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Electrical Energy Storage by SIEMENS

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1 Challenges for the power supply today and tomorrow

2 Further challenges for all aspects of the power supply

3 Storage technologies – Examining the options

4 SIESTORAGE - The modular energy storage concept

Challenge through change
Modern power production – Stable power systems?

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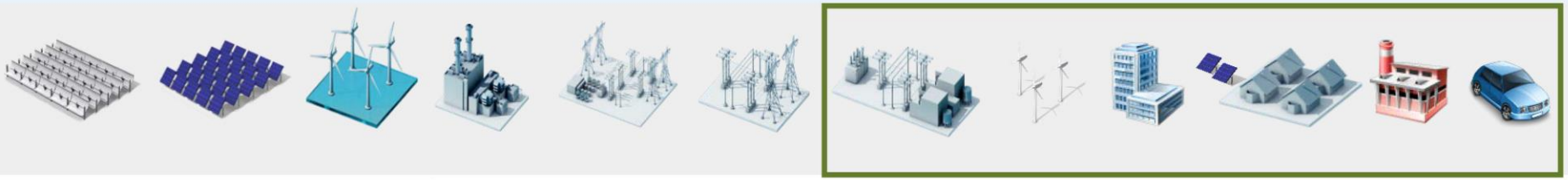
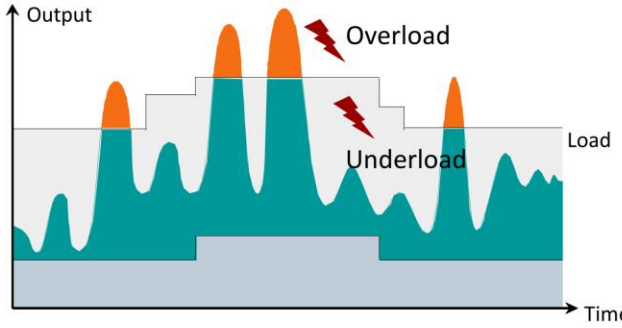


Renewable energy

Production incalculable
- Wind turbines
- Large solar power plants

Required: Power system stability



Distributed power generation

Consumers become generators
- Photovoltaics
- Self supply/infeed

Solutions

- Technology for flexible generation (e.g. peaker power plants)
- Grid expansion
- Smart grids and equipment
- Energy storage

Challenge through change
Future prospects for the energy architecture

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The task: Using renewable energies

Today's challenges ...

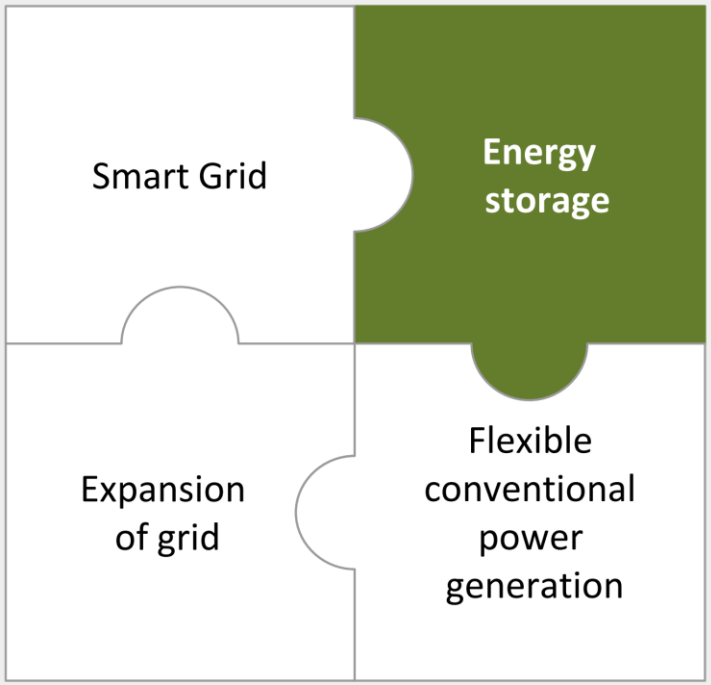
- Germany 2010: Up to 150 GWh of potential wind energy production is capped due to overloading
- United States, TX 2009: 17% of potential wind energy production is capped due to overloading

... will be even greater tomorrow:

