



Serving PEVs in charging stations

Optimal sizing of grid connection, battery pack and renewable energy generation in an EV charging station – minimizing cost to meet demand

Cavtat 18.6.2015

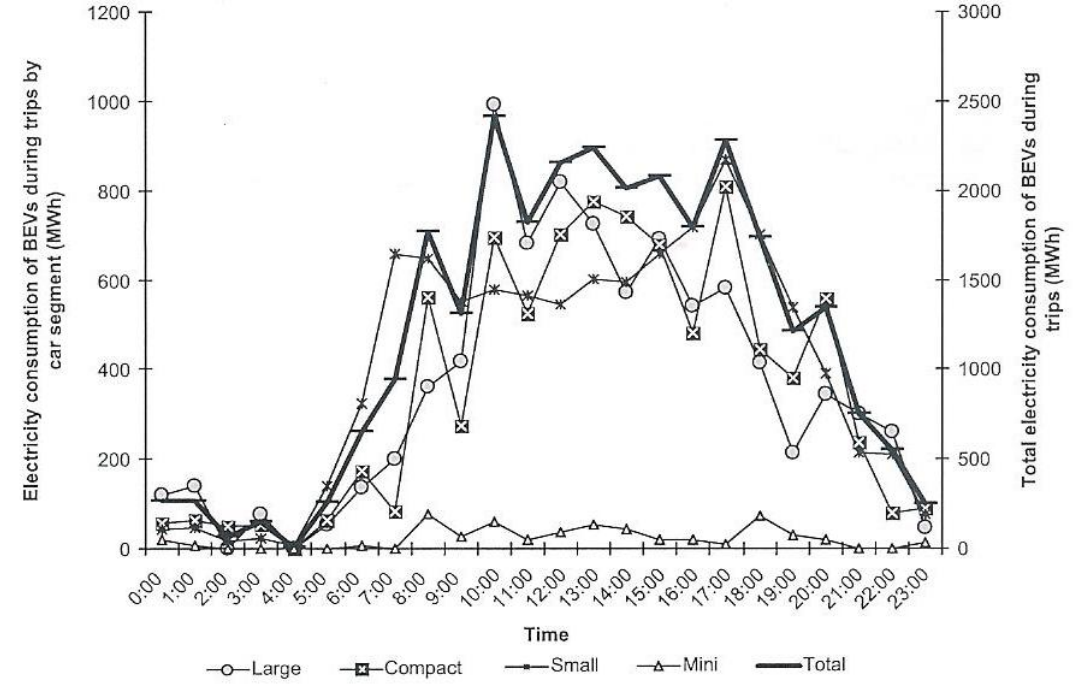
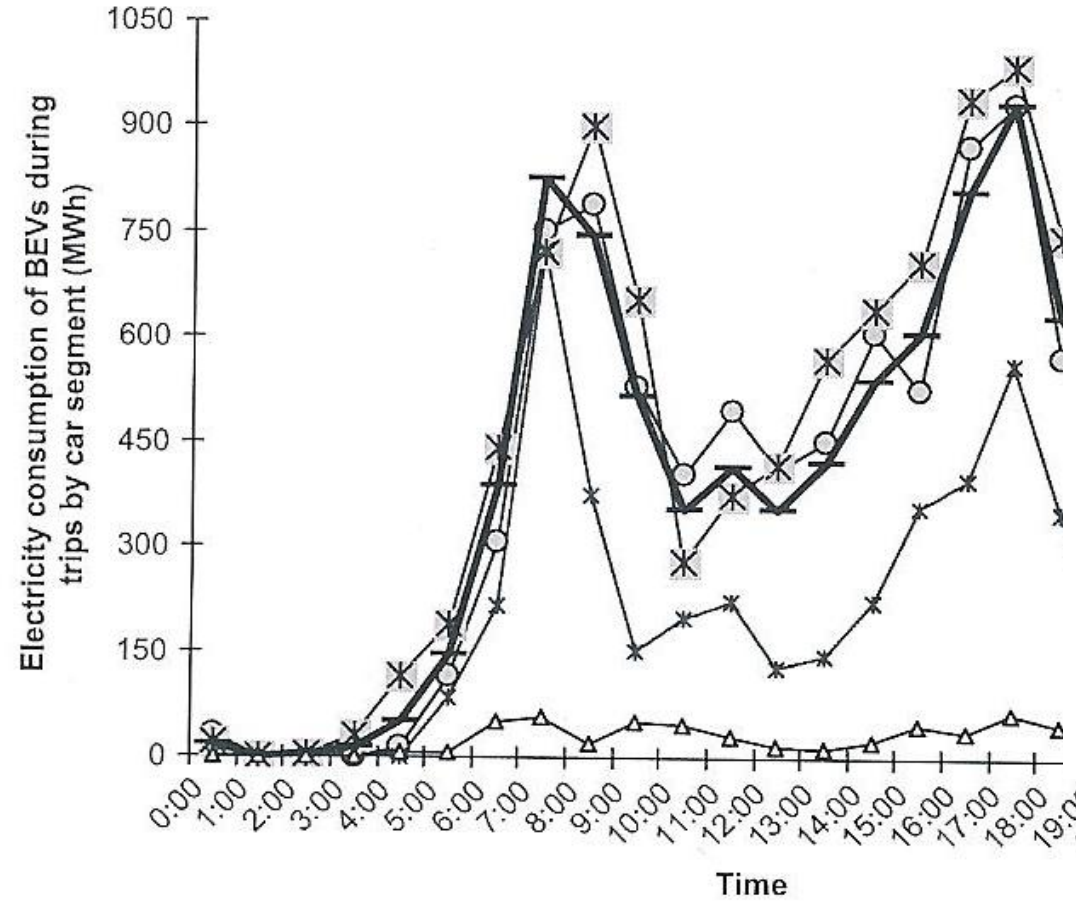
Content

