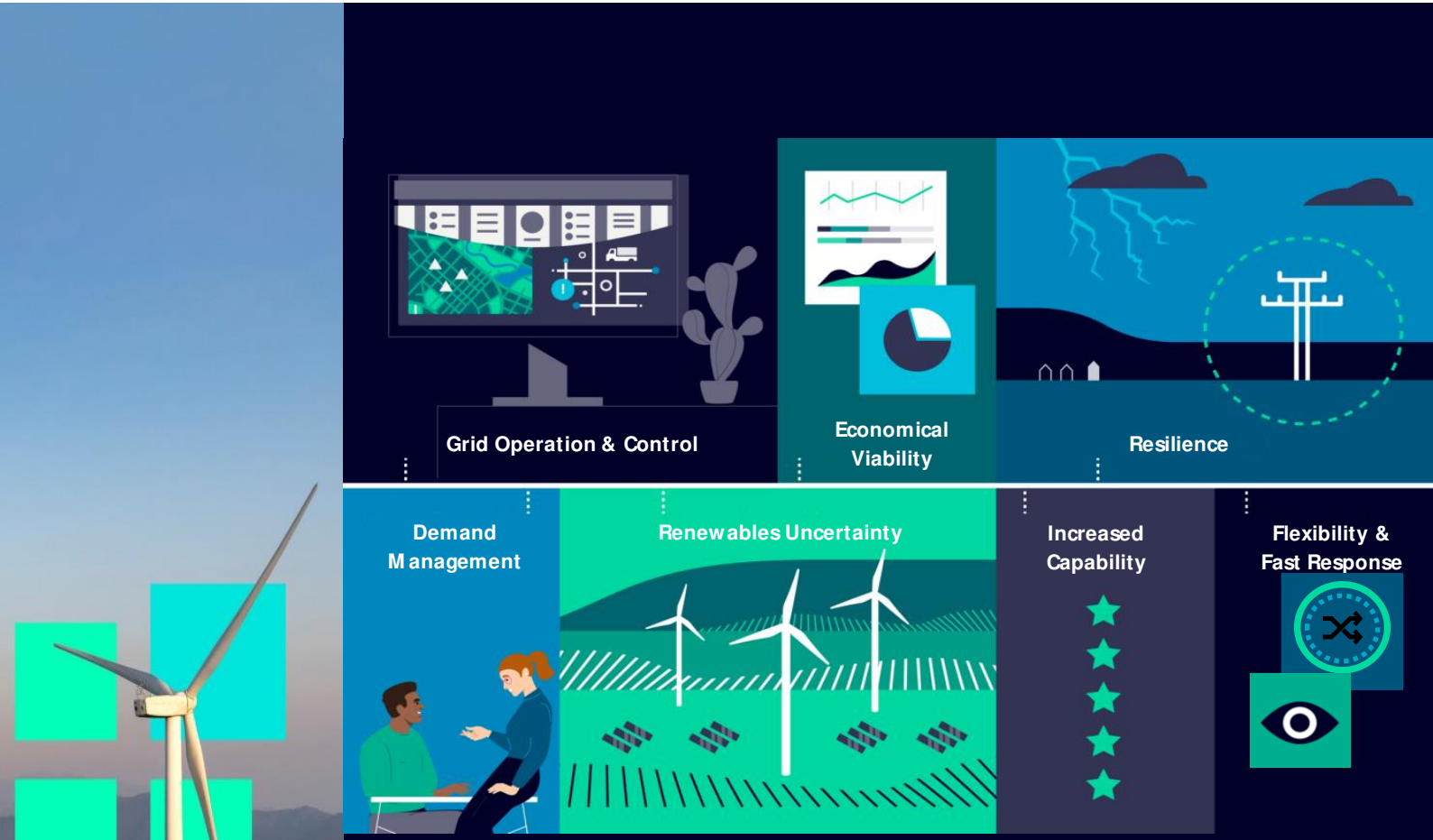
APEX 2023

Role of Storages in the Energy Markets

SIEMENS

The Roles Played by Energy Storage

Balance the uncertainty that permeates the net-zero power grid



SIEMENS

Growth of Storage in wholesale energy markets

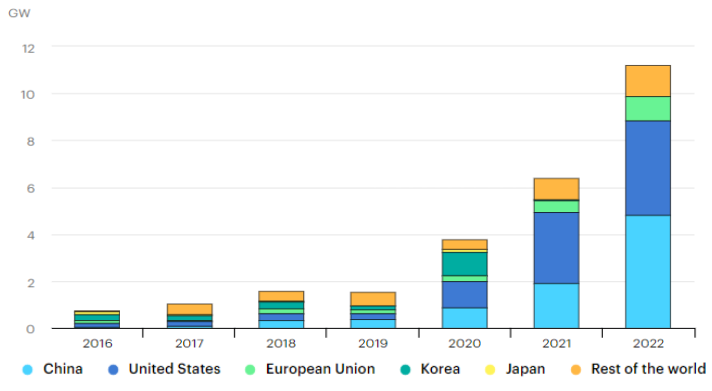
Why is it important to incentivize the storage participation?

China & US are leading the way, however important milestones have been achieved by the EU and India.

Pumped-storage hydropower is still the most widely deployed storage (around 160 GW globally)

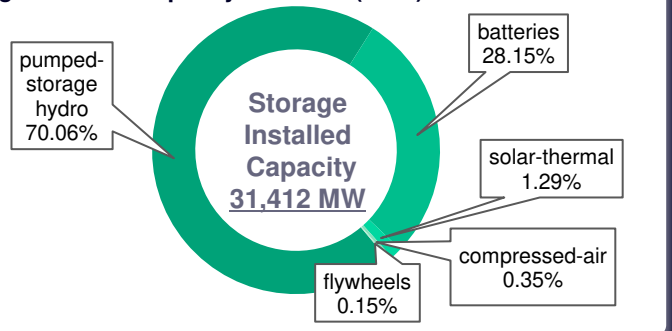
Grid-scale batteries are catching up (28 GW with a 75% increase in 2022)

Annual grid-scale battery storage additions, 2017-2022



Source: International Energy Agency (2023)

Storage Installed Capacity in the US (2023)



Source: Energy Information Administration (2023)

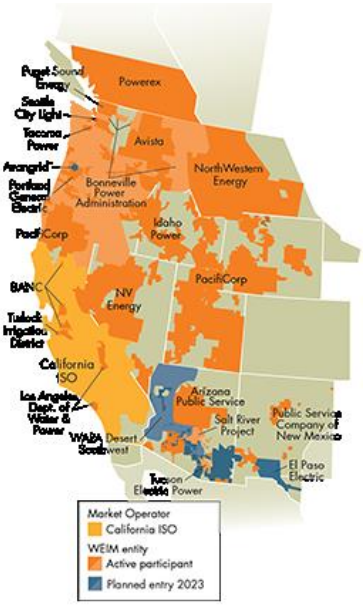
Mandate of the net-zero initiatives, due to climate pressure, offers several opportunities for storage resources

- Frequency regulation
- Arbitrage
- Ramping/ Spinning reserve
- Excess of wind/ solar energy storage
- Voltage/ Reactive support
- Load management
- Load following
- Peak Shaving
- Co-located renewable firming
- T&D deferral
- Backup Power

SIEMENS

Spotlight on our journey with CAISO

Enabling a consistent revenue stream for storage resources beyond subsidies



U$ 4.2 bi.