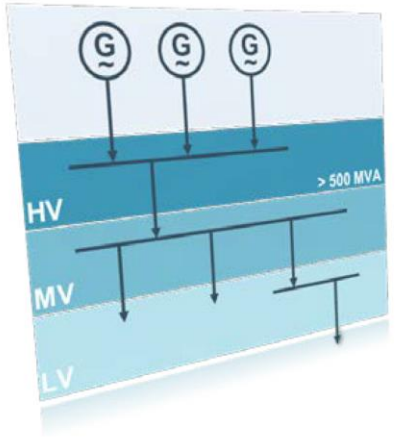
- Germany 2030: approx. 24,000 GWh of excess energy expected!
- EU 2050: 80 % of energy production is to come from renewable energies according to proposed legislation

Source: Bundesverband WindEnergie, EEG, Team Thermal Storage, Source E ST MC / SR 2011 / Basic case 1 – 9 % of production (26 % of the installed base) from volatile renewable energy sources
2 – 31 % of production (54 % of the installed base) from volatile renewable sources, assuming maximum grid expansion "Copper sheet" modell)

A solution approach: Energy storage



From conventional generation and distribution to challenging networks with distributed/renewable generation

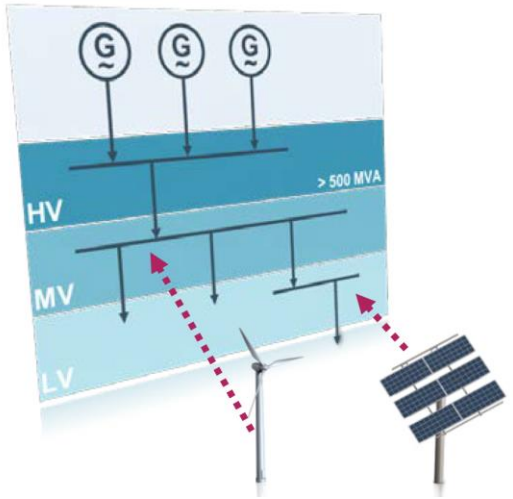


Conventional electricity generation and distribution

- Provides adequate short-circuit power
- It is important to note that:

The available short-circuit power is an indicator for power system stability

This means:
Electricity supply generated with conventional generators ensures **system stability**.



Generation from wind and solar

- Leads to considerable fluctuations in generating output
- Causes imbalance between generation and load
- Is stochastically dependent on the weather

This means:
No short-circuit power
+ Variation between generation/load
Low power system stability

Challenge through change
A green solution: Energy storage

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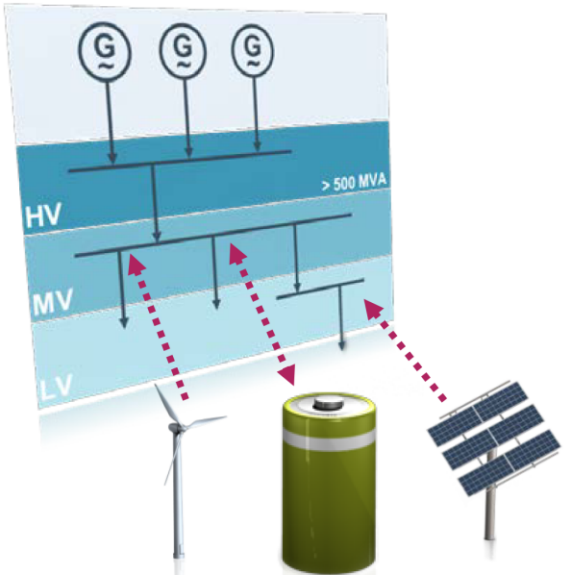
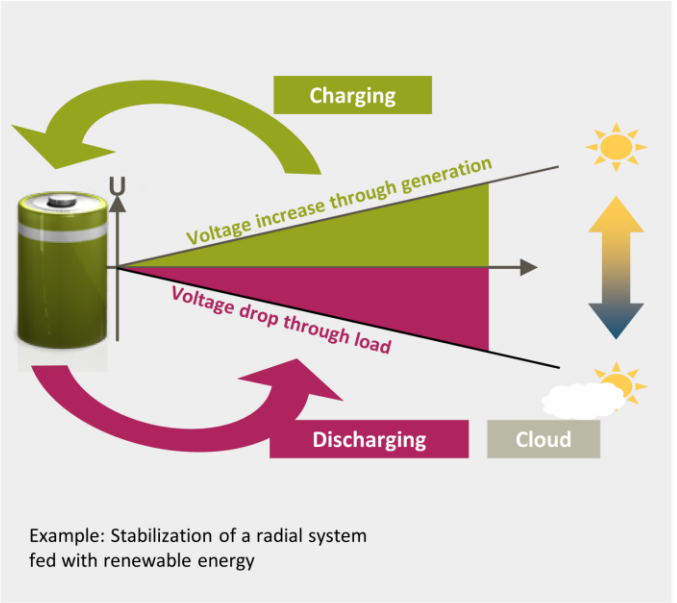
Modern power supply is a big challenge …
Energy storage is an intelligent solution.