- Demand for charging
 - Estimated electricity consumption for EVs in the literature
- Main cost factors for a EV charging station with energy storage
- Estimating grid connection and energy storage capacity using a techno-economic model for a single charging station



Estimated electricity consumption for EVs

R. Loisel et al. / Energy Policy 65 (2014) 432-443

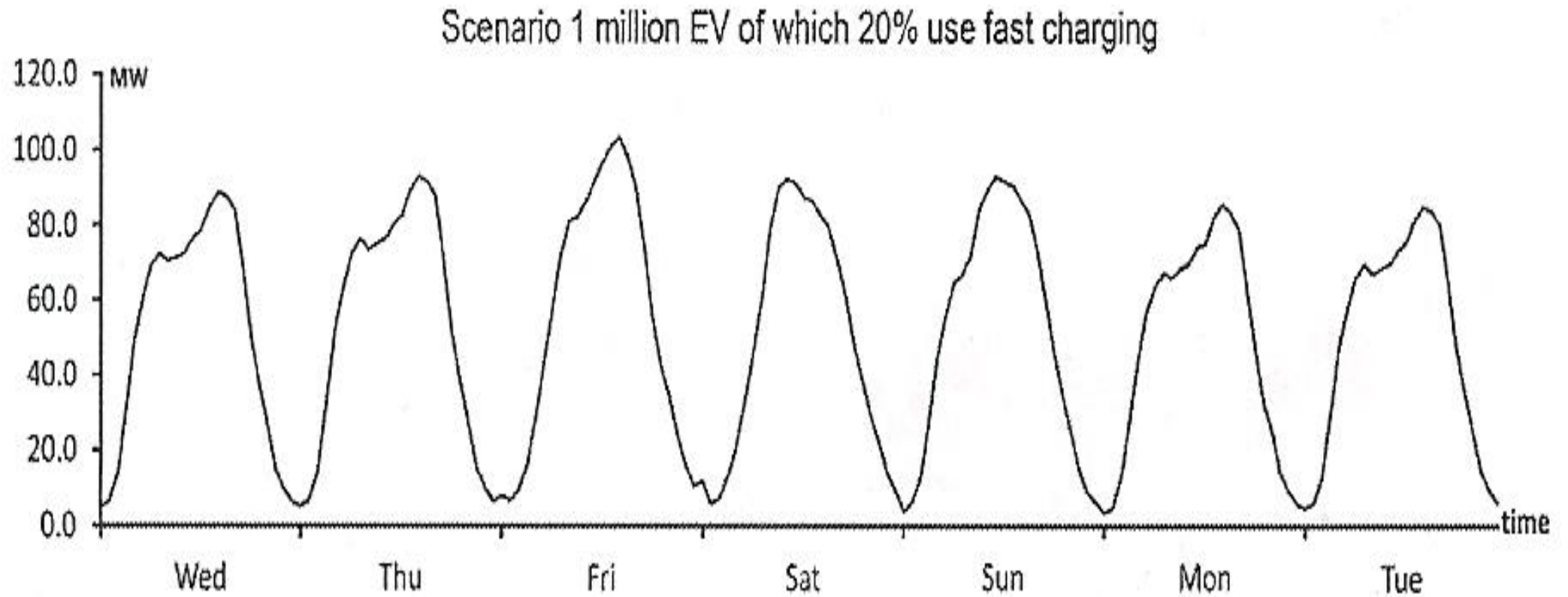


—○— Large —×— Compact —*— Small —△— Mini ——— Tot



(Loisel, Pasaoglu et al. 2014)

