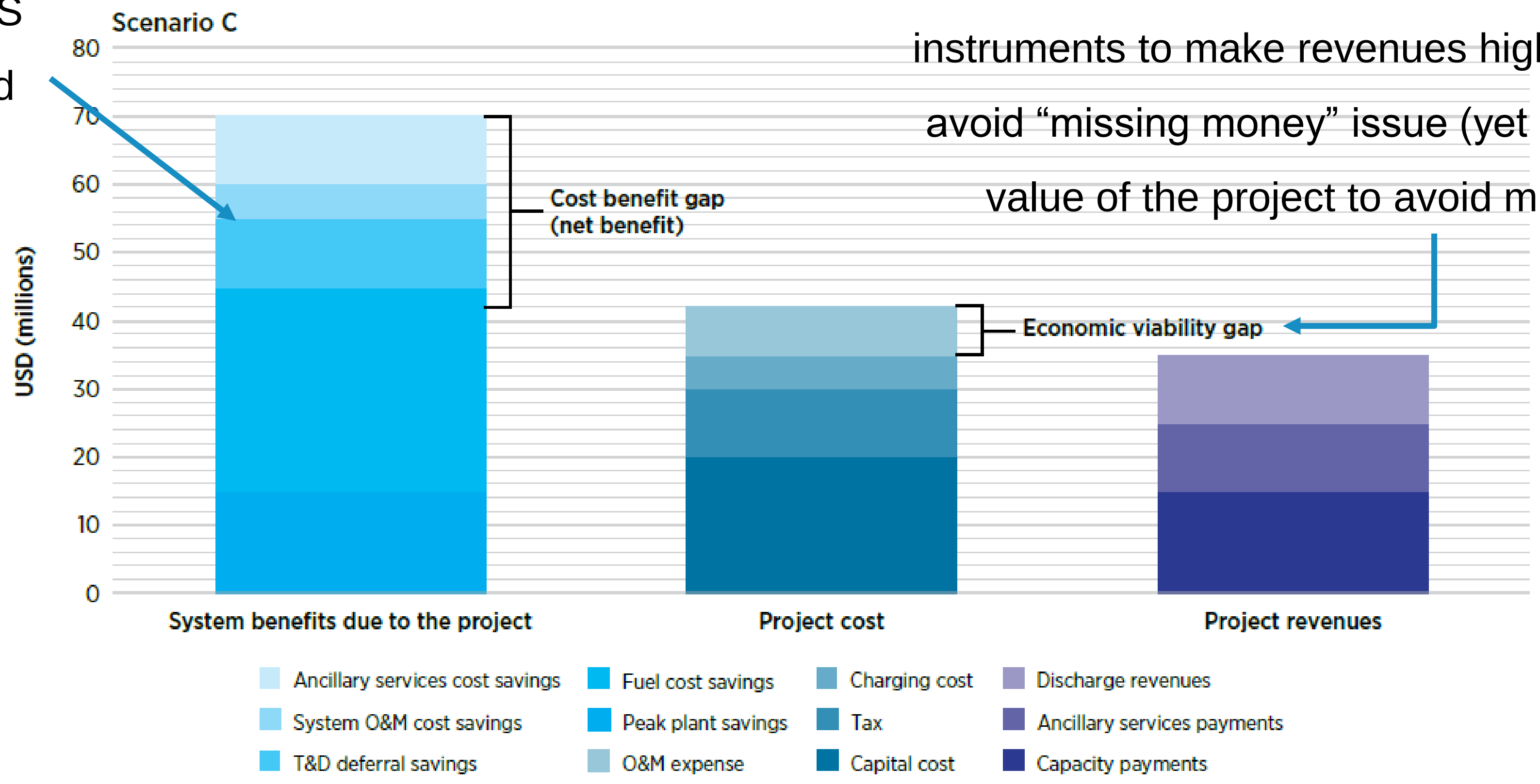
Reasoning: Some system benefits of ES cannot be monetized based on existing regulations

Goal: identify the "economic viability" gap between monetizable revenues for the project and its costs, testing instruments to make revenues higher than project cost to avoid "missing money" issue (yet lower than the system value of the project to avoid misallocated money)