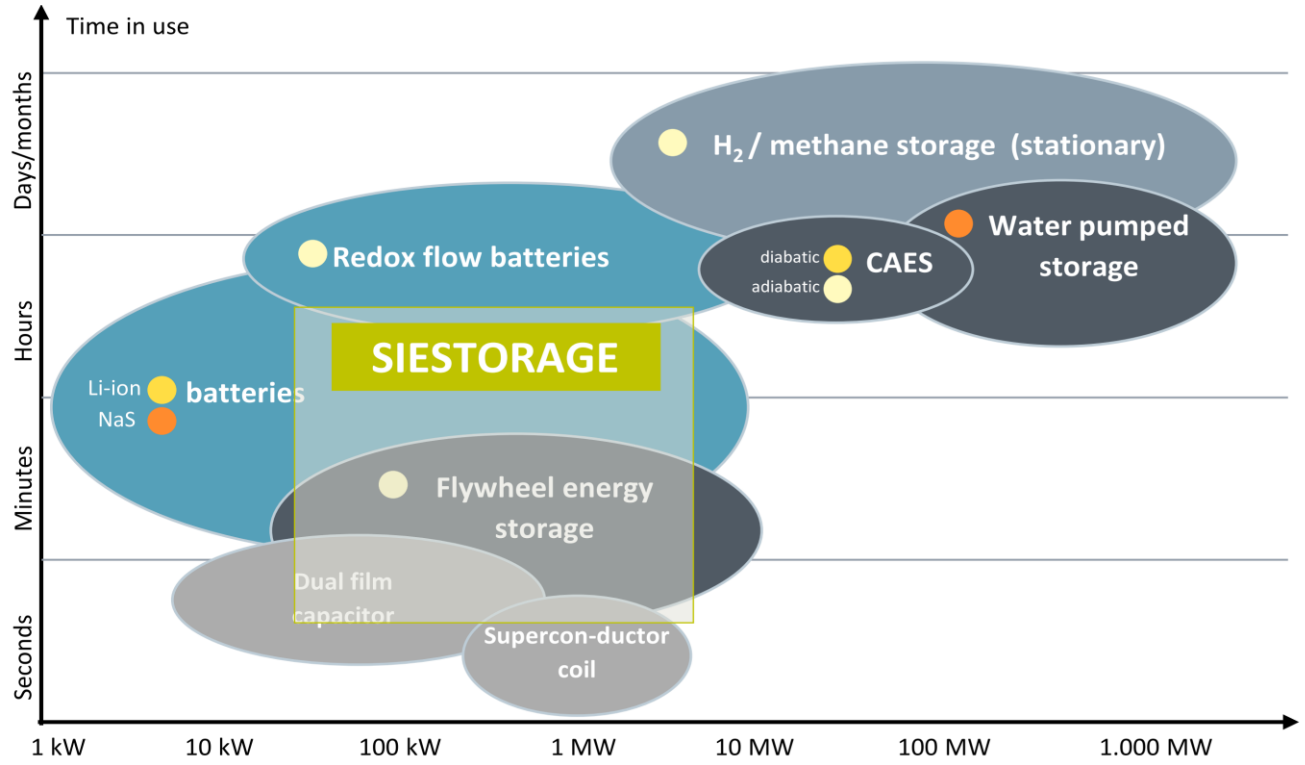




Example: Stabilization of a radial system fed with renewable energy

- Adequate balancing energy available
- Active and reactive power compensation
- Uniform load of the power network