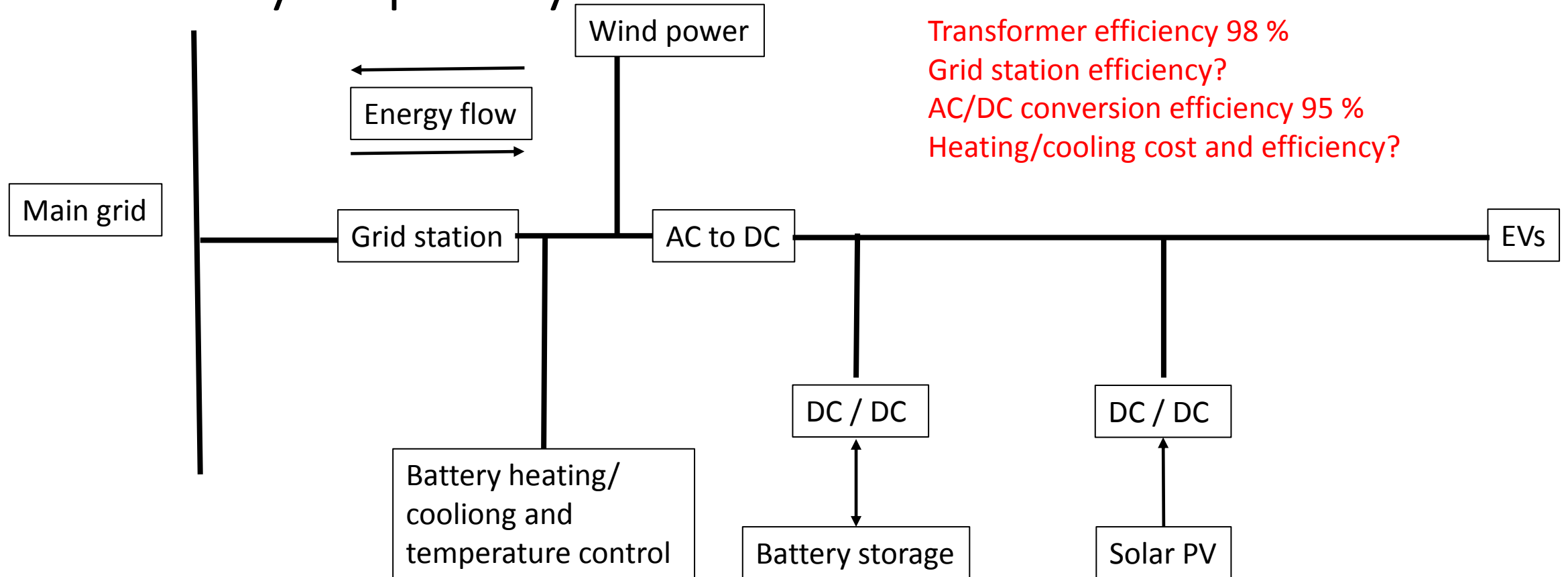
Syntetic demand for energy for EVs



Source: Schroeder and Traber 2012, based on Barnes 2008



Main cost elements affecting grid- and battery capacity

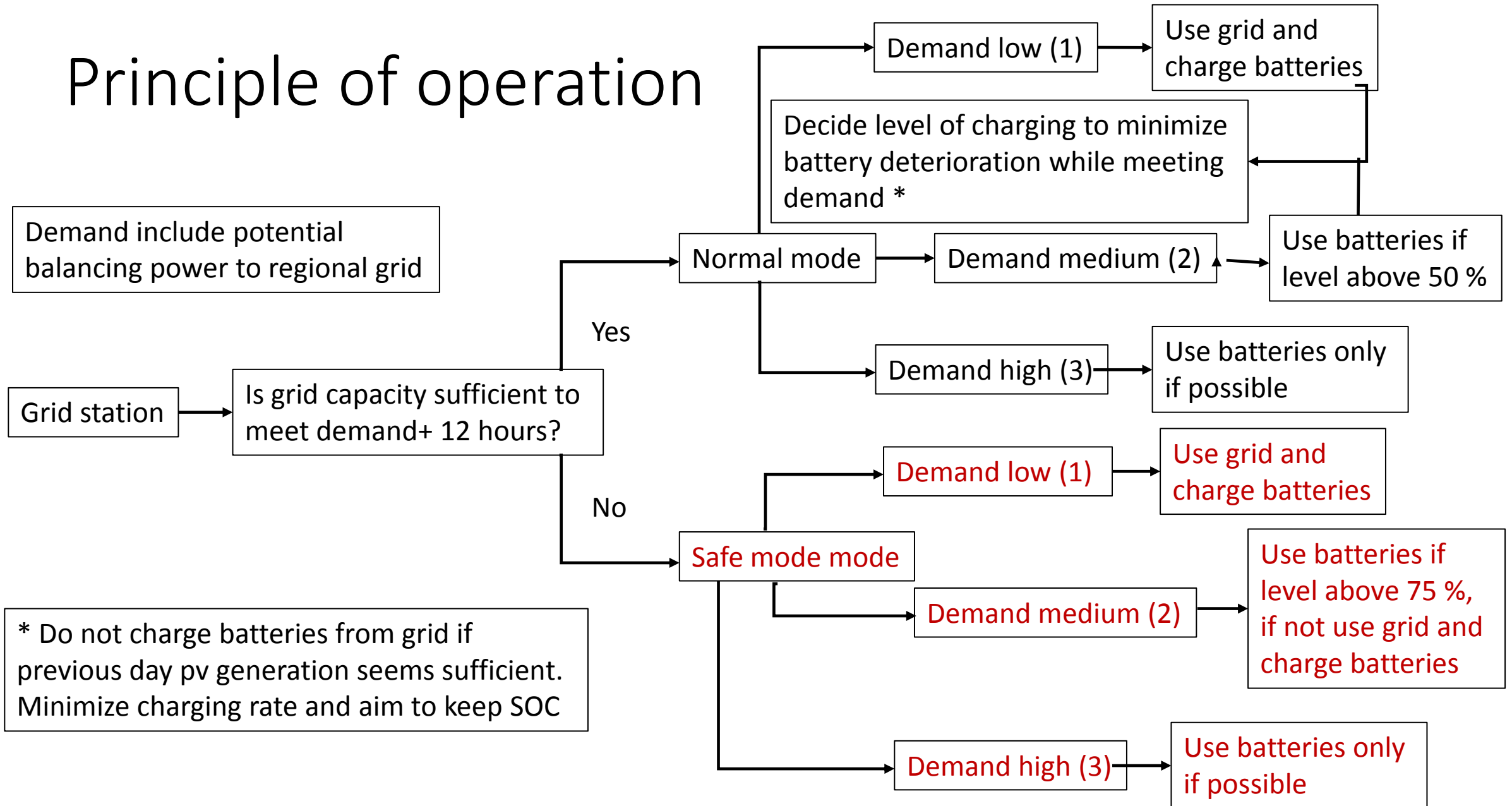


Cost calculation issues

- Grid electricity cost is composed of several elements, effect charges, fixed monthly cost, electricity price and taxes.
 - Small diurnal and work week/weekend electricity price difference, hence minimize power demand rather than energy
- Discharge has a cost in terms of reduced capacity on the batteries depending on the depth of discharge, as well as storage only.
- Maximize the use of onsite renewable generation for charging

