Νέες Τεχνολογίες Αποθήκευσης Ηλεκτρικής Ενέργειας για Μεγαλύτερη Διείσδυση Φωτοβολταϊκών και Αιολικών στο Δίκτυο

Phoenix Solar ΕΠΕ

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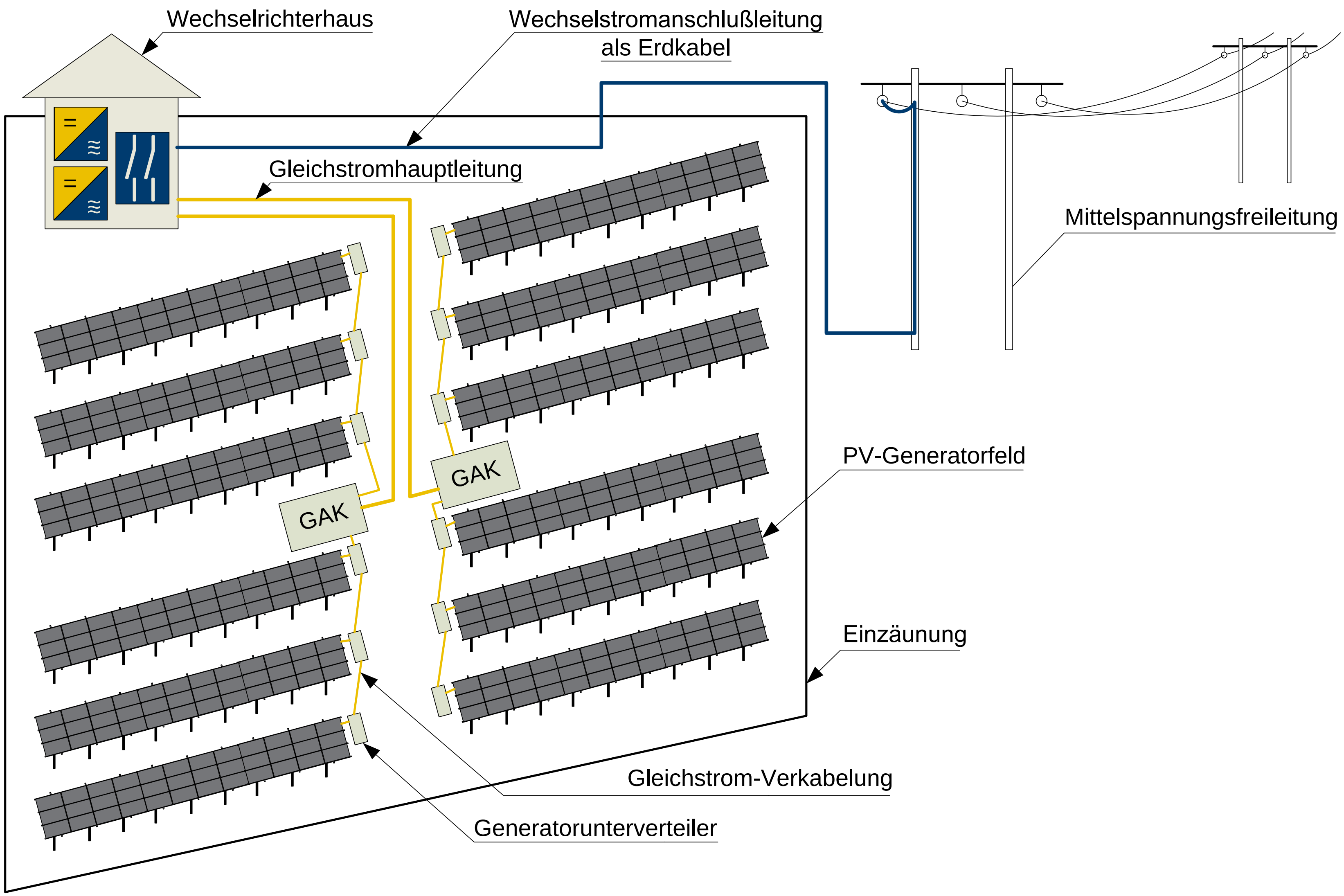
Electricidad Solar

Elettricità Solare

Solar Electricity

Électricité Solaire

Is the Network Infinite?



Is the Network Infinite?