Storage technologies: different application areas and advantages of SIESTORAGE



Technology

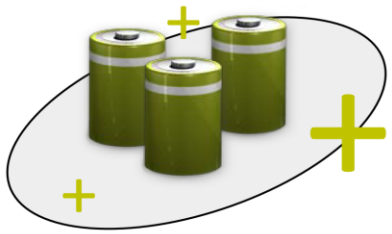
- Chemical storage
- Electrochemical storage
- Mechanical storage
- Electrical storage

Maturity

- Commercial application
- Market launch
- Demonstration

Source: Study by DNK/WEC „Energie für Deutschland 2011“, Bloomberg – Energy Storage technologies Q2 2011
CAES – Compressed Air Energy Storage

The advantages of SIESTORAGE (Li-Ion)



- Charging/discharging at constant power
- 2-4 times higher C rate than other battery technologies
- High energy density
- Total discharges possible, negligible self-discharge, no memory effect
- Optimum operating temperature 25°C to 45°C
- Recyclable & eco-compatible

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The modular energy storage concept

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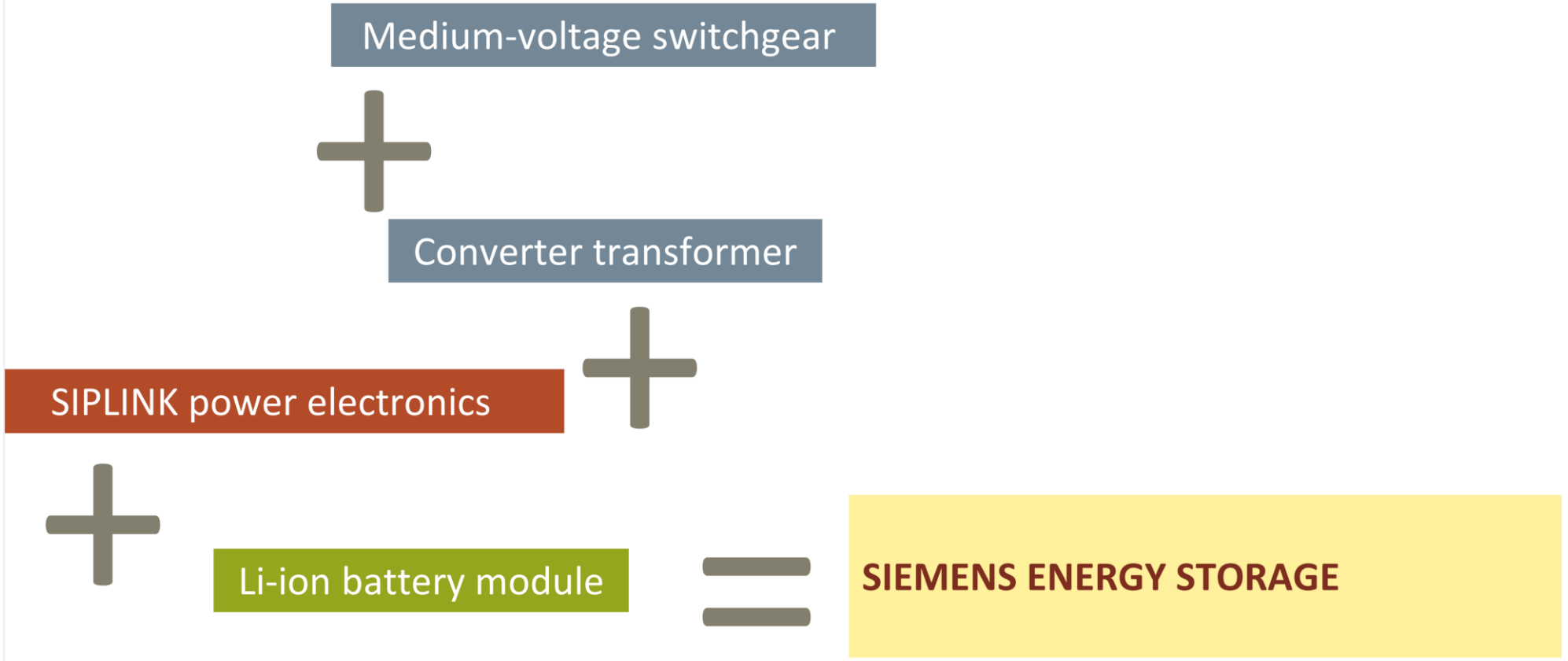
Four modules – One intelligent solution



