ATEPS NEDERLAND BV

ADVANCED TECHNOLOGIES FOR ENERGY & POWER SYSTEMS

HDC

Belgacloud

High End Cloudservices

Advanced Technologies for Energy & Power Systems

Introduction

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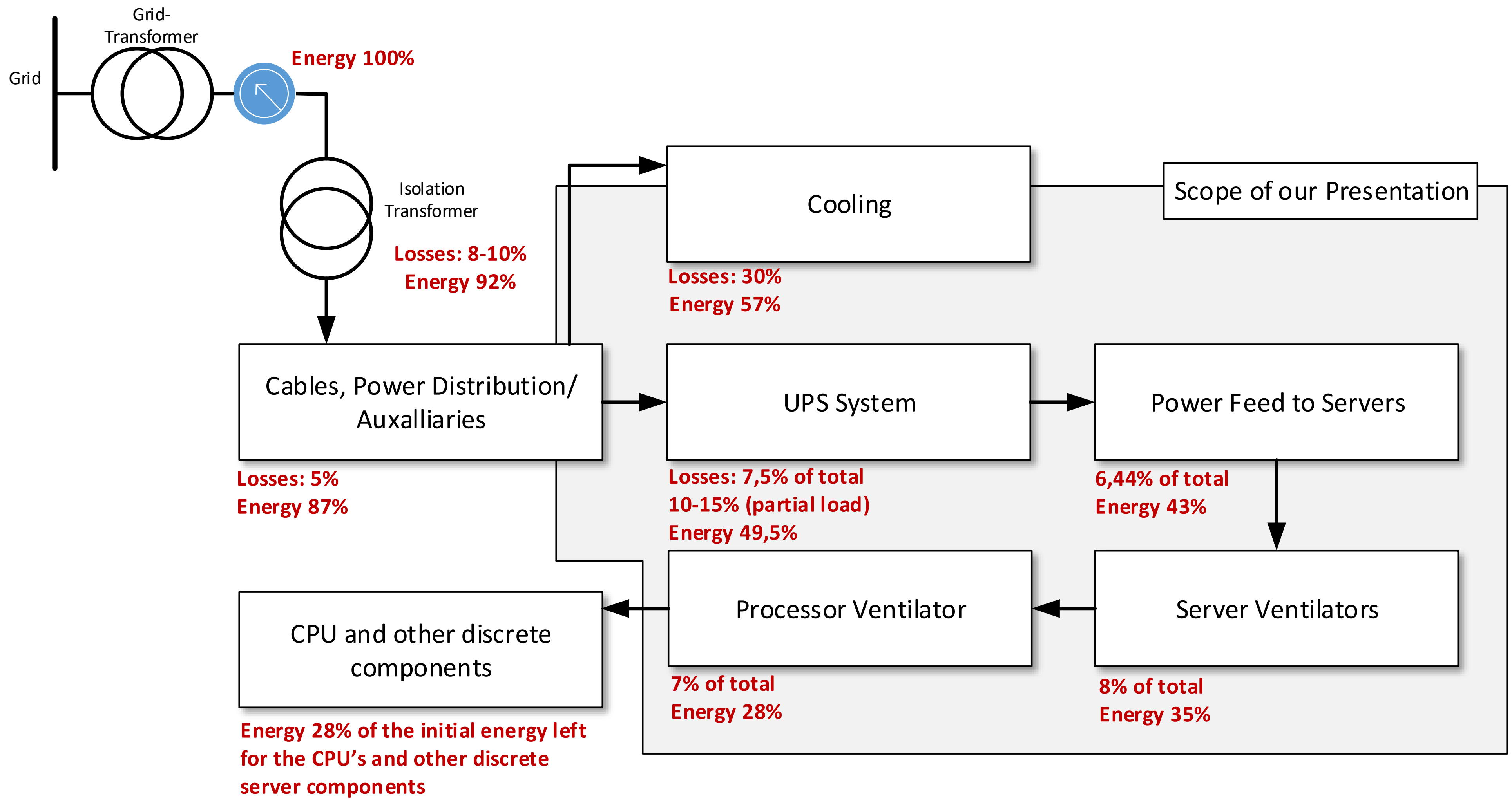
Energy losses datacenter value chain



