VRB Energy Storage Systems
-
mean to materialize electricity networks of the future

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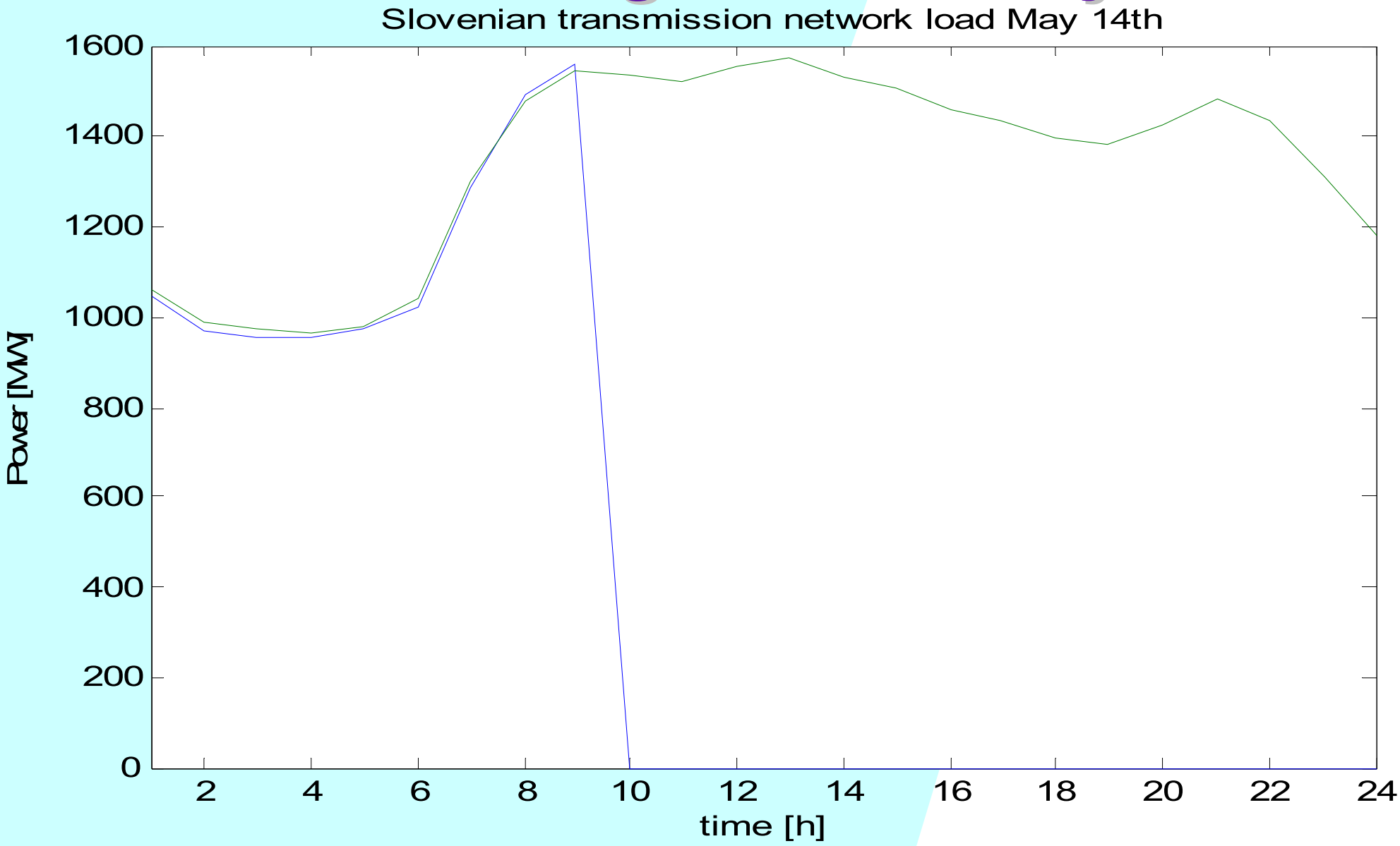
Targets for Electric Energy Supply Industry

- Being independent from foreign energy sources and supplies
- Use as much renewable energy sources as possible in order to reduce CO2 emission and achieve sustainable energy supply
- Use market mechanisms to achieve secure and high quality energy supply
- Keep all commodity in our life style
- Have cheap energy