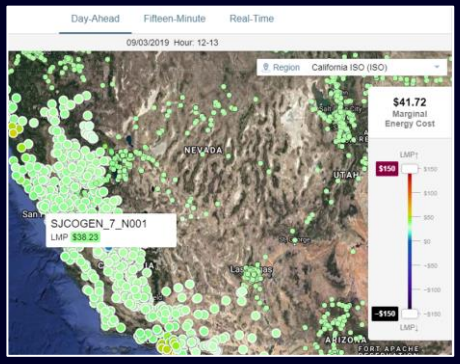
gross benefit since Nov 2014, just from the **EIM Real-Time Market.** Currently extending to the **Day-Ahead (EDAM).**

California ISO

Customer: California Independent System Operator

Period: Since 2009 - Ongoing

Highlights: EMM SCUC™ Optimization Engine provides Locational Prices and Schedules for the EIM and DAM.



CAISO Provides Open, Transparent Markets, Greens the Grid and Powers the lives of 30 million consumers

- Established methods to inform the Customers and involve their judgment in selecting the features to update the base EMM software.

Energy Storage Unified Model

State of Charge Optimization
SOC Balance Constraints
SOC Limit constraints for hourly, end of horizon envelopes
SOC reservation for AS deliverability
Supports Energy, Regulation, Reserves, Flexible Ramping

Hybrid Resources

Joint characteristics at the Point of Common Coupling
Individual Hybrid Resource
Multiple Co-Located Resources
Aggregate Capability Constraints (jointly and sub-aggregate)

Market Participants at CAISO

EIM: 195 Battery (11,300MW)

DAM: 157 Battery (8,622MW)

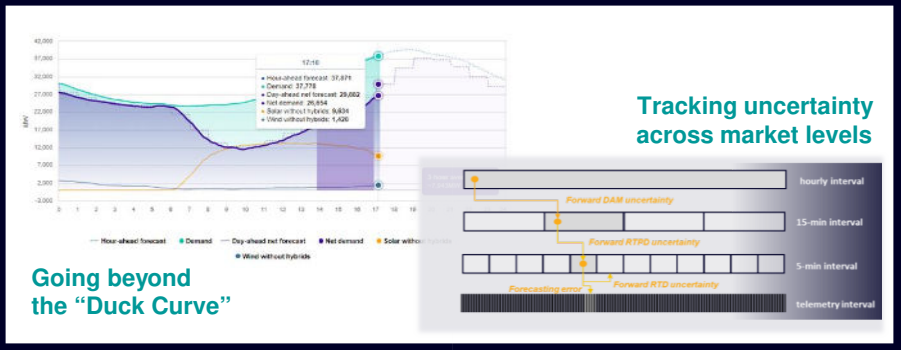
SIEMENS

Long- and Short-Term Storage in Energy Transition

Storage Resources bridge the time gap between uncertain events

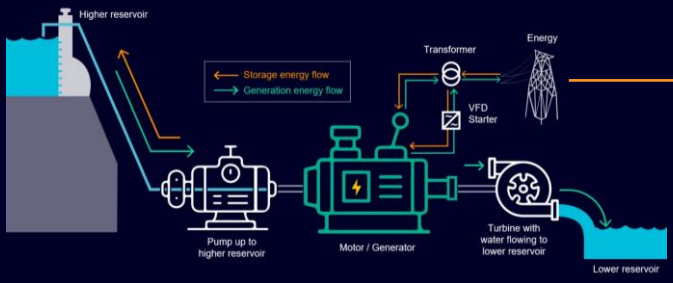
Flexibility provision with ramp as a service

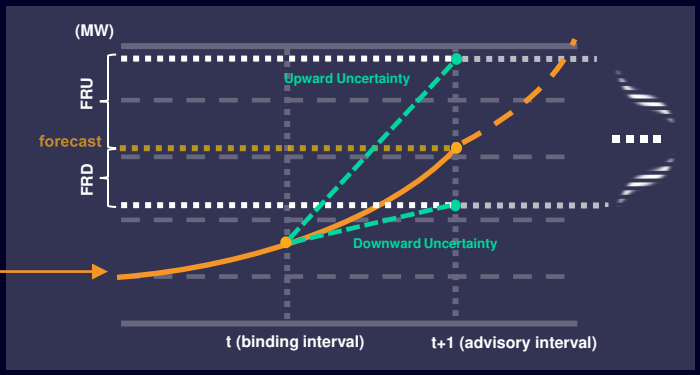
Sustainability targets of the energy transition will keep pushing the increase of renewables resources. The storage technology will be vital to maintain dispatchable levels to compensate the higher uncertainty in grid operation



CAISO Markets: Flexibility Requirements up to **400 MW in RTD** (5-minute), **2500 MW in RTPD** (15-minute) and **5000 MW in DAM** (hourly)

Detailed Resources Models according to storage technology: Pumped Storage, Batteries, Flywheels, Compressed-Air, CHP, Hybrid Resources,…





Providing Flexibility Commodities in Upward/Downward Direction according to Resources Capabilities

SIEMENS

Managing Congestion with Storage

Beyond planning, fast operation decision to relief the grid

Very Effective in the Wholesale Market

- **Optimal storage schedules, with locational price signals,** to support congestion management while increasing storage revenue.

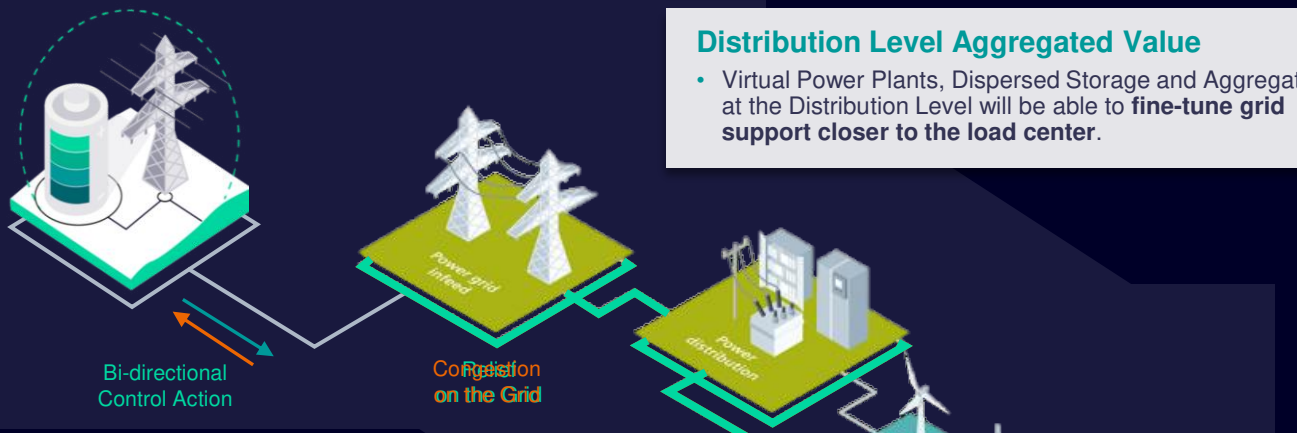
Increase Grid Controllability and Flexibility

- More options for counter flow and control actions from **both sides of storage operation** (charging & discharging)

Distribution Level Aggregated Value

- Virtual Power Plants, Dispersed Storage and Aggregators at the Distribution Level will be able to **fine-tune grid support closer to the load center**.