Mainland Network

1. In the beginning of RES Programmes, not much attention was paid to the potential hosting capacity of the Network.
2. In this respect, the Network is a “passive” component and is considered as vast.
3. As a promotion mechanism, intermittent RE sources feed energy produced into the Network with priority against other power supply systems.
4. Usually, the intermittent nature of RE sources is not visible in the Network function, in terms of sustaining frequency and voltage at the required levels.

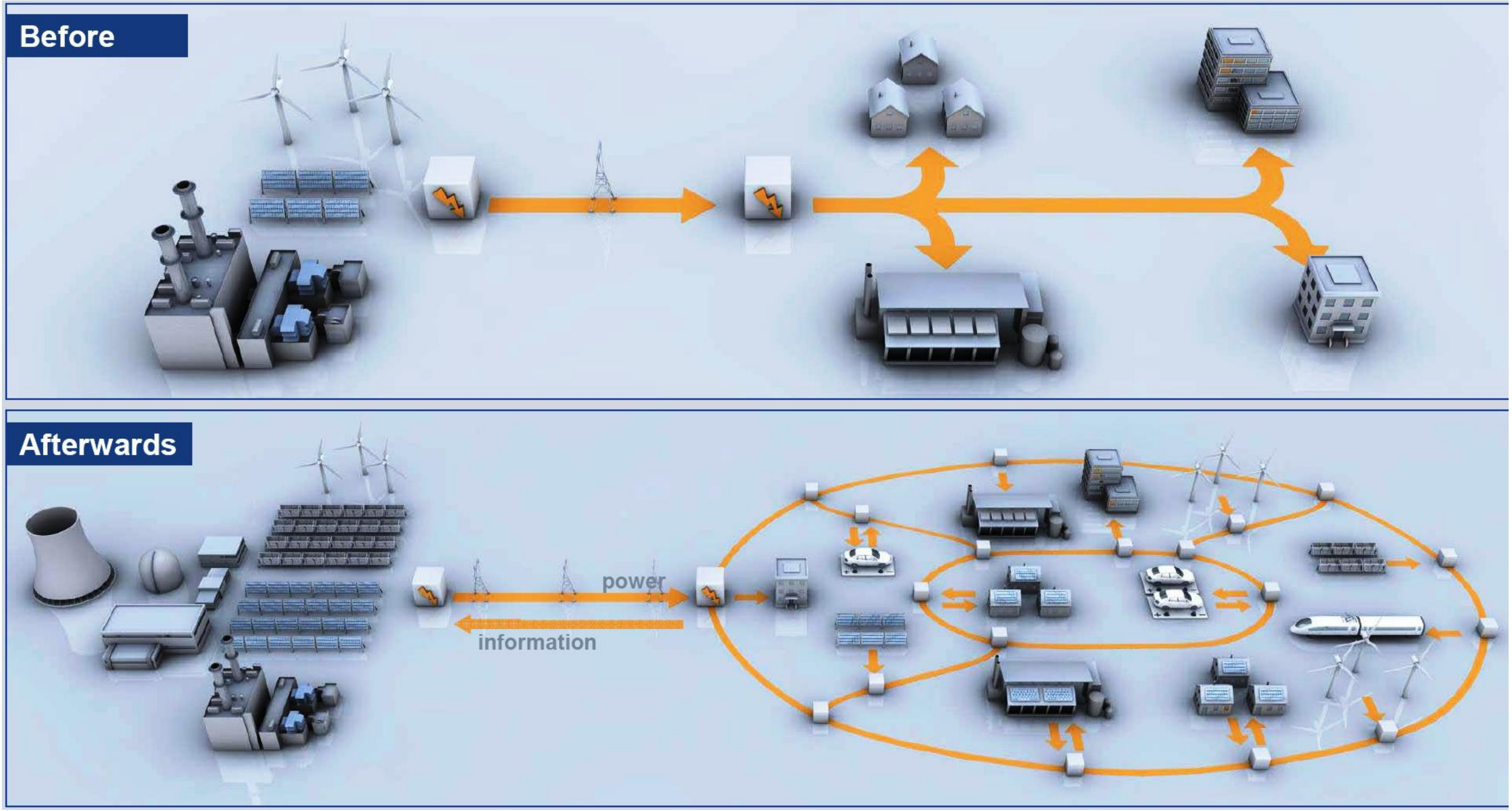
Island Network

1. On non-interconnected islands, the Network is local, has a “dynamic” seasonal nature and is usually formed by diesel generators.
2. Some penetration form RE sources is allowed, with strict rules and conditions.