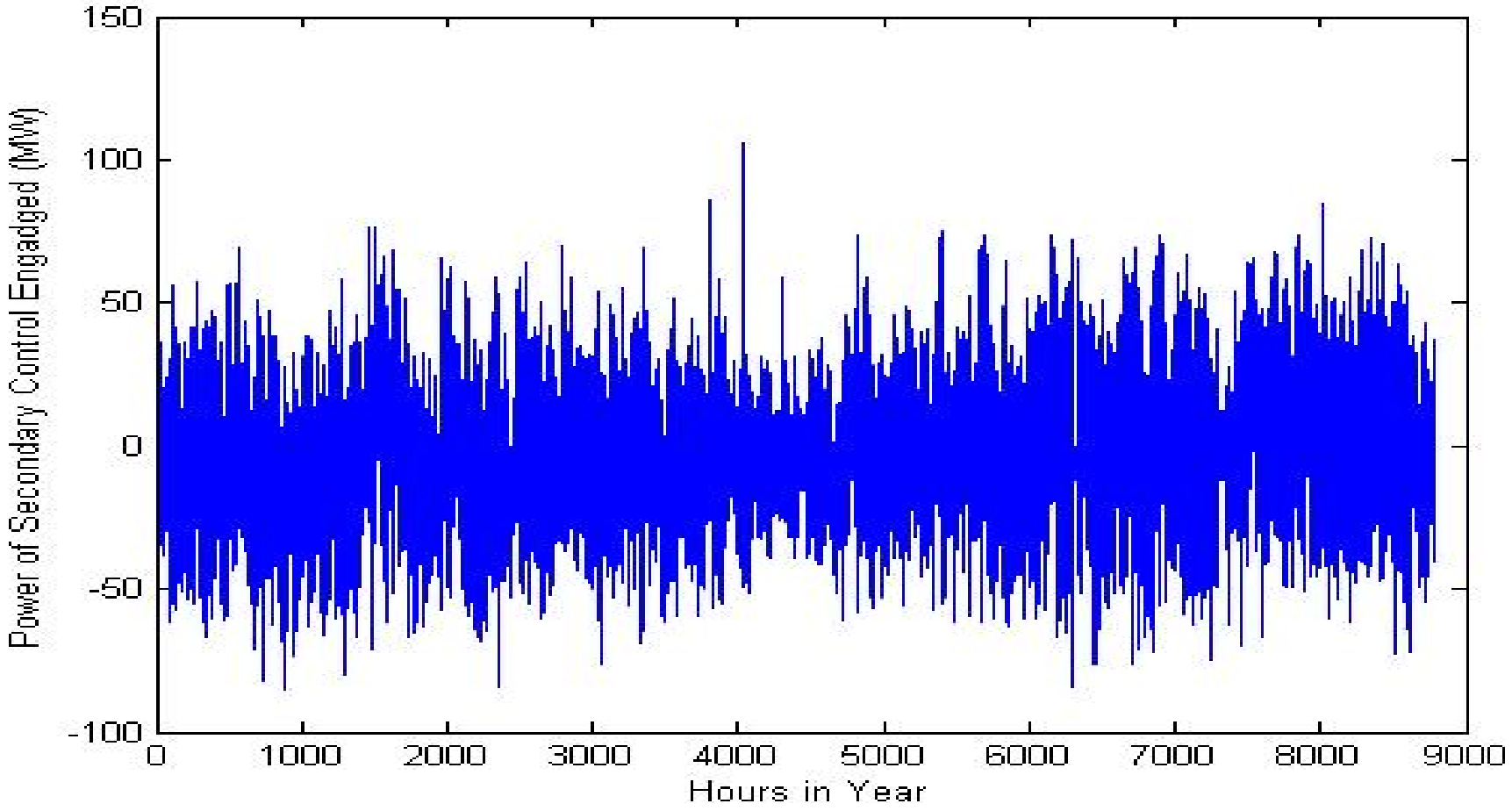
IS THAT ALL POSSIBLE?

Predictable Situation in “Big Electric System“



Predictable Situation in “Big Electric System“??