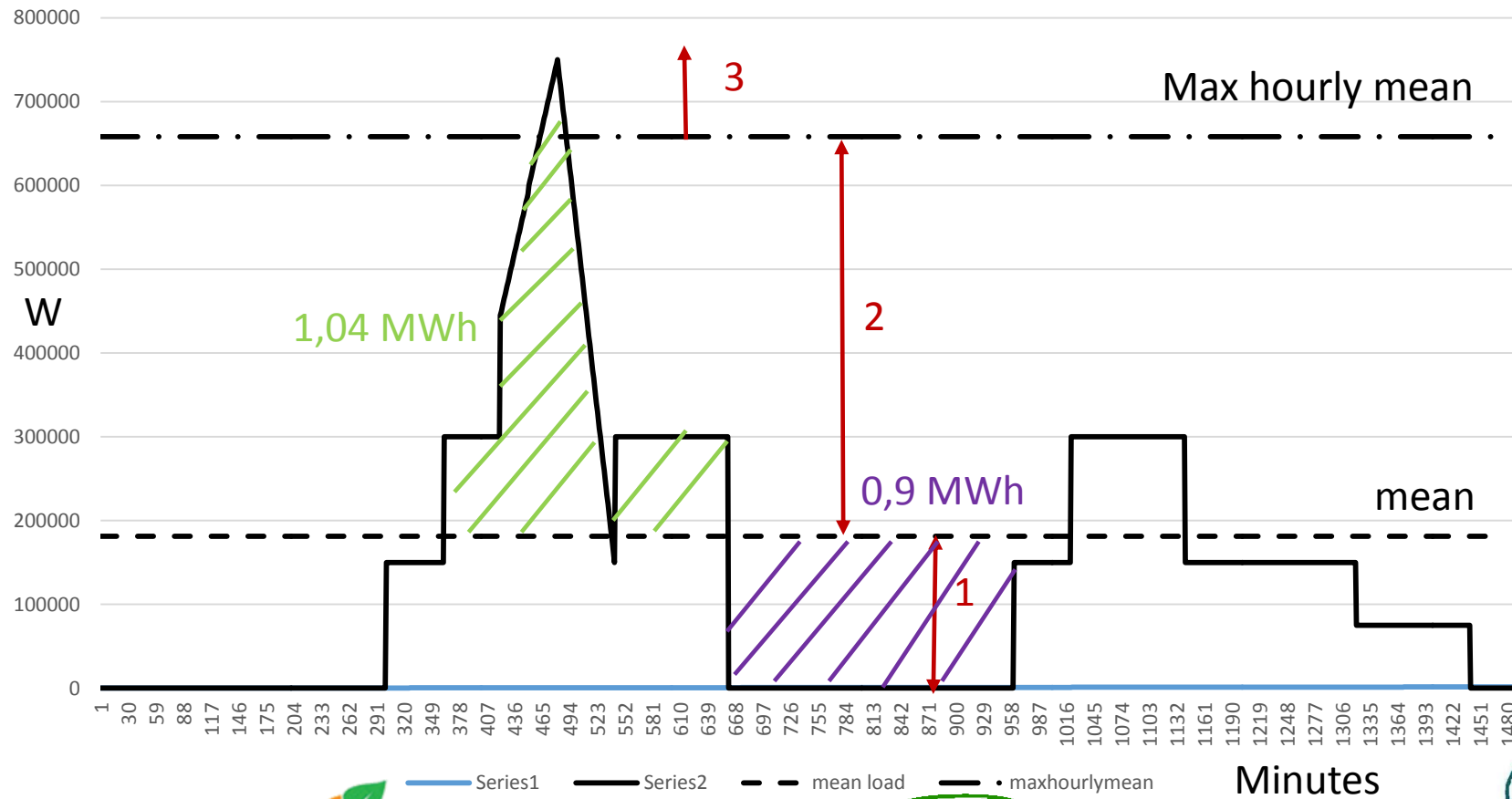


Principle of operation