Conclusion

<u>Network safety and protection</u>, <u>Grid reliability</u> and the <u>Quality of Supply</u> will be enhanced through active management of RES, with central battery storage playing a key role in the Smart Grids of the future.

Network Complexity



Large Battery Stationary Systems for Storage

- The new challenge: the increased integration of “volatile” RE sources in the energy mix requires advanced energy storage solutions.
- Advanced energy storage technology is essential to increasing the efficiency of power grids and enabling them to become smarter, cleaner and more reliable. MW-scale grid storage solutions help integrate RES such as wind and solar into the existing grid infrastructure.
- Large battery systems assist traditional power generation lower plant emissions, reduce O&M and capital costs and become more valuable by enabling generators to sell power to the grid that was previously set aside. Thus, the utilisation factor is optimised in both sides, i.e. the RE generation and the receiving transmission and distribution assets.
- Conventional battery technology, e.g. lead-acid, are not suitable because of the operational temperature range and the high number of cycles required.
- The Li-ion battery seems to be an ideal solution in providing additional benefit through energy handling for stabilising Networks.
- **Li-ion batteries are “working” batteries**, meaning high numbers of charge/discharge cycles and handling lots of kWh in their lifetime. By just using them as backup systems, cost efficiency cannot be achieved.

Large Battery Systems – Key Benefits

INCREASE SYSTEM EFFICIENCY

- Decouple generation and load
- Reduce emissions
- Increase asset efficiency and utilization
- Reduce operating and maintenance costs
- Provide versatile, continuous-use asset that generates revenue
- Ease transmission constraints

IMPROVE GRID STABILITY AND RELIABILITY

- Provide ancillary services
- Improve frequency regulation and balance load at a lower cost
- Provide new capacity that can be deployed quickly
- Provide dependable frequency response

ENABLE INTEGRATION OF RENEWABLE SOURCES

- Mitigate intermittency, “firming” of renewables
- Provide greater ramp rate control
- Supports Renewable Portfolio Standards (RPS) targets

INCREASE ENERGY SECURITY

- Support utilization of diverse domestic energy supply, including renewable sources

Large Battery Systems – Applications

GENERATION

- Frequency Regulation
- Blackstart
- Renewable Integration
- Spinning Reserve
- Power Plant Hybridization
- Ramp Rate Management