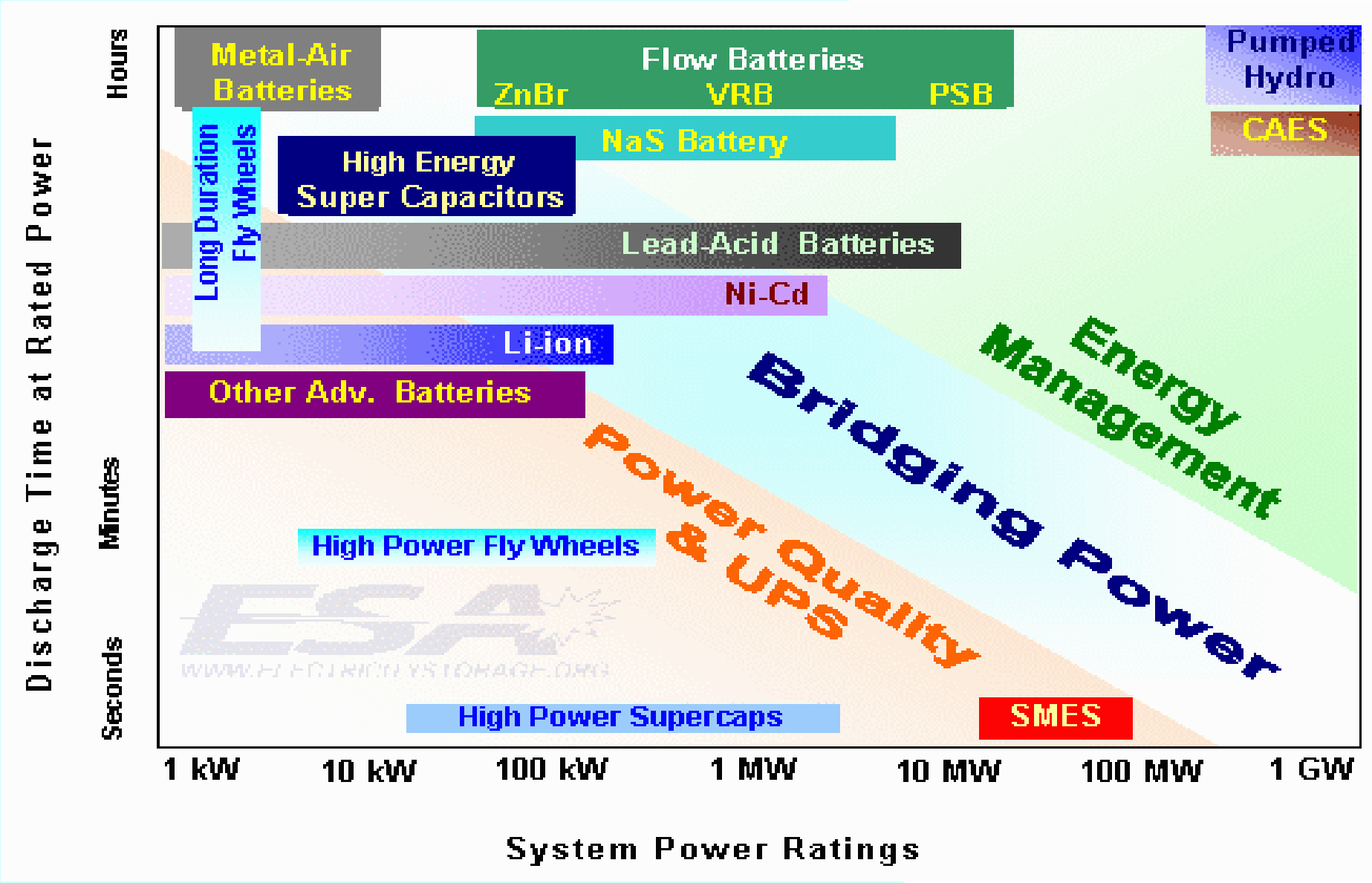
- Severe fluctuations in load and generation



How to keep energy balance in “small System“

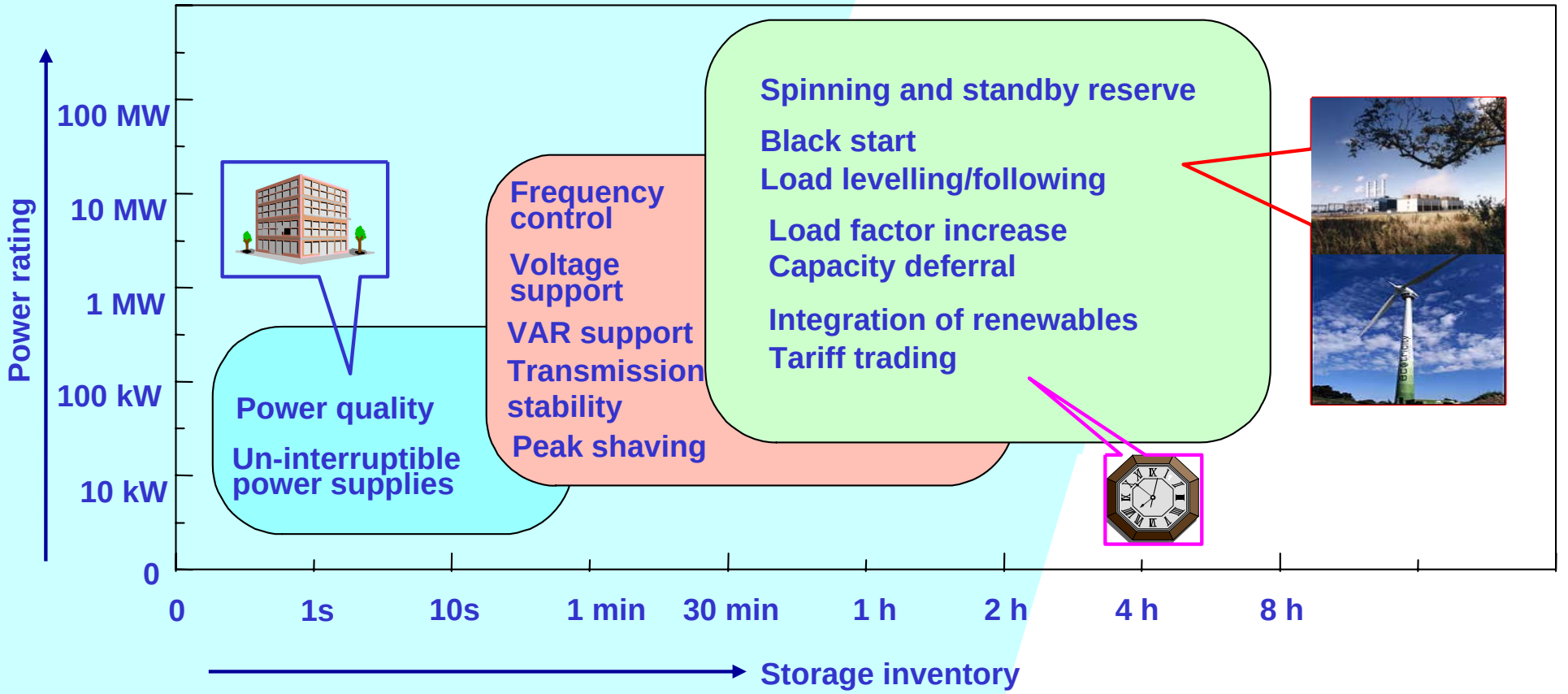
- Few loads and no statistical rules
- Integration of renewable energy sources (RES) and many of them behave as negative load
- Periods of – and + in system power and energy balance are inevitable
- Consequences:
  - Conventional energy needed sources for periods of –
  - Not all possible energy produced during periods of +
- Energy storage is one possible solution