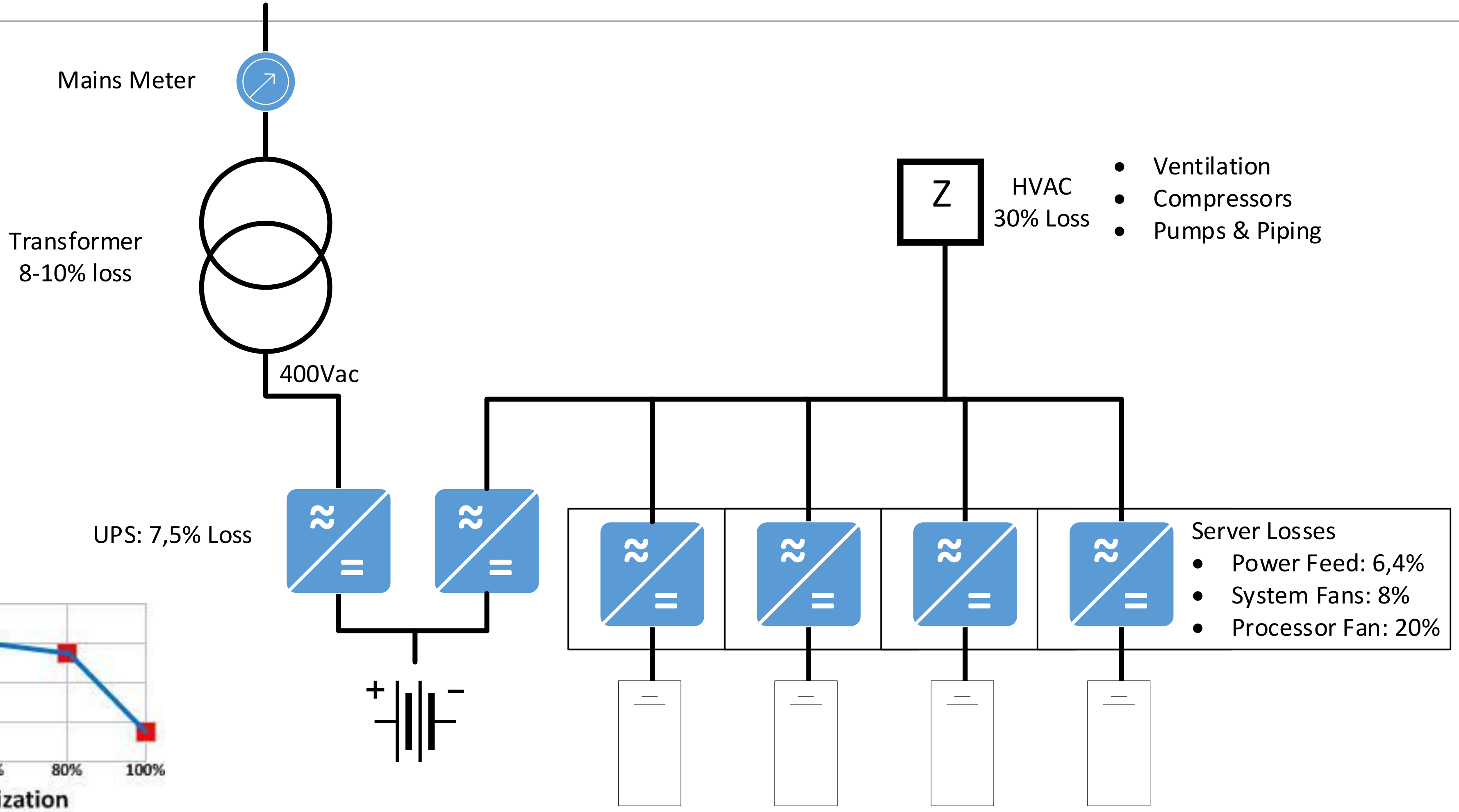
Typical Datacenter challenges

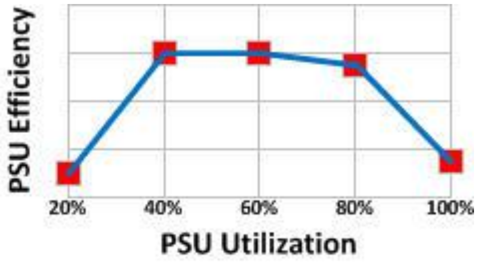
- Power consumption approx. 63% of the OPEX
- Heat generation due to power conversions, are a considerable part of the energy and maintenance cost (HVAC)
- System availability >99,9999%
- Power failures impacts ‘work at hand’ but also scheduled number crunching.

Typical Datacenter challenges

- Traditional power distribution configuration: total energy losses >70% between grid and CPU.
- Heat generation due to power conversions, are a considerable part of the energy and maintenance cost (HVAC)
- DC-based data center power distribution system + other changes -> losses are reduced as much as 60%
- is reduced to 2% to the server.