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Modular energy storage concept in application

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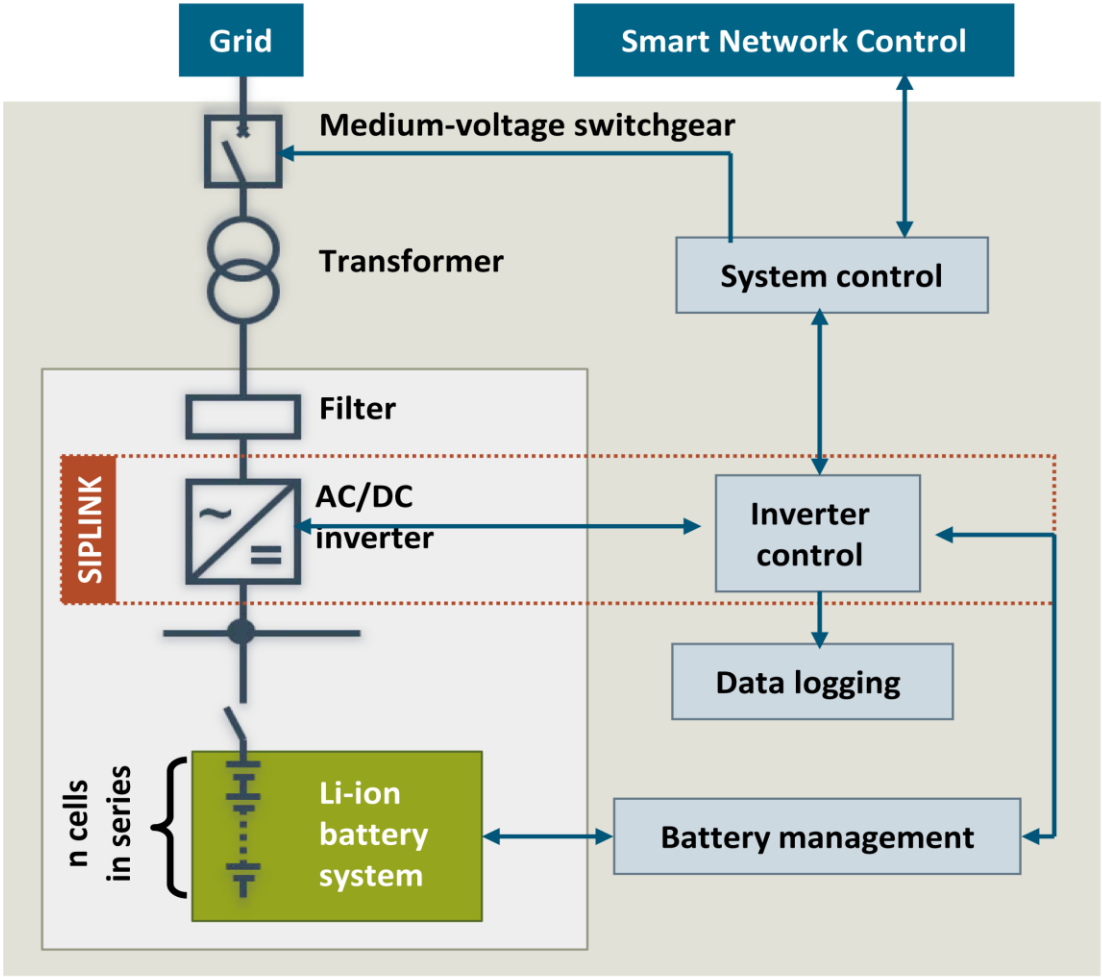
- **Powerful combination:**
  Cutting edge power electronics
  + high-power Li-ion batteries
- **Variable through modularity:**
  In power and capacity
  With parallel connection of combined energy storage cabinets on the AC-side
- **Adequate capacity:**
  up to about 2 MWh
- **Top performance:**
  Modular up to about 8 MW