Energy Storage Technologies

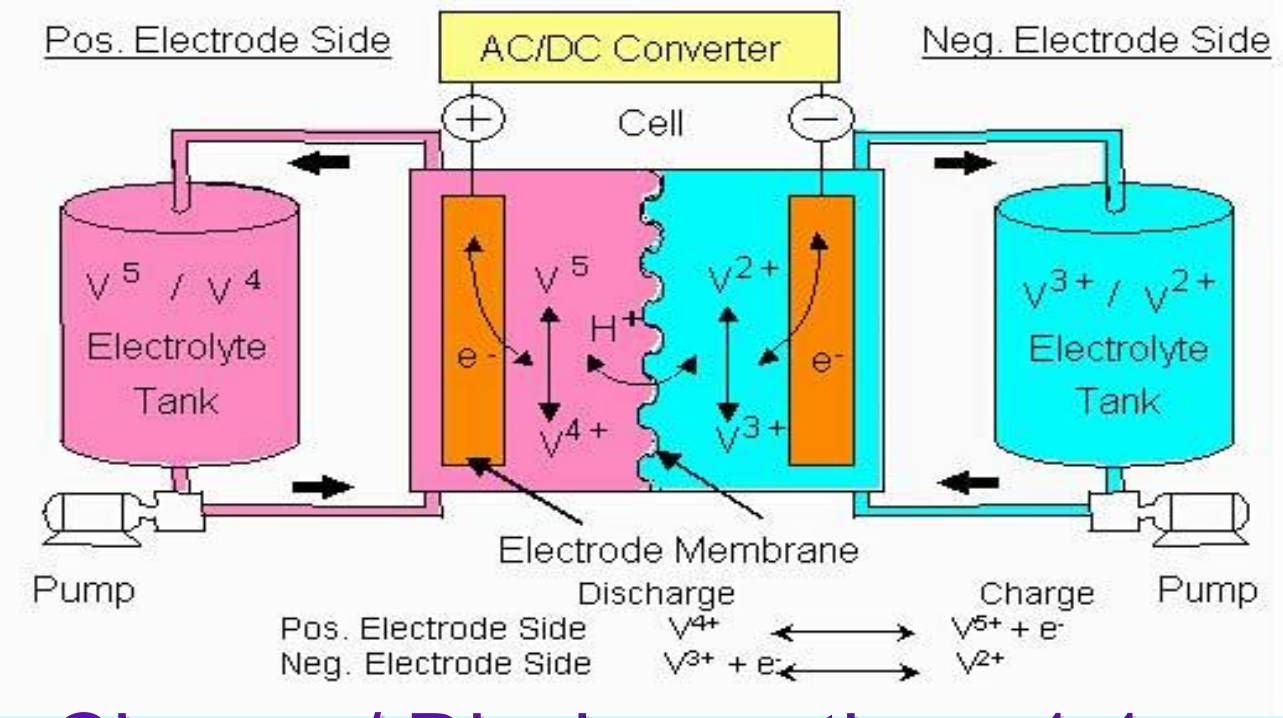


Applications of Energy Storage in Power System

- Applications in correlation with power and energy



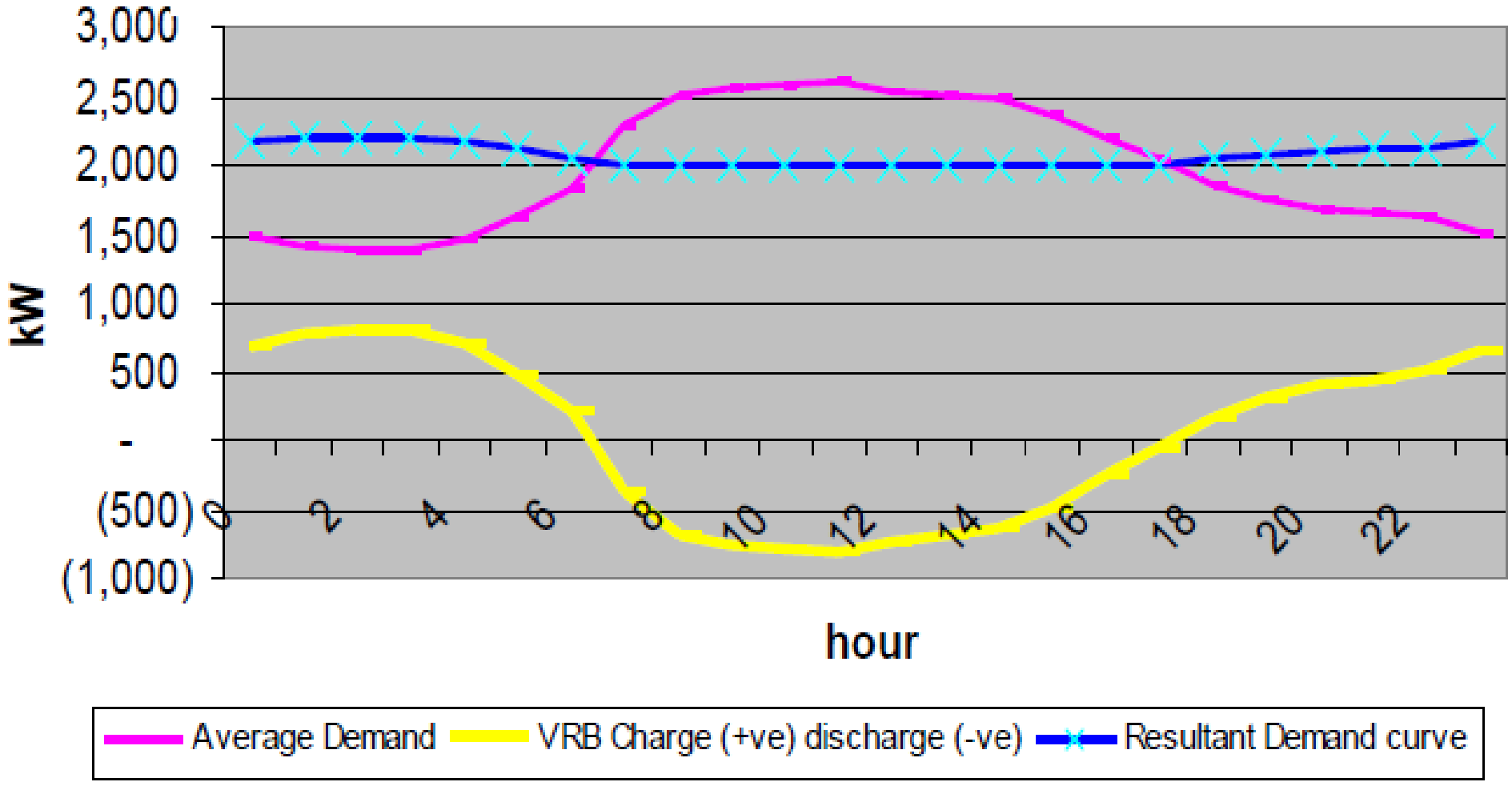
VRB Energy Storage System Technology



- Vanadium Redox Battery
- Independent P and W capacity dimensioning
- Long life

- Charge / Discharge time 1:1
- Efficiency up to 80%
- Dynamic response in the range ms
- P=5-10.000 kW W=10-100.000 kWh