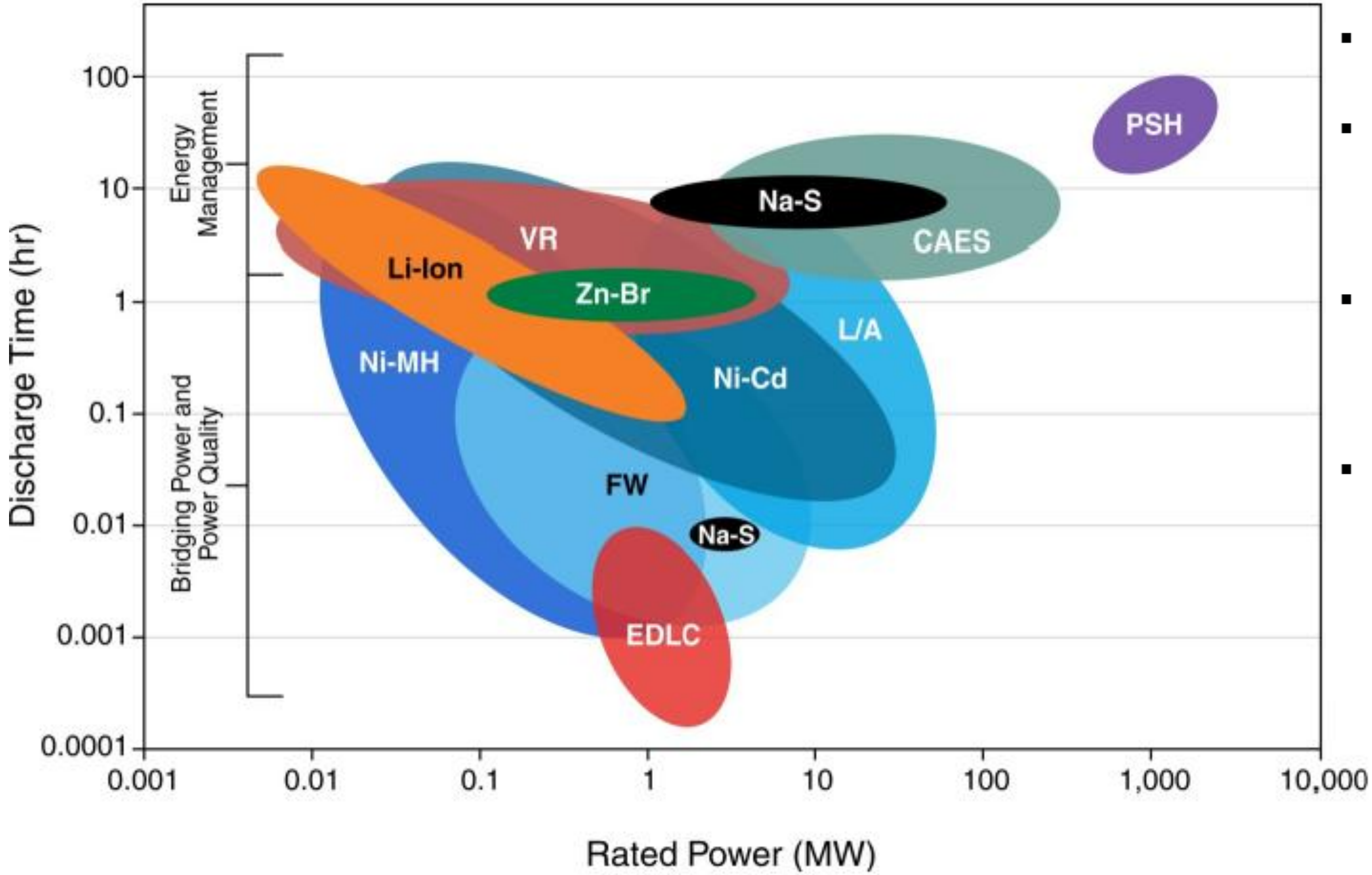
TRANSMISSION

- Voltage Support
- Dynamic Line Rating Support
- Renewable Integration
- Dynamic Stability Support
- Loss Reduction

DISTRIBUTION

- Residential and Industrial Backup Power
- Renewable Integration
- Community Energy Storage for Utilities

Battery Technologies – review



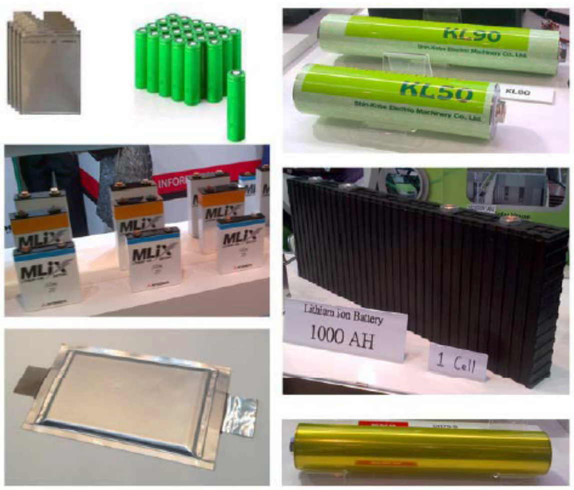
CAES	Compressed air	Ni-Cd	Nickel-cadmium
EDLC	Dbl-layer capacitors	Ni-MH	Nickel-metal hydride
FW	Flywheels	PSH	Pumped-storage hydropower
L/A	Lead-acid	VR	Vanadium redox
Li-Ion	Lithium-ion	Zn-Br	Zinc-bromine
Na-S	Sodium-sulfur		

- There is no universal solution for electrical energy storage.
- For discharge times up to 100 seconds supercaps (double layer capacitors) are preferable. Flywheels are suitable.
- Requirements up to approximately 10 MW for max. 6-8 h can be addressed by battery-type solutions (e.g. PV and single wind turbine)
- Among the large-scale solutions (pumped hydro, CAES, H_2) hydrogen provides the highest possible energy density and enables storage capacities > 100 GWh.

Li-ion Battery Technology

Form-Factor

- Pouch Cells
- Prismatic Hard Case
- Cylindric
- Etc.



Chemistry

- $LiMn_2O_4$ (LMO)
  Lithium Manganese
- $LiNiMnCoO_2$ (NMC)
  Nickel Manganese Cobalt
- $LiFePO_4$ (LFP)
  Iron Phosphate
- $Li_4Ti_5O_{12}$ (LTO)
  Li-Titanate
- $LiNiCoAlO_2$ (NCA)
  Nickel Cobalt Aluminum Oxide
- Etc.