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Modular structure

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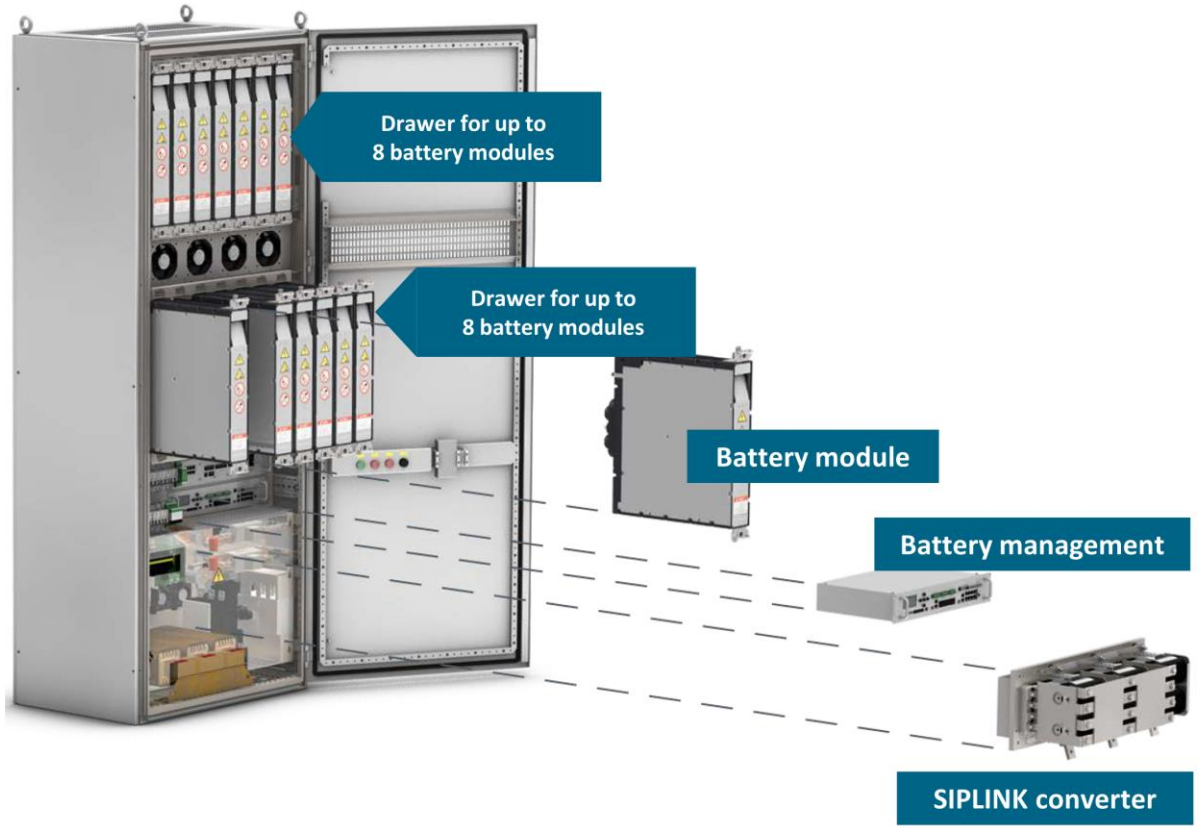

Combined energy storage cabinet (batteries + converter)
for up to 16 battery modules up to 24 kWh / 144 kWp

Control cabinet
(controlling of energy
and power flows)

Power connection cabinet

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As modular container solution