Application: Load leveling for industrial customer

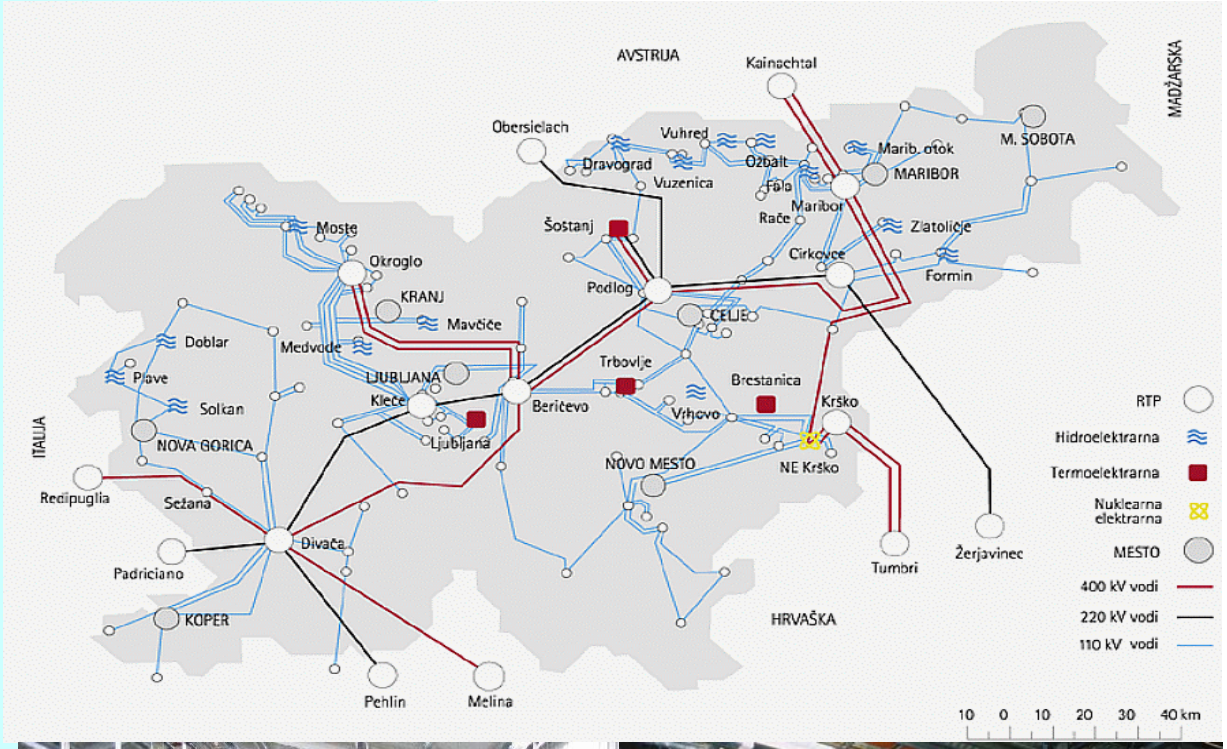


Application: Secondary P/f control

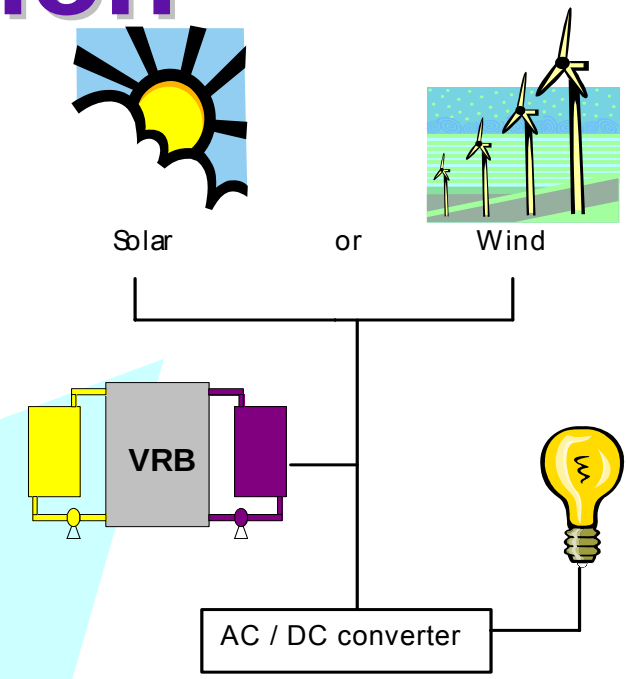
- Control band: Psc = ±(1...1,5)√Pk => ±80 MW for Slovenia.
- Wide range of power fluctuations frequency.
- Provided by conventional power plants (Hydro & Thermal).
- Need to operate with lower power => lower generation of existing power plants
- About ±35 MW of power band in fluctuation frequencies high enough to be compensated with energy storage

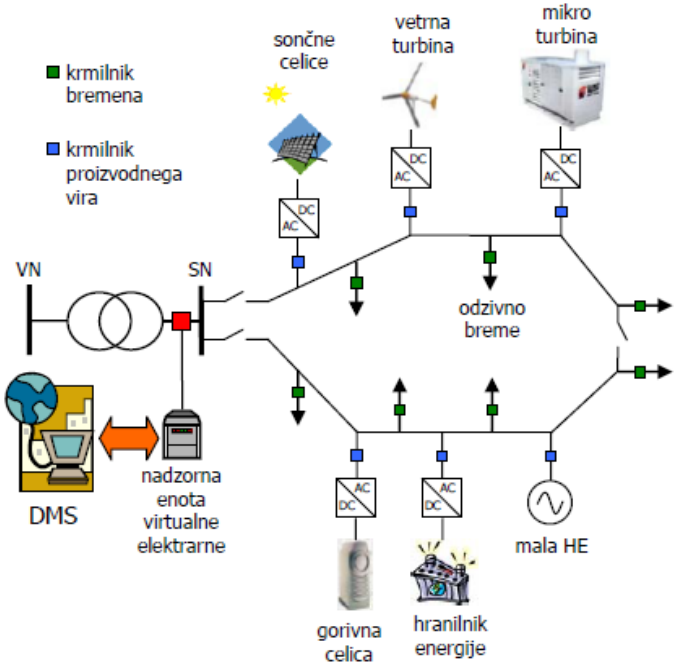
Application: Secondary P/f control

- Suggested configuration: 5-6 Storage units in 110/20 kV substations
- Increased generation from existing power plants
- Many other benefits for the system