Congestion may appear in any part of the grid paths or at specific spots throughout the day



Operators need to take the best assertive and timely decisions

SIEMENS

Storage Integration – A long term perspective

Above and beyond storage technology, new opportunities from multi-energy coupled markets

Policy & Regulation

Business cases for storage can be complex. Regulation and energy market designs may increase incentives to **flexibility deployment** and ensure **long-term viability** of storage resources.

Also new adoption of new regulation for opening **wholesale markets to DERs** at distribution level will boost dispersed storage and aggregator.

Technology Growth

Energy mix is becoming more diverse. The new **H_2 value chain** will pivot the perspective of storage for market operators (fixed to multi-purpose mobile).

Multi-energy coupled models are powerful tools to economically dispatch hydrogen, gas & hydro energy chains.

Evolving Digital Environment

Privacy preserving and interoperable systems will pave the way to surpass the challenges of storage integration with digital twins.

The increase on data volume and granularity, along with real-time requirements, will require **high-performance computing solutions**.

Demand Side Load Management

Smooth the DER's injection patterns and **provide peak shaving** with dispersed storage at distribution level.

The aggregated co-located storage behavior and optimization may also benefit wholesale markets through **TSO/DSO integration**.

SIEMENS

Contact

Ashmin Mansingh
Head & Senior Key Expert
Energy Market Management
Email: Ashmin.Mansingh@siemens.com
Phone: +1(952)250-1775

SIEMENS

Disclaimer

Subject to changes and errors. The information given in this document only contains general descriptions and/or performance features which may not always specifically reflect those described, or which may undergo modification in the course of further development of the products. The requested performance features are binding only when they are expressly agreed upon in the concluded contract.

REPUBLIC OF TÜRKİYE
ENERGY MARKET
REGULATORY AUTHORITY

Electricity Storage Regulations in Türkiye

Gökay KÜTÜKCÜ

Head of Wind and Solar Energy Group

Energy Market Regulatory Authority

Content

- Storage Activities in the Electricity Market Regulation
- Storage Systems in Combination with Wind and Solar Energy PPs

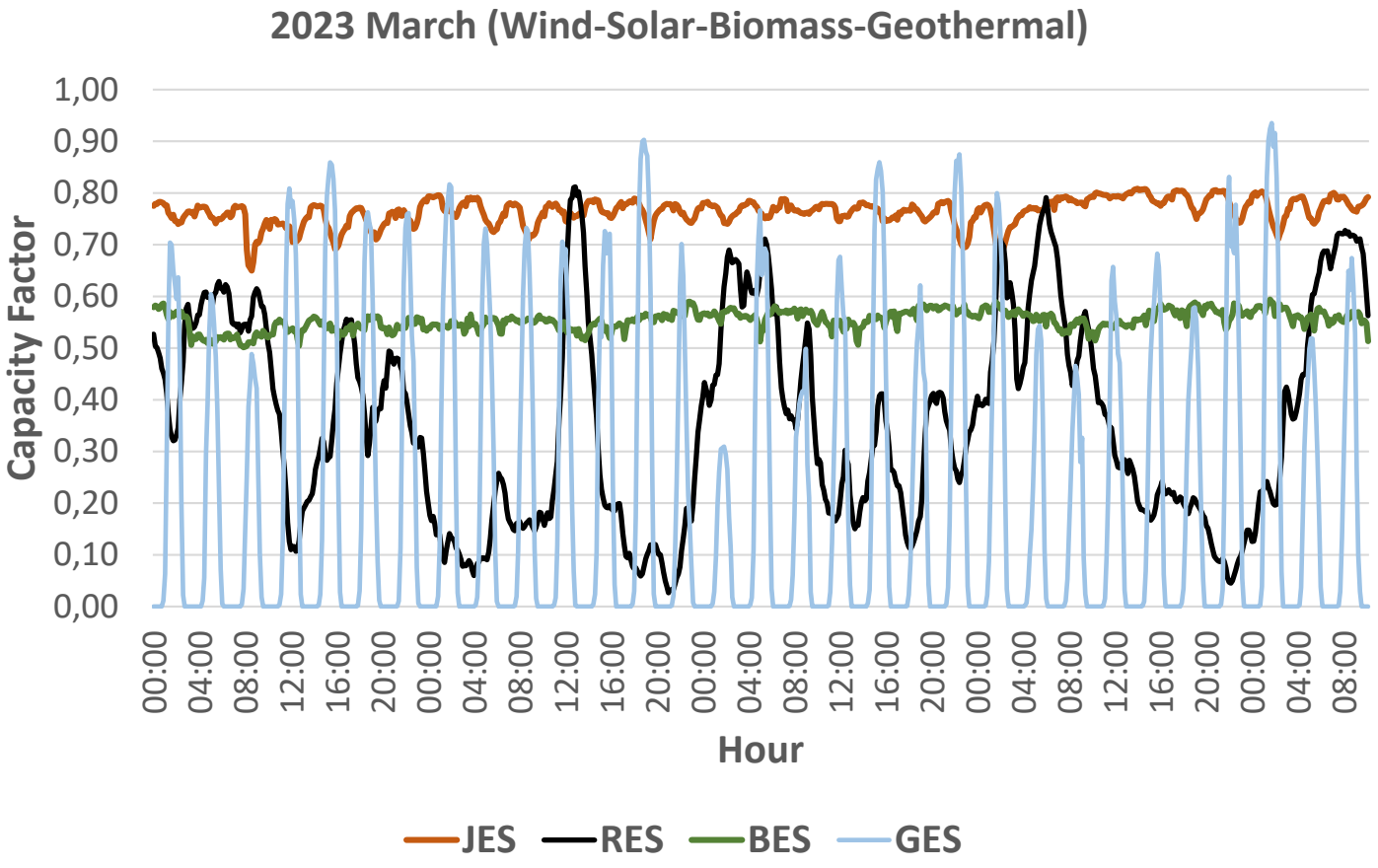
Storage Activities in the Electricity Market Regulation (2021)

1. Storage facilities integrated with generation facilities
2. Storage facilities integrated with consumption facilities
3. Autonomous Storage Facilities
4. Storage facilities of distribution companies

Storage Systems in Combination with Wind and Solar Energy PPs (2022)

Major objective of the regulation is to increase the stability of wind and solar energy based power plants' intermittent generation through the addition of storage facilities.