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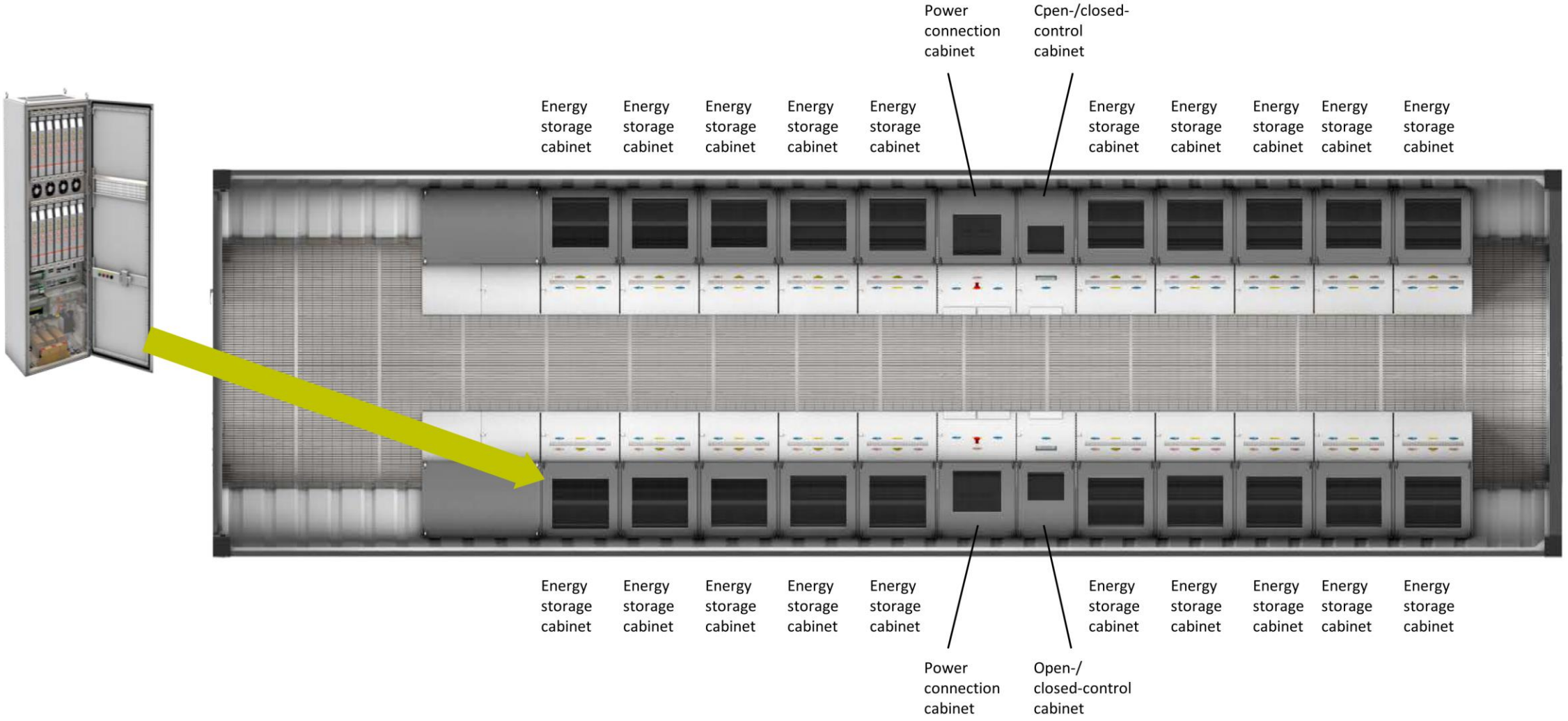

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Modular container solution

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Modular structure: Various configurations and storage sizes possible

Usable capacity*
16 kWh to 24 kWh depending on battery type

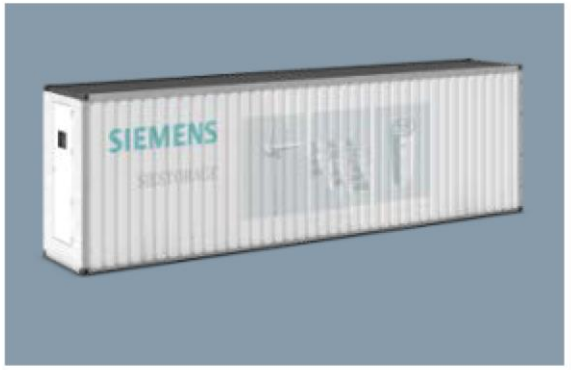
Rated power
32 kW to 96 kW depending on battery type

Usable capacity*
48 kWh to 72 kWh depending on battery type

Rated power
96 kW to 288 kW depending on battery type

Usable capacity*
80 kWh to 120 kWh depending on battery type

Rated power
160 kW to 480 kW depending on battery type



Usable capacity*
Up to 500 kWh in standard container

Rated power
1 MVA to 2 MVA depending on battery type

The advantages of the modular design

- **Different configurations and storage sizes possible**
- **No need for balancing between cabinets**
- **High reliability & availability**
- **Easy to maintain**

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Pilot plant in Italy

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Handover of pilot plant: February 2012

Connection to medium-voltage system
of Italy's largest power distributor: ENEL
Power output: 1 MVA
Capacity: 500 kWh

Application:

- Frequency control
- Integration of photovoltaic plants
- Fast charging station for electric vehicles
- Black start capability

An intelligent, flexible and green solution for numerous applications

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Va multumesc pentru atentie!

Vasile Cristea

Energy Management Division

Regional Sales Manager MS