Characteristics

- Calender life time
- Cycle lifetime (80% of initial)
- Energy Capacity
- Energy Density
- Charge Current
- Discharge Current
- Efficency
- Power
- Thermal conditions
- Operating Temperature
- Safety
- Maintainable in Batterysystem?
- Cost / Total Cost of Ownership

Most Important

Li-ion Battery Technology – Characteristics

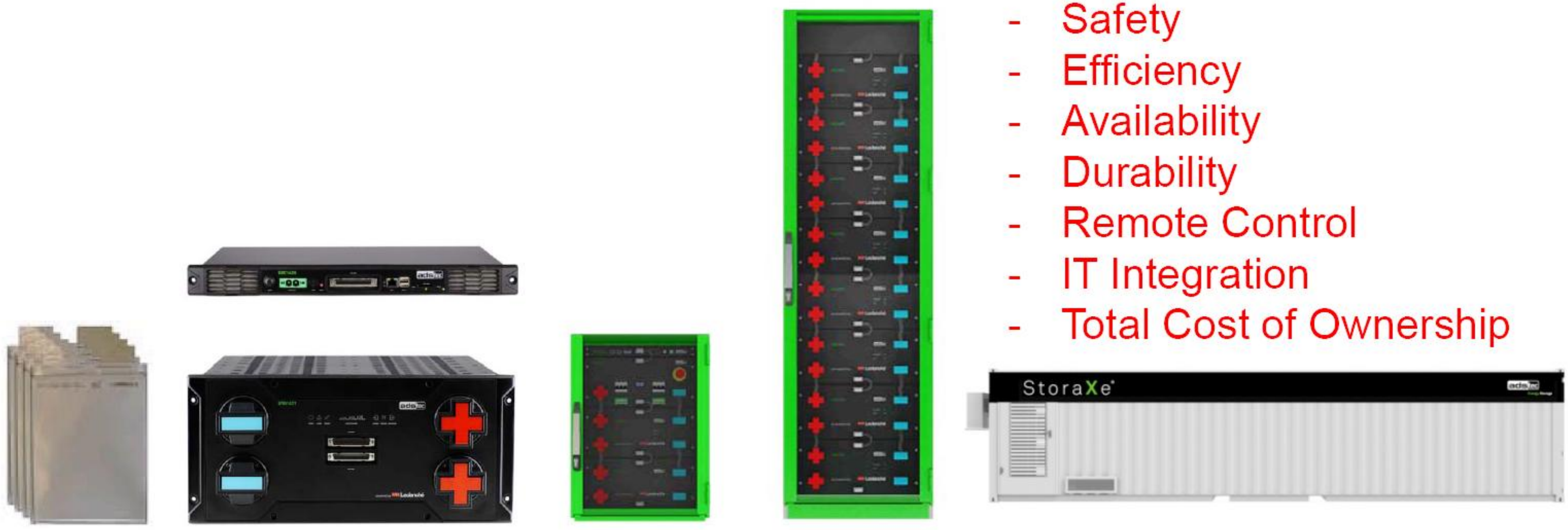
Round-trip efficiency, [%]	**>90**
Power rating, [MW]	0.1-5
Specific energy, [Wh/kg]	100-250
Energy density, [Wh/lt]	250-620
Power density, [W/kg]	230-340 (up to 1500)
Specific power, [W/Wh]	3-6
Specific mass, [kg/kWh]	11
Response time	sec
Charge time	min to hours
Discharge time	15min-4h
Cycle life, [cycles]	>4,000 @80% DoD **>10,000 @50% DoD**
Lifetime, [years]	**8-15**
Self-discharge per month, [%]	5-8 at 21 C 15 at 40 C 31at 60 C

Li-ion Battery Technology – Characteristics

Operating temperature, [C]	-10 to +50
Capacity range, [Ah]	2.2-40
Memory effect	no
Environmental impact	minimal
Maintenance	no
Recyclability	yes
Health and safety risks	moderate
Investment cost energy, [$/kWh]	500-1500
Expected overall storage cost, [$/kWh]	250-500
Fixed O&M costs, [$/kW-yr]	10-25

Li-ion Battery Technology – Modularity

- Scalability
- Easy to maintain
- Safety
- Efficiency
- Availability
- Durability
- Remote Control
- IT Integration
- Total Cost of Ownership