Storage Systems in Combination with Wind and Solar Energy PPs (2022)



General Rules

- Ratio of the installed capacity of the generation unit to the installed capacity of the storage unit must be equal to maximum one
- Ratio of the electricity storage capacity undertaken to the installed capacity of the electricity storage unit must be equal to minimum one

WIND/SOLAR **(MW)**
50 MW

STORAGE UNIT **(MW)**
at least 50 MW

STORAGE UNIT **(MW)**
50 MW

STORAGE CAPACITY **(MWh)**
at least 50 MWh

General Rules

The installed capacity must be minimum **20 MW**

The installed capacity must be minimum **10 MW**

The maximum capacity must be **250 MW**

The applications are prioritized based on the date that all of the required data and documentation is submitted in full.

APPLICATIONS

	Number of applications	GW
Wind	1,863	126,1
Solar	3,957	131,6
Total	5,820	257,7

Nearly 4000 applications were submitted for solar wind power with storage and another 1900 for wind farms in less than one year, translating to a 258 GW in total power capacity – 126 GW against 131 GW, respectively, in rounded numbers.

APPLICATIONS

	Number of pre-license	GW
Wind	162	11.4
Solar	222	10.3
Total	**384**	**21.7**

35.5 GW of capacity has been allocated to these applications by the transmission system operator, which means that the investors have committed to installing 35.5 GW of storage units.

If the entire allocated capacity is put into operation, there is a potential for a total of 35 GW of storage installed capacity to be put into operation in the next 7 years.

THANK YOU

PRELICENSE APPLICATION Necessary Document

- Pre-license Application form
- Certificate of authorization for real persons to represent the entity
- A copy (certified by trade registrar) of the Articles of Incorporation
- Fact sheet on the partnership structure of the company
- Fact sheet on company capital (at least 5% of the total planned investment is required)
- Fact sheet on Generation Facility
- 1/25.000 and 1/5.000 scale maps covering facility location
- Single-line diagram
- Zoning status sheet
- Fact sheet testifying to non-sensitive nature of the location pursuant to EIA Regulation Annex-5
- Declaration on non-forbidden nature of the location (it should not be a fertile agricultural land),
- Guarantee letter (MW x 50,000 TRY EMRA Board Decision)
- Pre-license application fee
- The factsheet on the ownership of the sites to be used for generation facilities

Integration and Applications of Storage in Markets

Coordinador Eléctrico Nacional (CEN)

Jaime Peralta, Vice President

September 2023

APEx
Association of Power Exchanges

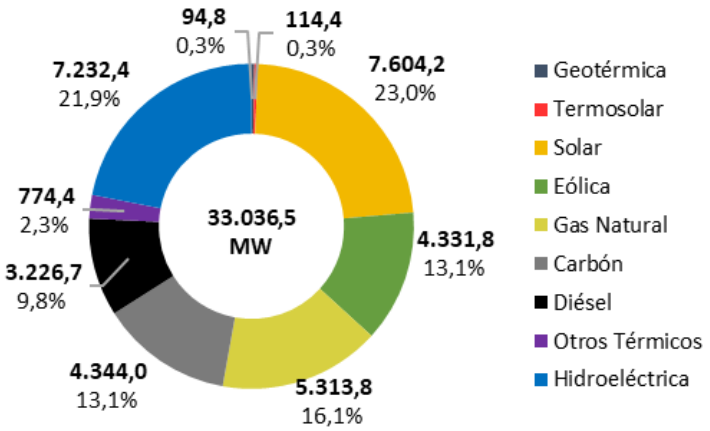
COORDINADOR ELÉCTRICO NACIONAL

SERVIMOS A CHILE CON ENERGÍA

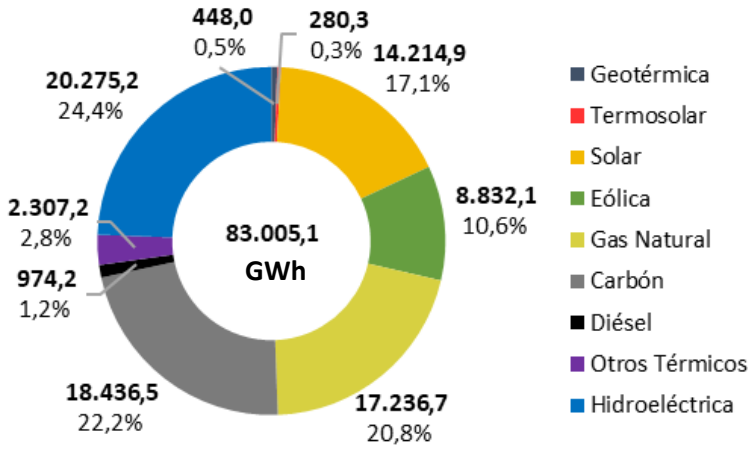
CHILE'S ELECTRICITY SYSTEM

- **Statistics for 2022:**
  - ✓ Installed Capacity : 33,036 MW
  - ✓ Energy Generated: 83,005 GWh
  - ✓ Peak Demand: 11,906 MW
  - ✓ Transmission Lines: 38,160 km
  - ✓ VRE Share / Peak: 28% / 68%
  - ✓ Storage (BESS/CSP): 191 MW / 1,785 MWh
- **July 2023:**
  - ✓ VRE Capacity: 12,734 MW (4,060 MW U/C)
  - ✓ VRE Share / Peak: 31% / 71%
  - ✓ Storage (BESS/CSP): 303 MW / 2,346 MWh
  - ✓ BESS U/C (2024): 621 MW / 2,391 MWh
- **Long-term Renewable Goals:**
  - ✓ Carbon Neutrality by 2050
  - ✓ Decarbonization Plan by 2040/2030?