A project will only be expected to materialize if monetizable revenues are more than project costs

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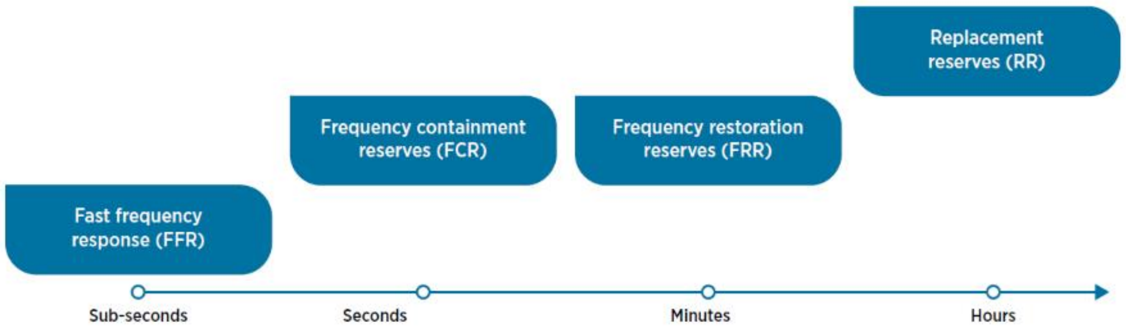
Part 3:

Real-world cases of storage use in power systems

Case 1: Operating Reserves

1. Challenge – Increased need of operational reserves and a faster response

- Operating reserves can be defined as the additional capacity above the capacity needed to meet the actual load, which is made available either on-line or on-standby to assist in case of a mismatch between demand and supply



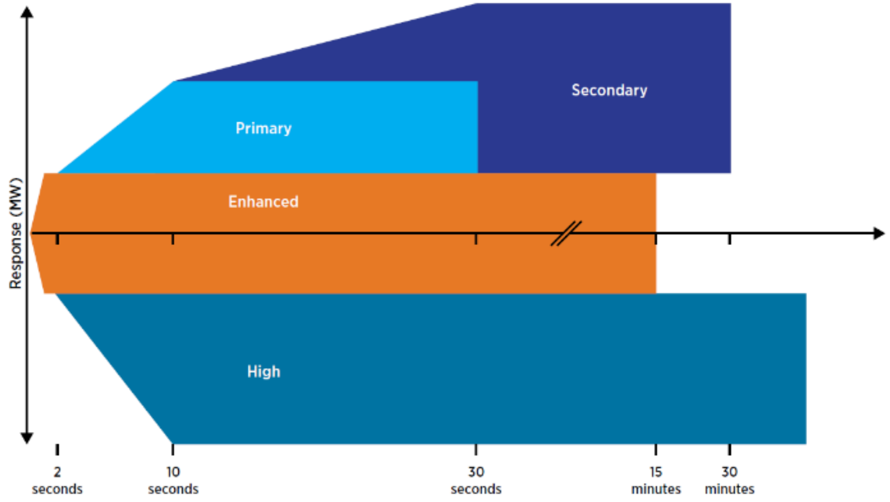
Summary of Operating Reserves

2. Solution – Innovative products to provide reserves

- Electricity storage is an ideal resource to provide operating reserves – it can act as both a load and a generator
- Useful to have innovative products where storage could provide more valuable services, e.g. Enhanced Frequency Response (EFR)

3. Real-life Scenario

- In August 2015, National Grid launched 200MW auction to provide EFR
- 2 projects awarded to UK investment firm Low Carbon – Glassenbury (40MW) and Cleator (10 MW)
- Annual production of 28MWh and 7MWh respectively
- The 2 projects provide ¼ of total EFR capacity in the UK and help to stabilize frequency in the UK's grid



Frequency Response Services in the UK (Source: National Grid, 2016)

Case 7: Reduced Peaking Plant Capital Savings

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1. Challenge – Ensure Generation Adequacy

- To operate the power system in a secure and reliable way, supply must equal demand at all times
- Due to the limited predictability of VRE, ensuring system adequacy could become increasingly challenging (also due to climate change)