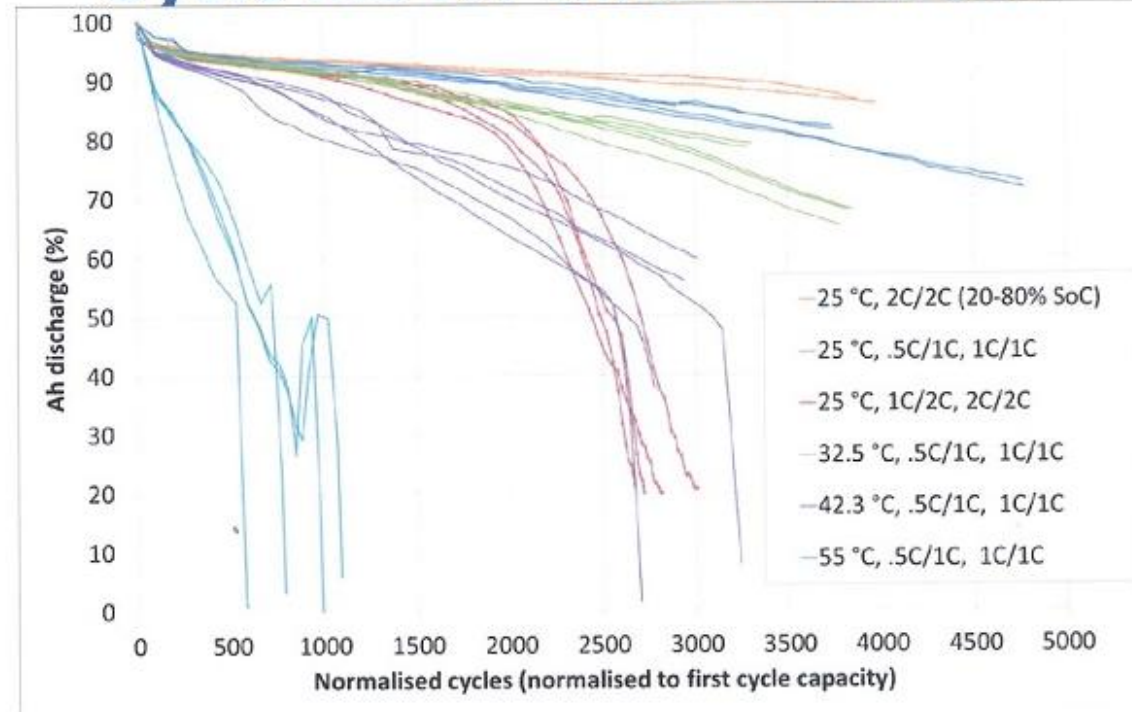
Demand profile (schematic)