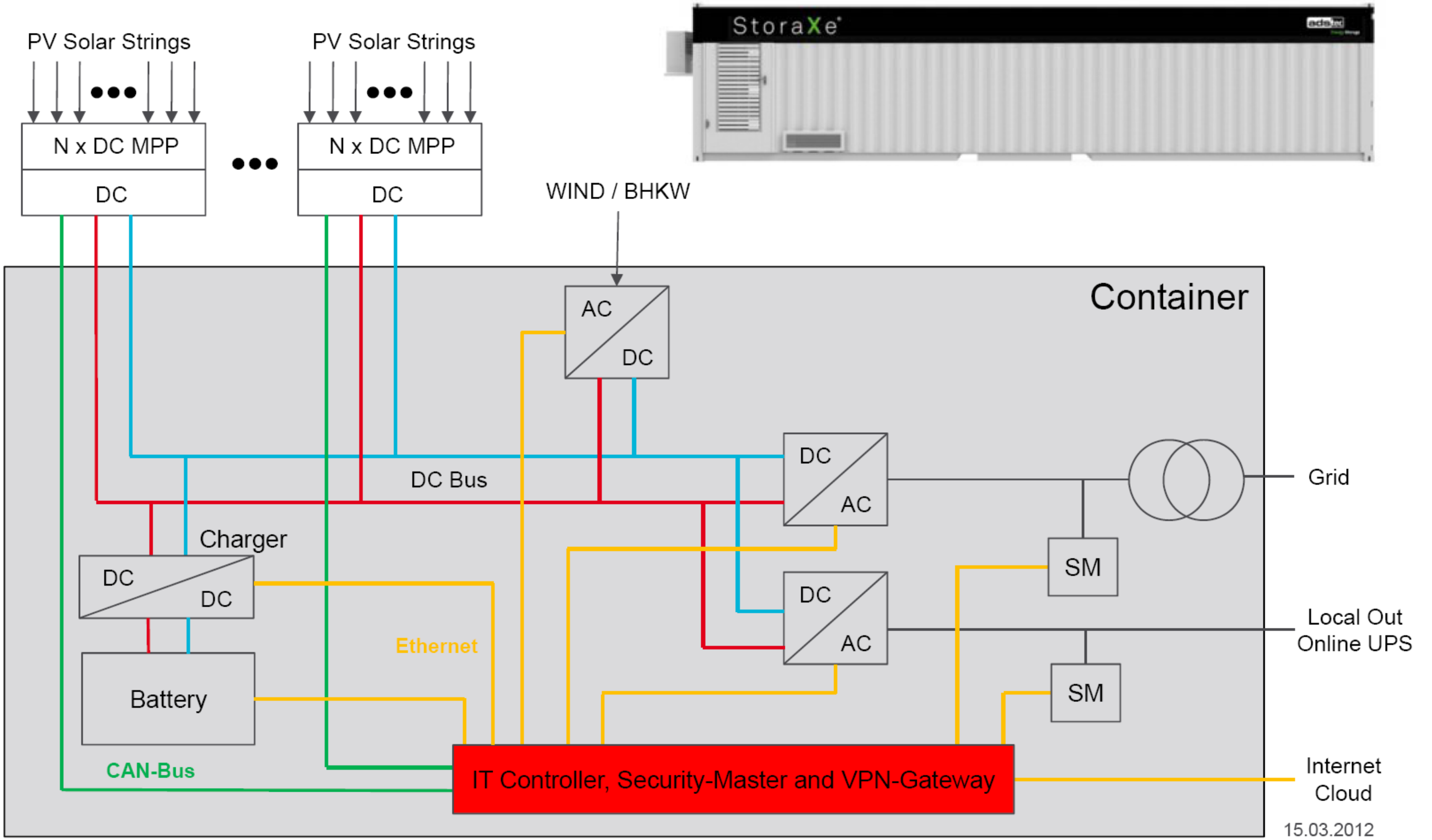
Cells

Battery Modules
Battery Controller

Battery Systems
19” Racks

Storage Solutions up to MWh
20” or 40” Feet Container

System Design and Integration



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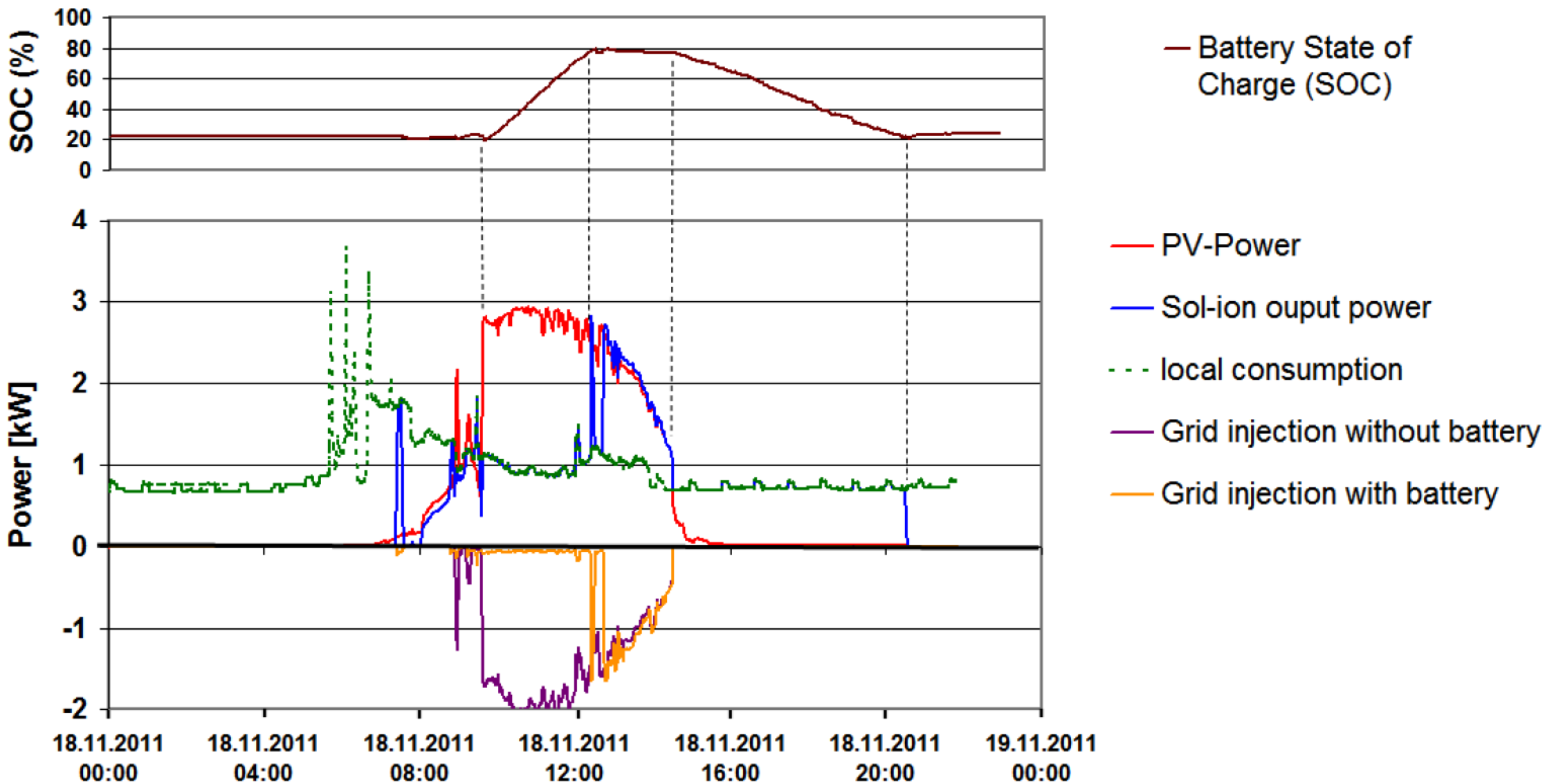
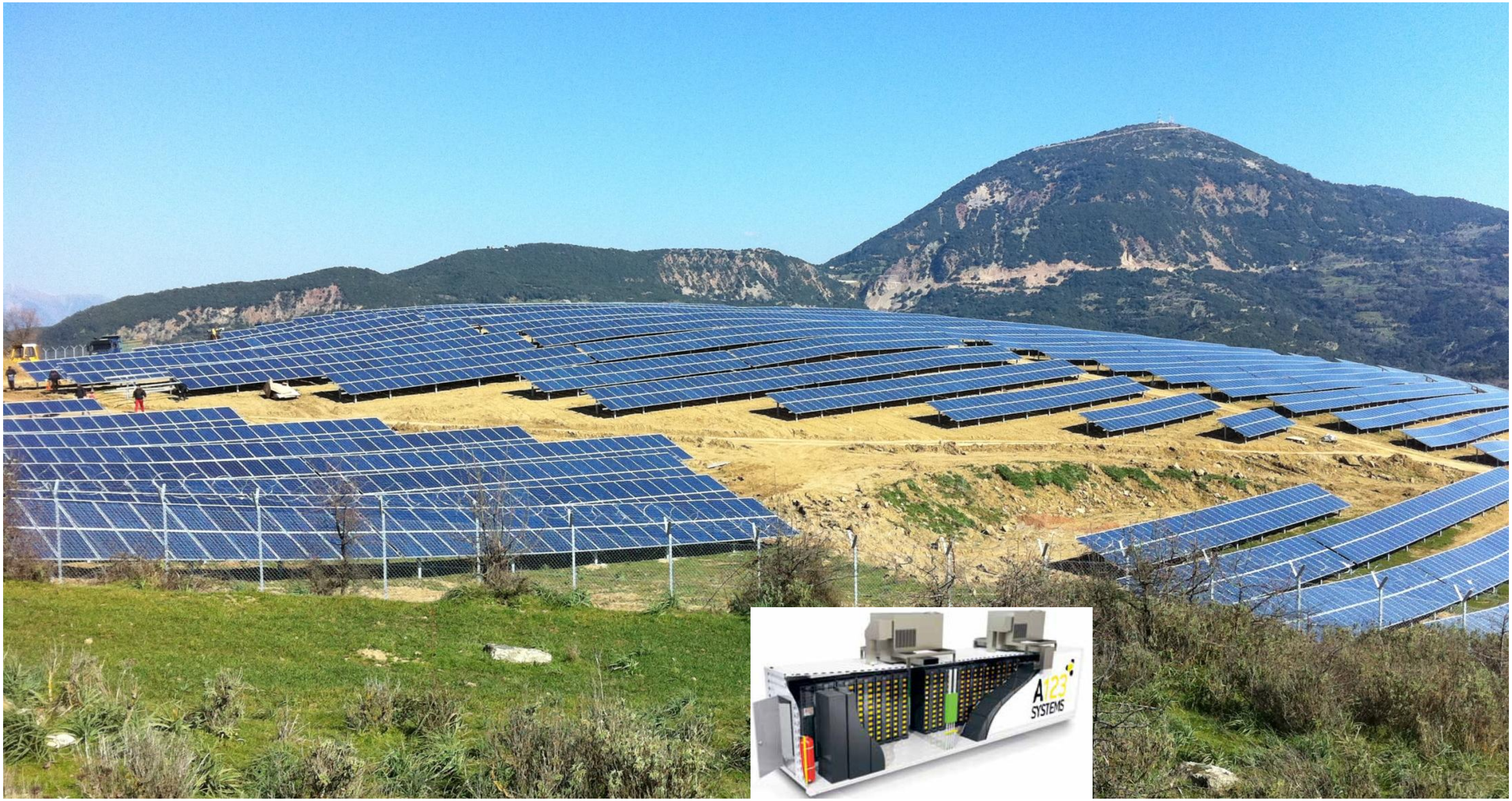
Operation with and without Battery



Conclusions

- Future electricity Networks will be much more complex compared to today's "passive" Networks.
- Access to an "active" Network will be an issue to be tackled by all potential power supply producers. Presently, the usage of RES in existing distribution grids is limited.
- The next generation distribution networks will utilise the potential of RE sources in ancillary services, in line with security of supply and network stability.
- Central battery storage systems will minimise the intermittent nature of RE systems, especially wind and solar, and will allow such resources to be optimally integrated into the new electricity networks.
- Stationary storage solutions will be part of the so-called "Smart Grids" and battery systems will play an important role in the concept of "New Energy Solutions".
- The Li-ion battery is a mainstream storage technology for stationary usage in decentralised systems. Among other storage technologies, Li-ion batteries have certain characteristics, making them almost ideal for power servicing to electrical grids.
- Modular Li-ion battery systems allow scalable solutions ranging from kWh to MWh.
- The high efficiency and high cycle lifetime expectancy of Li-ion technology are valuable characteristics for batteries used to regulate energy.

Sophisticated PV Plant Design & Management



Ευχαριστώ Πολύ για την Προσοχή Σας!

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