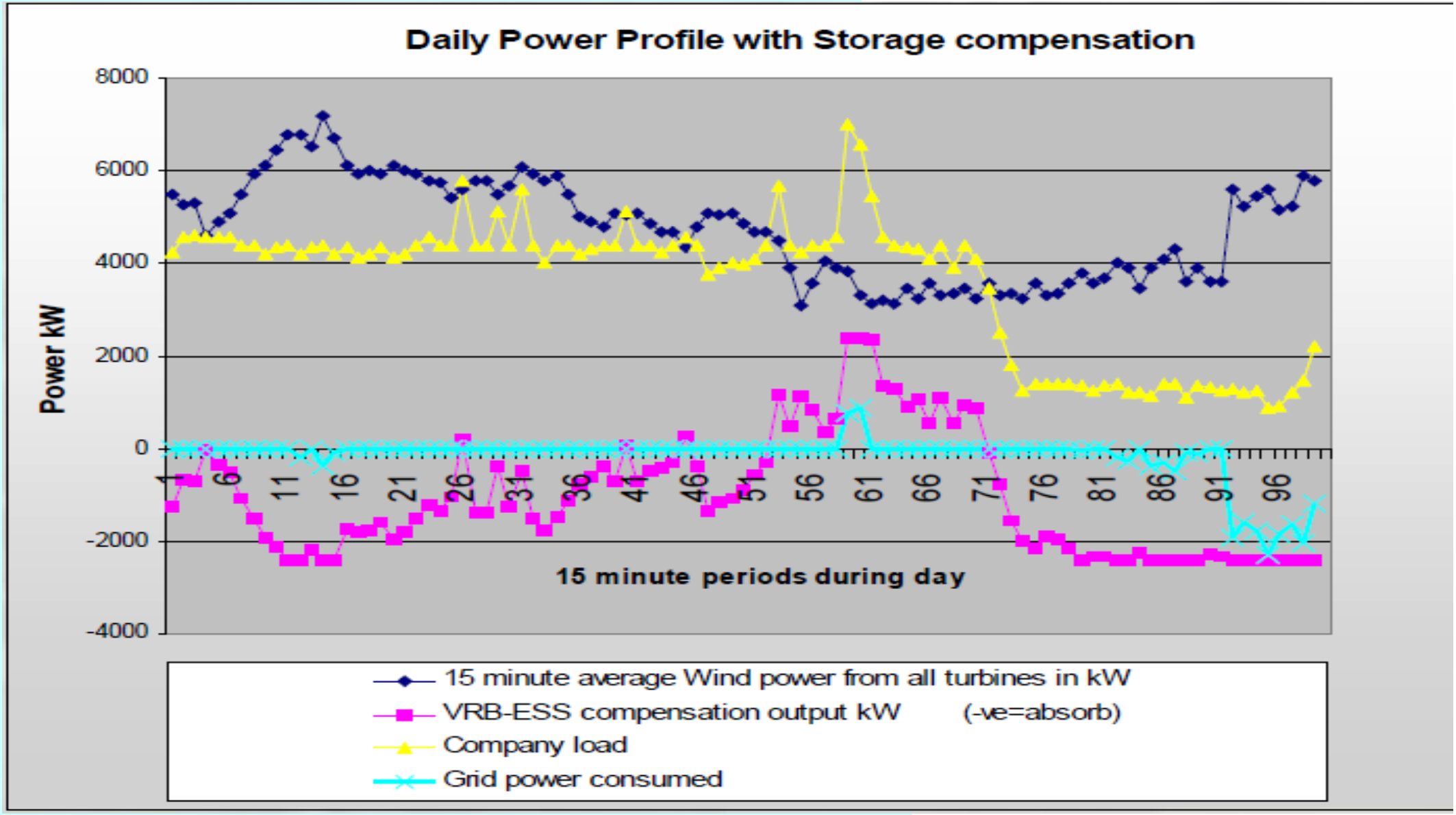


Application: RES integartion



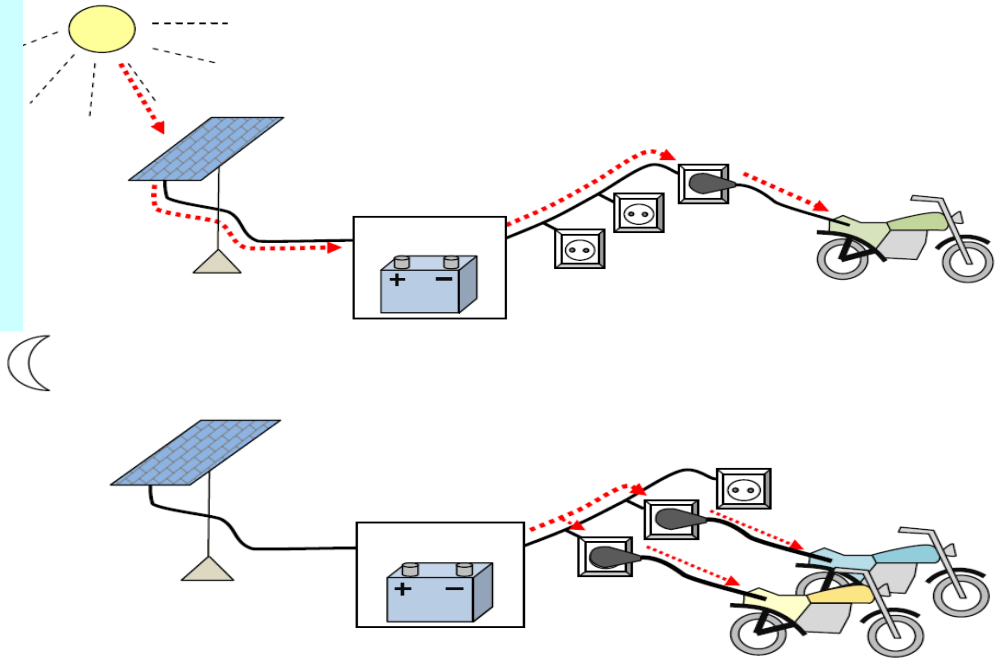


Application: Wind for industrial consumer



Application: 0 CO_2 emission mobility

Model	Battery capacity (kWh)	Range (km)	Recharge time (h)	Charge Power (kW)	Battery type
Vectrix Scooter	3,7	55 - 90	3	1,5	Ni/MH
iO 1500GT Scooter	2,0	50 - 70	3 - 6	0,6	Pb/acid
iO Citybike Vienna	0,2	20+	1 - 3	0,2	Ni/MH
Flyer T8 bike	0,3	12 - 37	4 - 6	0,06	Li-ion
Lectra VR24 Motorbike	2,6	22 - 40	4	0,44	Pb/acid
EZ Go Golf Cart	7,9	10	10	1,0	Pb/acid
Smart fortwo EV	15,0	115	3,5 - 8	2,8 - 3	Na/NiCl

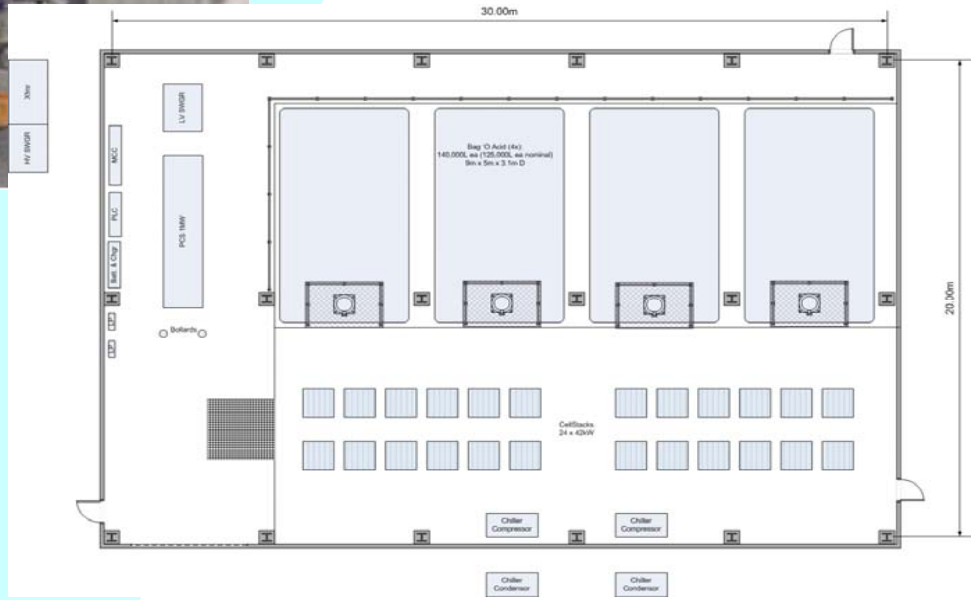


4-Wheel Electric Vehicles

Model	Battery type	Energy (kWh)	Range (km)	Charge Power (kW)	Recharge time (h)
Smart For 2 EV	Na/NiCl	15	115	2,8 - 3	4 - 8
Austin Mini Mini E	Li-ion	35	160 - 250	11,5/6,9/2,76	2,4/3,8/10,1
Renault Ondelio Ze	Li-ion	16, 2 - 20	125	<6,8	n/a
Chery S18	Li-ion	14 - 15	150	3,75 - 2,7	4 - 6
GEM 4x4	Li-ion	6,5	50	1,73	2 - 4
Tesla Motors Roadster	Li-ion	57	350	14,8/6,9	3,5/8
Ford e-Ka	Li-ion	28	150 - 200	< 6,8	6 - 8
Mitsubishi i-MiEV	Li-ion	16	160	3-ph 50/3	30min/7

Application: Other benefits for the system

- Peak shaveing
- Better use of exisitng generation a transmission capacities
- Regulations
- PQ
- Reliability
- Stability
- Supply of sites without power network
- Contingency supply



Thank you for your attention

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