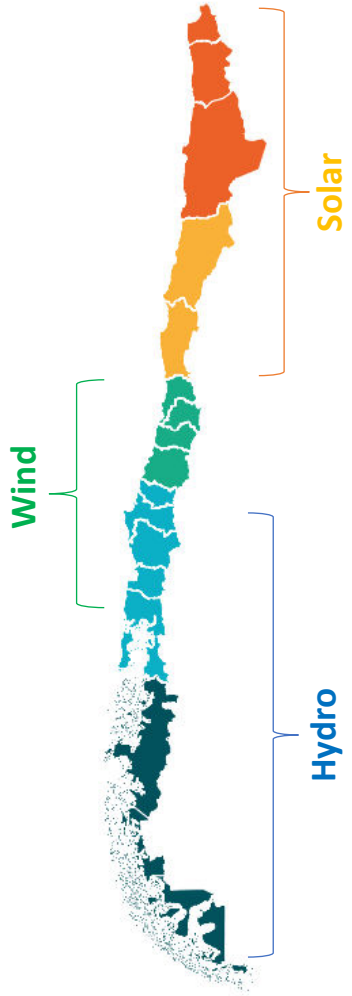
Installed capacity



Energy Generation



Renewable Potential



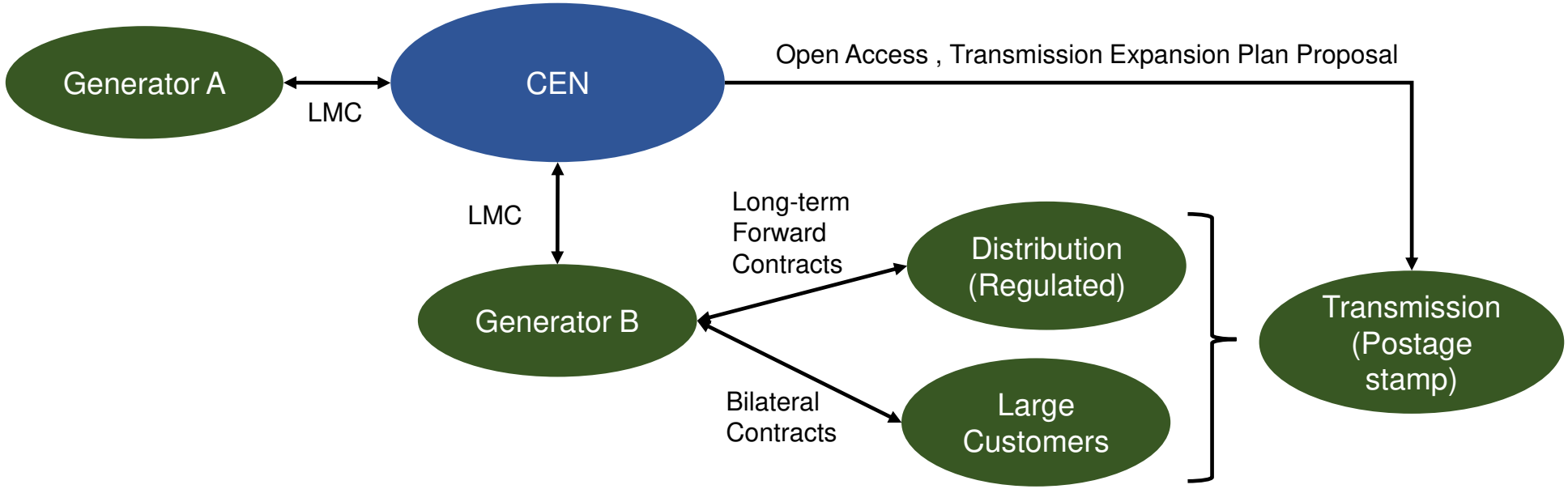
ENERGY MARKET IN CHILE

Market Structure:

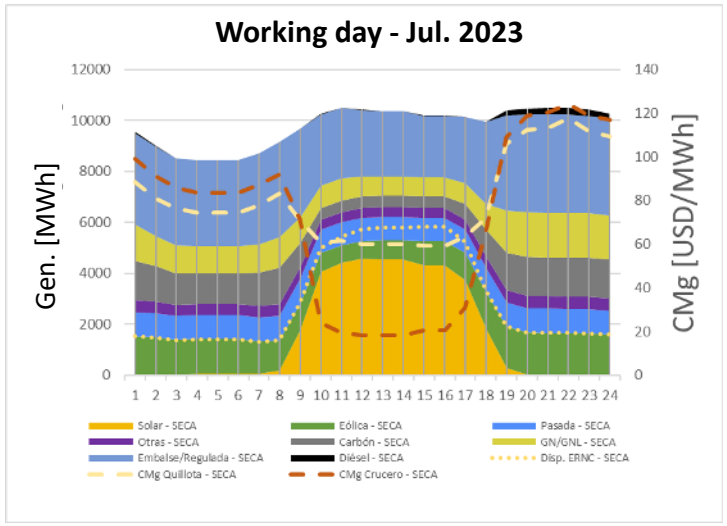
- Contract-based (PPA) energy market.
- Cost-based wholesale (difference) market for energy and bid-based for ancillary services.
- Regulated capacity payment according to plants availability during peak demand.

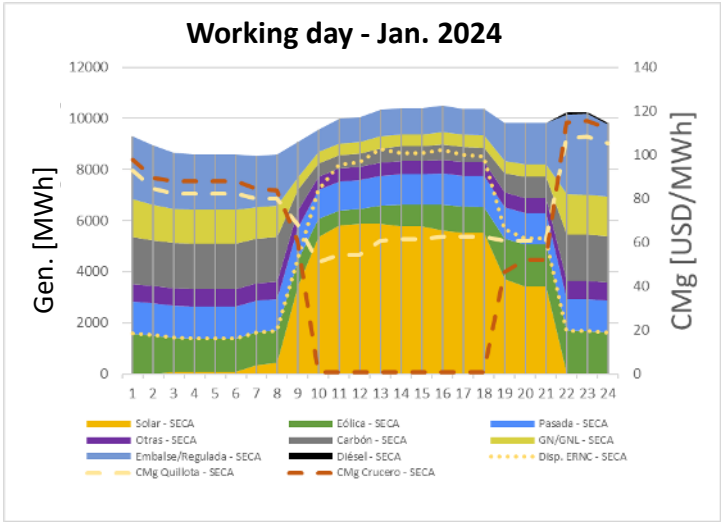
CEN Role:

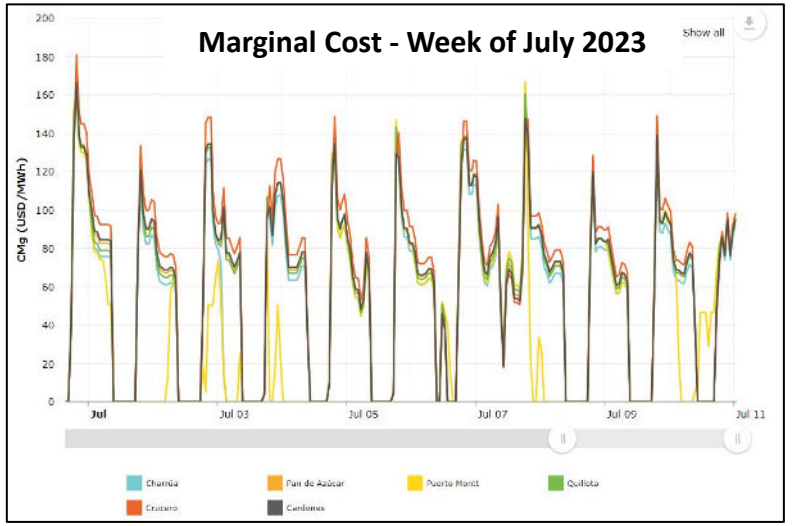
- Day-ahead energy and ancillary service markets.
- Set locational marginal cost (LMC) based on real time ops.
- Energy and AASS and balances and settlements based on LMC.