Max discharge 0,7 C, Charge 0,2 C



Battery degradation

Cycle life for NMC Li-ion cell



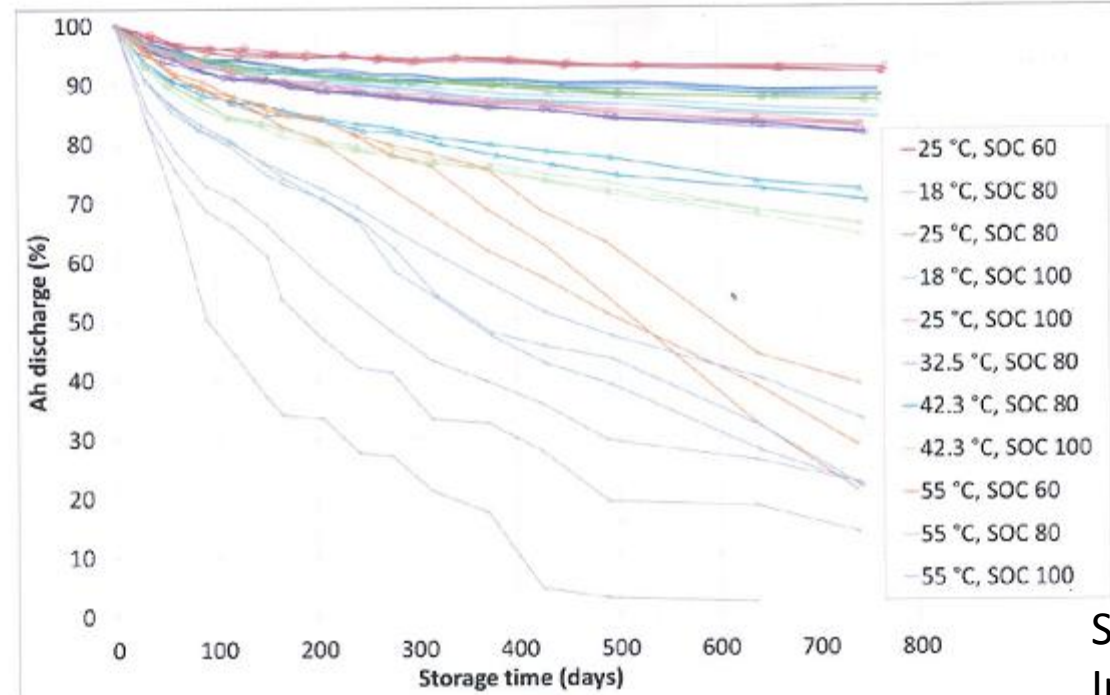
Source: Vie (2015)
Institute for Energy Technology

Lesson 2: Accelerated cycling heats cells, main source of increase in degradation – Thermal management!



Battery degradation

Calendar life for NMC Li-ion cell



Source: Vie (2015)
Institute for Energy Technology

Lesson 1: do not put your EV in the sun



Model calculations

- Levelized cost of energy (LCOE)
 - What cost should be included? Land rent? Others?
- Net present value (NPV)
 - Variable price similar to gasoline prices?
- The model will investigate the «neighborhood» of the starting capacities of battery and grid connection to reduce LCOE.
- The model will provide a number of outputs, e.g., battery capacity degradation.



Summary

- Establish a set of scenarios for EV charging demand for a single charging station
- Establish a techno-economic model the EV charging station with grid connection, energy storage and renewable energy generation.
 - Estimate optimal size of grid- and battery energy capacity
 - Estimate optimal operation, e.g., battery charge and discharge
- Have a focus on realistic parametrisation of important cost elements, i.e., grid effect charges and battery degradation.
 - High time resolution at one minute