2. Solution – Capacity Mechanisms vs. Scarcity Price

- Solutions can be classified into:

a) Energy-Only Markets

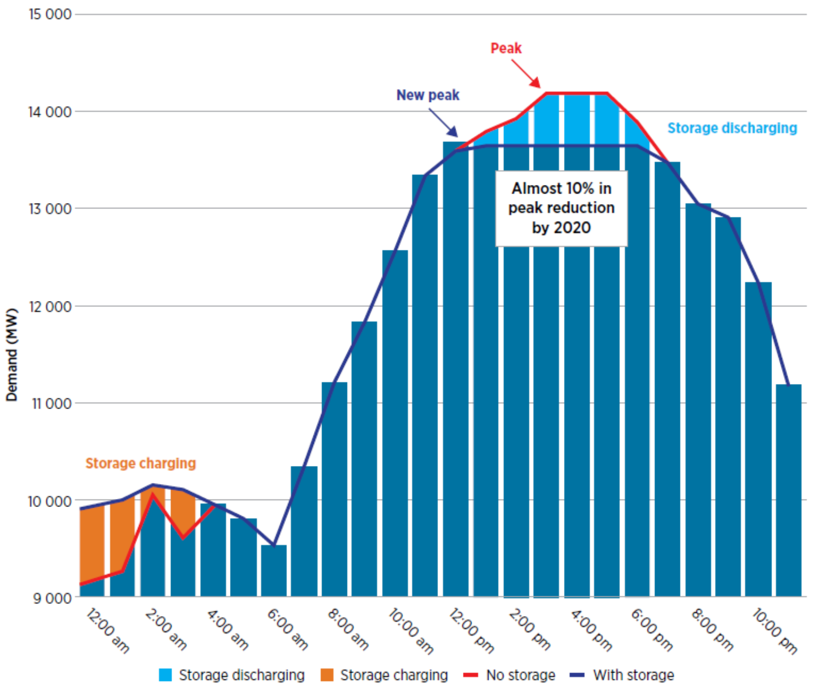
- Affirms that market price signals are enough to ensure generation adequacy, e.g. through very high prices during scarcity events
- It assumes that electricity markets are perfectly competitive, and prices will signal when (and where) new generation capacity is required

b) Security of Supply Mechanisms

- Implies that the regulator intervenes to ensure generation adequacy
  - ✓ Price Mechanisms - set an income that generation will receive for providing firm capacity
  - ✓ Quantity Mechanisms - the regulator establishes the capacity required to ensure generation adequacy
- For electricity storage, security of supply mechanisms might be a better option since they provide a predictable (and stackable) revenue stream

3. Real-life Scenario

- An example of storage deployed via security of supply mechanisms is the UK capacity market
- Other systems are implementing capacity mechanisms where storage can participate (e.g., United States, Alberta or Italy)



2020 demand curve in Massachusetts with and without electricity storage
Source: (Customized Energy Solutions et al., 2016)

Conclusions

- ES supports VRE integration and its large scale deployment can provide considerable benefits to the power system and the society in general (i.e. economic, technical, environmental)

- ES projects will only be deployed if the gap between monetizable revenues and cost can be bridged by adjustments in policy, regulations and market design. Designing such adjustments and avoiding both "missing money" and "misallocated money" requires thorough quantitative analysis

- Cost-benefit analysis of ES need to consider the following:
  - Technical suitability of ES for specific system services – focus on those required for decarbonisation
  - Techno-economic comparison of ES against alternative options
  - Estimation of both monetizable and non-monetizable benefits of ES and comparison with ES costs

- Application and use of the ESVF requires some expertise on analytical tools and comes with a number of constraints:
  - Estimation of ES at the distribution level need to be based on assumptions and simplifications
  - Accuracy of results depends on spatial and temporal granularity of tools used in the analysis
  - Sector coupling – by definition – requires a multi-sectoral framework beyond the electricity market

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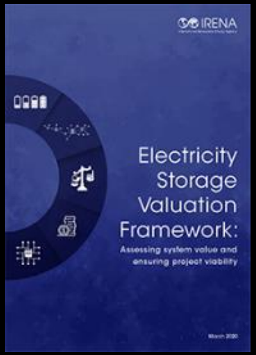

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