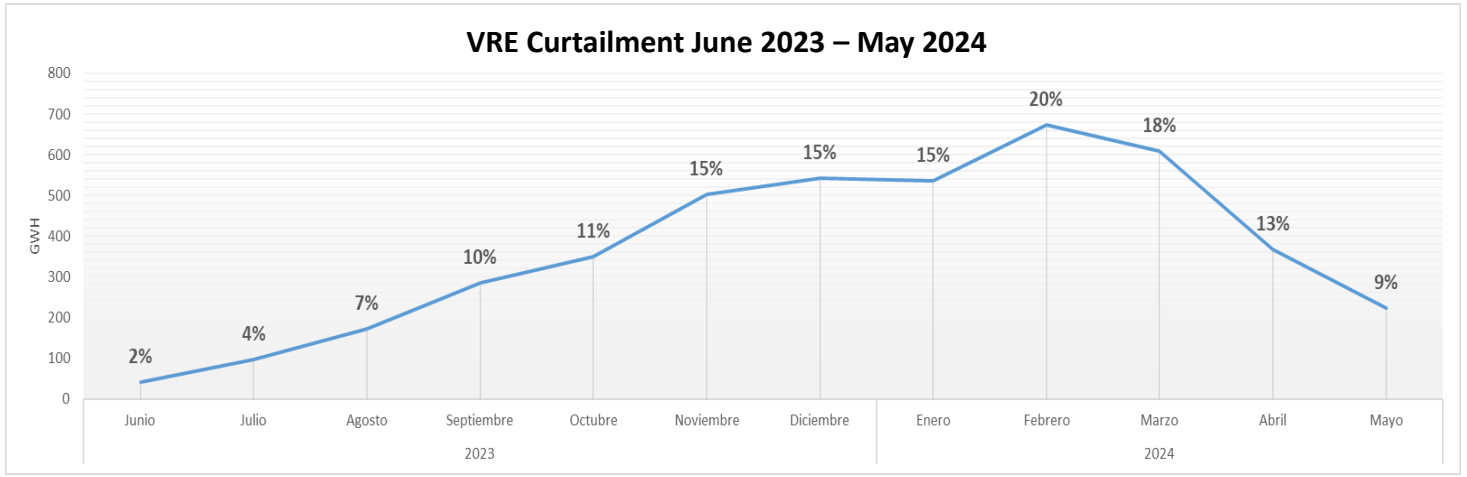


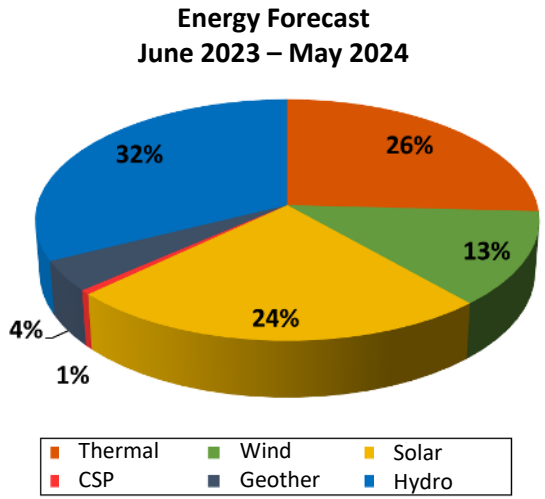
ENERGY MARKET IN CHILE











ENERGY STORAGE IN CHILE

- Installed capacity by 2024: 924 MW / 4737 MWh
  - ✓ Mostly BESS (1 CSP)
  - ✓ PPA, arbitrage, ancillary services, capacity
- Coal plant conversion to Carnot Battery 530 MW / 3180 MWh by 2026
- BESS Grid Booster 2x 500MW / 125MWh by 2026
- New regulation (Energy Transition Law)
  - ✓ Tender for 2,000 MW / 8,000 MWh of storage (2026)
  - ✓ Fix charge to end customers (same as Tx) + services
- Optimal LDES requirement by 2030: 2000-4000 MW, 6-8 hours
  - ✓ Transmission expansion criteria (Op. cost saving)
  - ✓ Shift thermal generation (forced generation), ancillary services
- Technical specifications and requirements
  - ✓ Future storage shall incorporate grid capabilities/attributes (Grid Forming)

ENERGY STORAGE IN CHILE

Andes Solar: PV 180MW + BESS 112MW / 560MWh

Commissioning : 2023

Arbitrage (centralized), capacity payment

Cerro Dominador: PV 100MW + CSP 114MW / 1716MWh

Commissioning: 2021

PPA Energy, capacity payment

Thanks !

COORDINADOR
ELÉCTRICO NACIONAL

SERVIMOS
A CHILE CON
ENERGÍA

N-SIDE

Integration of Storage into Electricity Markets

21st September 2023

APEx Conference

N-SIDE at a glance

N-SIDE

- Founded in 2000, university spin-off
- Offices in Belgium, US & Japan
- 200+ people (Energy & Life Sciences) 20% PhDs, 30 Nationalities
- 42% annual growth

Our Customers & Partners

Power Exchanges

JEPX, NORD POOL, omie, HEnEx, IEX, GME, semopx, CROPEX, TGE, epexspot

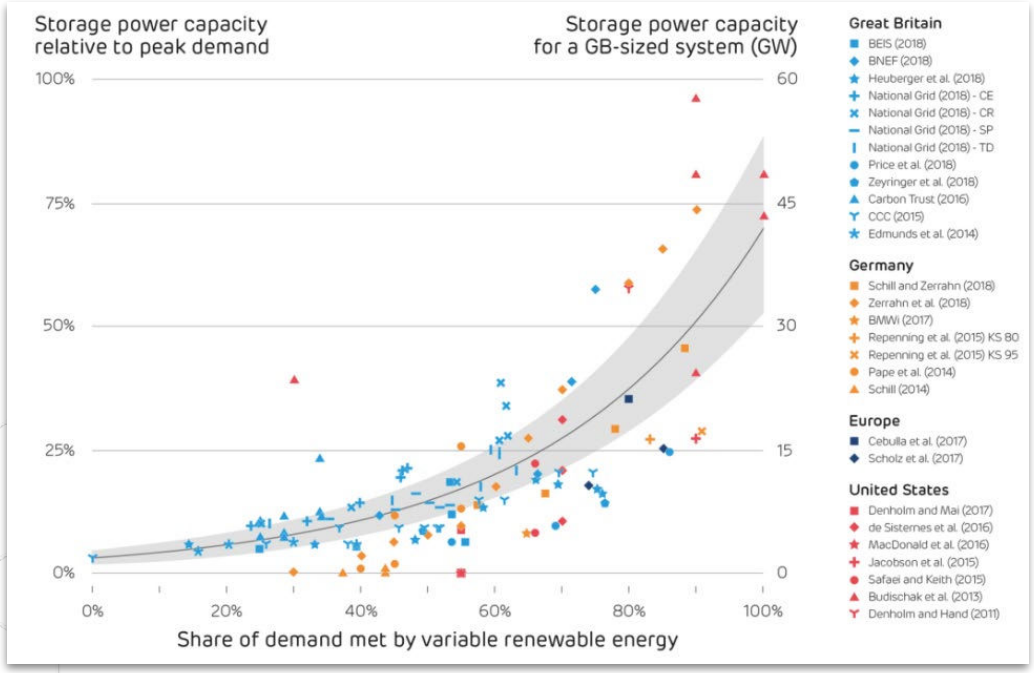
System Operators

SVENSKA KRAFTNÄT, entsoe, elia, Statnett, ENERGINET, swissgrid, TenneT, nationalgridESO, FINGRID

Our Offering

- Market Design Advisory Services
- Market Clearing Solutions
- Forecasting Solutions
- Advanced Analytics for System Operation
- Advanced Analytics for Asset Management

How much storage do we need?



Schmidt & Staffell (2019), Electric Insights

A set of factors determines the need for storage, including:

i) the level of penetration of VRE
ii) the pattern of electricity demand
iii) alternative available flexibility options

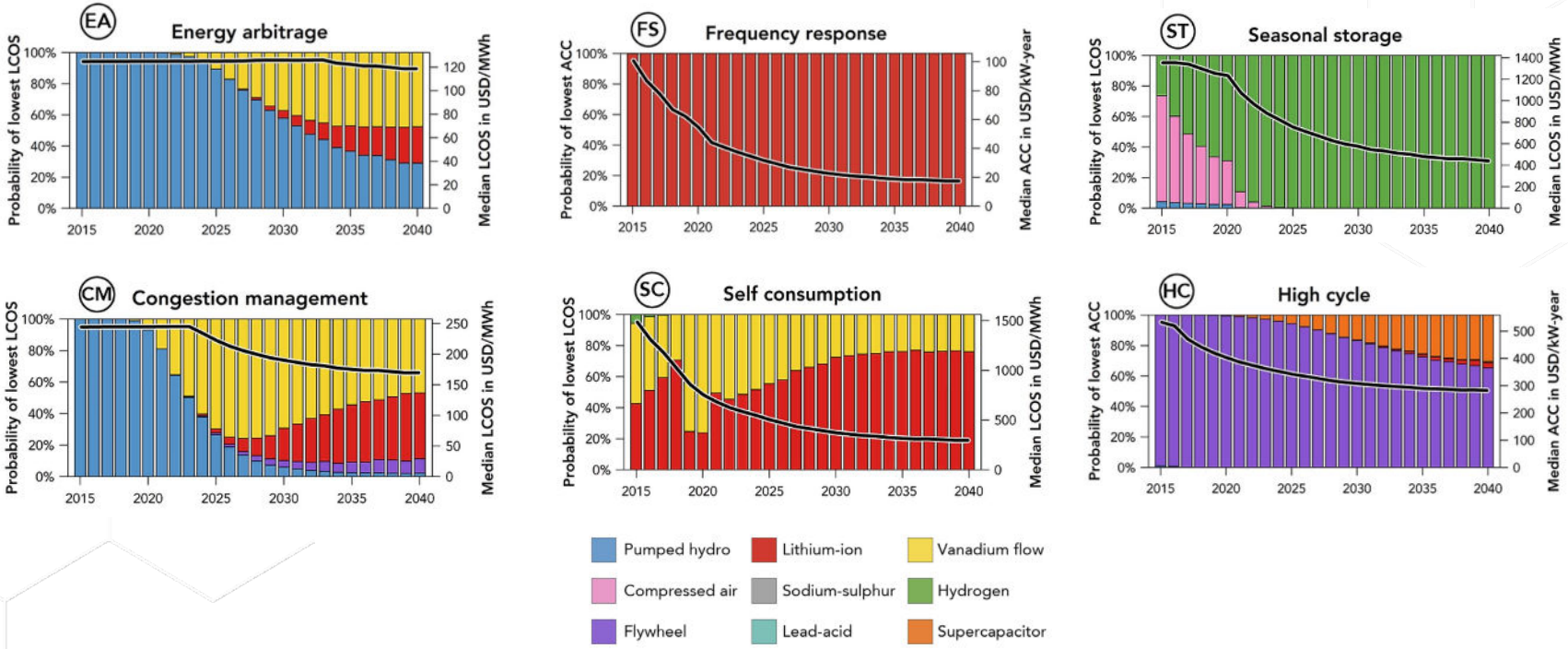
Bulk energy storage will be needed for **longer periods of time** to ensure reliability under all weather conditions.

Storage will be equally crucial for **absorbing excess** renewable generation.

Storage is expected to play a **larger role in all market segments**:

Wholesale market, reliability mechanisms, frequency/ stability, reserve, voltage control, congestion management, and system restoration.

Each technology is differently suited to different needs



Schmidt & Staffell (2023) Monetizing Energy Storage

Market Design Enablers

Geographical Granularity

Larger → Finer

Locational signals are key for efficient dispatch and to support congestion management

Market Time Unit

Larger → Smaller

Smaller “market time unit” enables a more accurate representation of variable resources and of demand response

Minimum Bid Size

Larger → Smaller

Smaller minimum bid size facilitates participation from dispersed generation, storage and demand response

Bid Expressiveness

Lower → Higher

Better reflection of the technical and commercial constraints of storage assets unlocks efficiency gains

Storage Orders

Challenge

- Order design is currently closely aligned to the technical parameters of **thermal units**.
- No consideration of key elements of **storage assets**, such as **State of Energy,** leading to **suboptimal resource usage.**

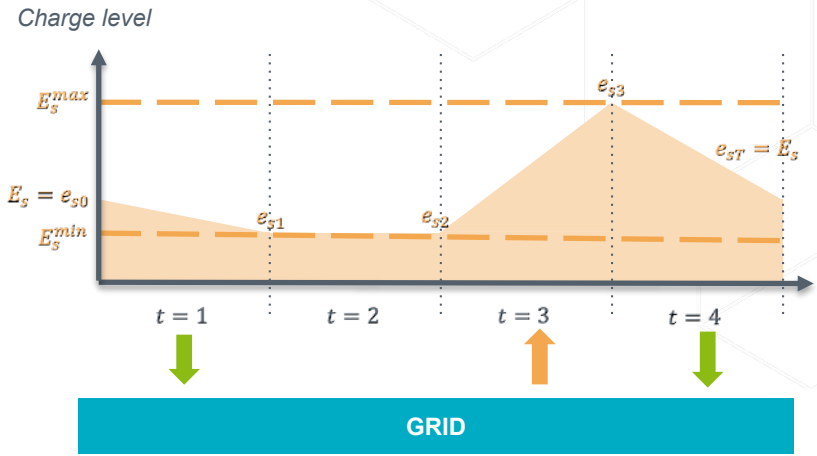
Solution

- **New type of order** to enable storage reflect its characteristics, such as SoC, SoE, (Dis)charge Rate, Min Spread.
- The clearing algorithm will optimise the **asset (across the trading period)** *and* **the market**.

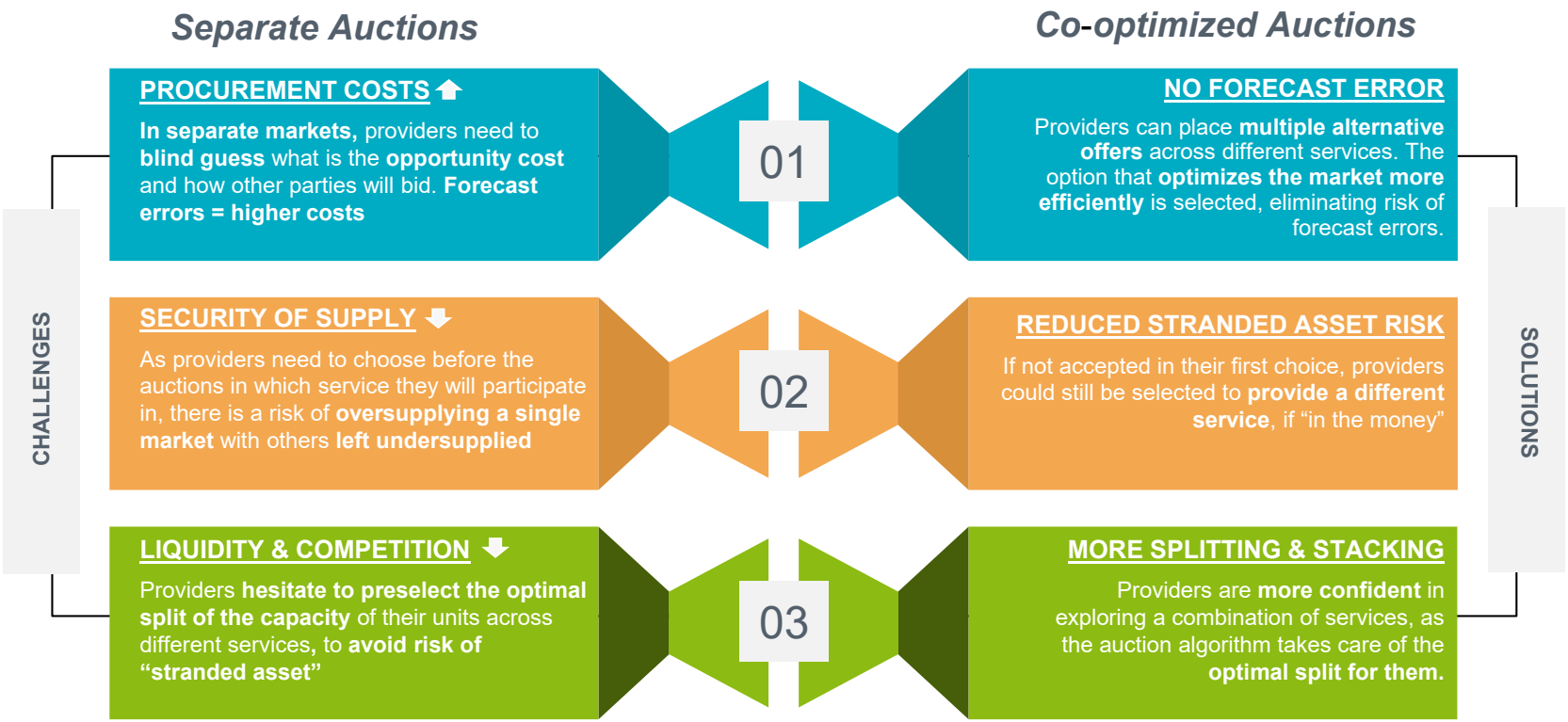
Impact

- Better **expressiveness** offered to storage is expected to:
  - Attract more storage volumes / liquidity
  - Create more accurate price signals
  - Reduce price volatility and prices

Optimal use of storage across the trading period



Co-optimization across Balancing Services



Takeaways

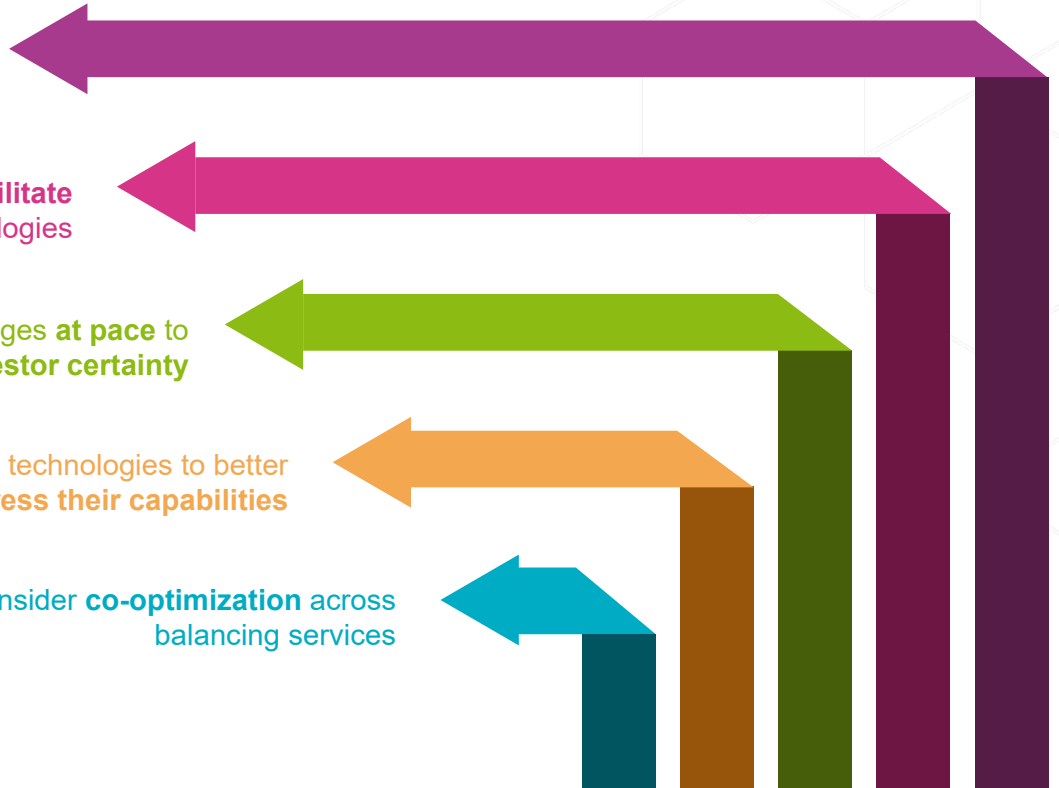
Proactively assess the **amount** and the **characteristics** of the flexibility needed

Send the **right price signals** and **facilitate participation** from a range of technologies

Deliver market design changes **at pace** to **create investor certainty**

Enable storage technologies to better **express their capabilities**

Consider **co-optimization** across balancing services



Marcelo Torres

Principal, Energy Markets

E: mto@n-side.com

T: +30 6951 921 831

www.n-side.com N-SIDE @nsidecom