Typical traditional AC - PSU layout





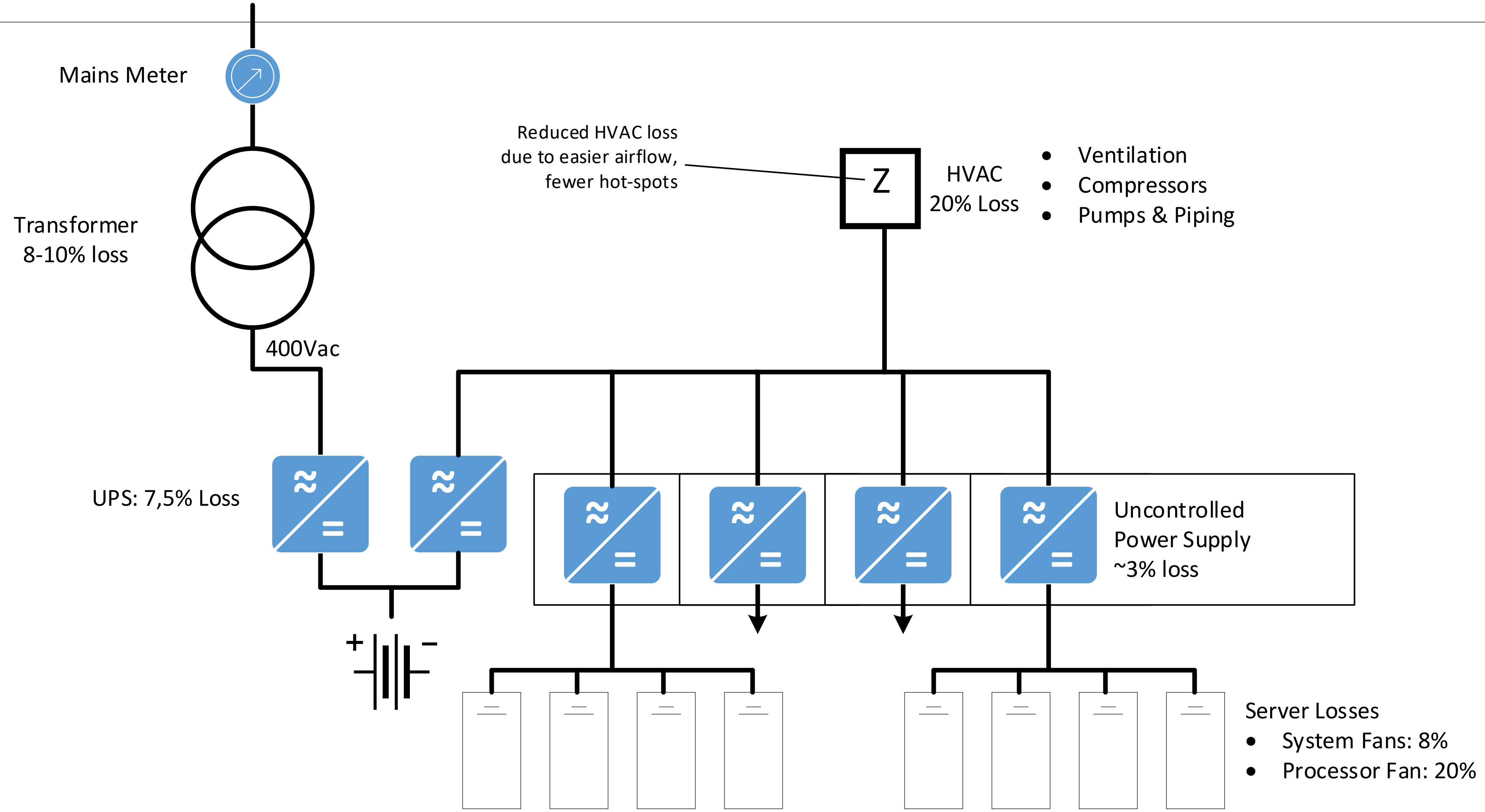
System Efficiency

- UPS losses: 6-12%
- Server Power Supply losses: 10-15%, very load dependent
- Cooling losses
- Losses >15%

>20% is realistic under changing server loads

- Facebook has undertaken a massive effort to improve the power efficiency in its data centers. With a traditional power distribution configuration, Facebook engineers determined that the total loss of energy was 11% to 17% up to each server. By moving to a DC-based data center power distribution system and making a number of other changes, this loss is reduced to 2% up to the server.

Typical DC - PSU layouts



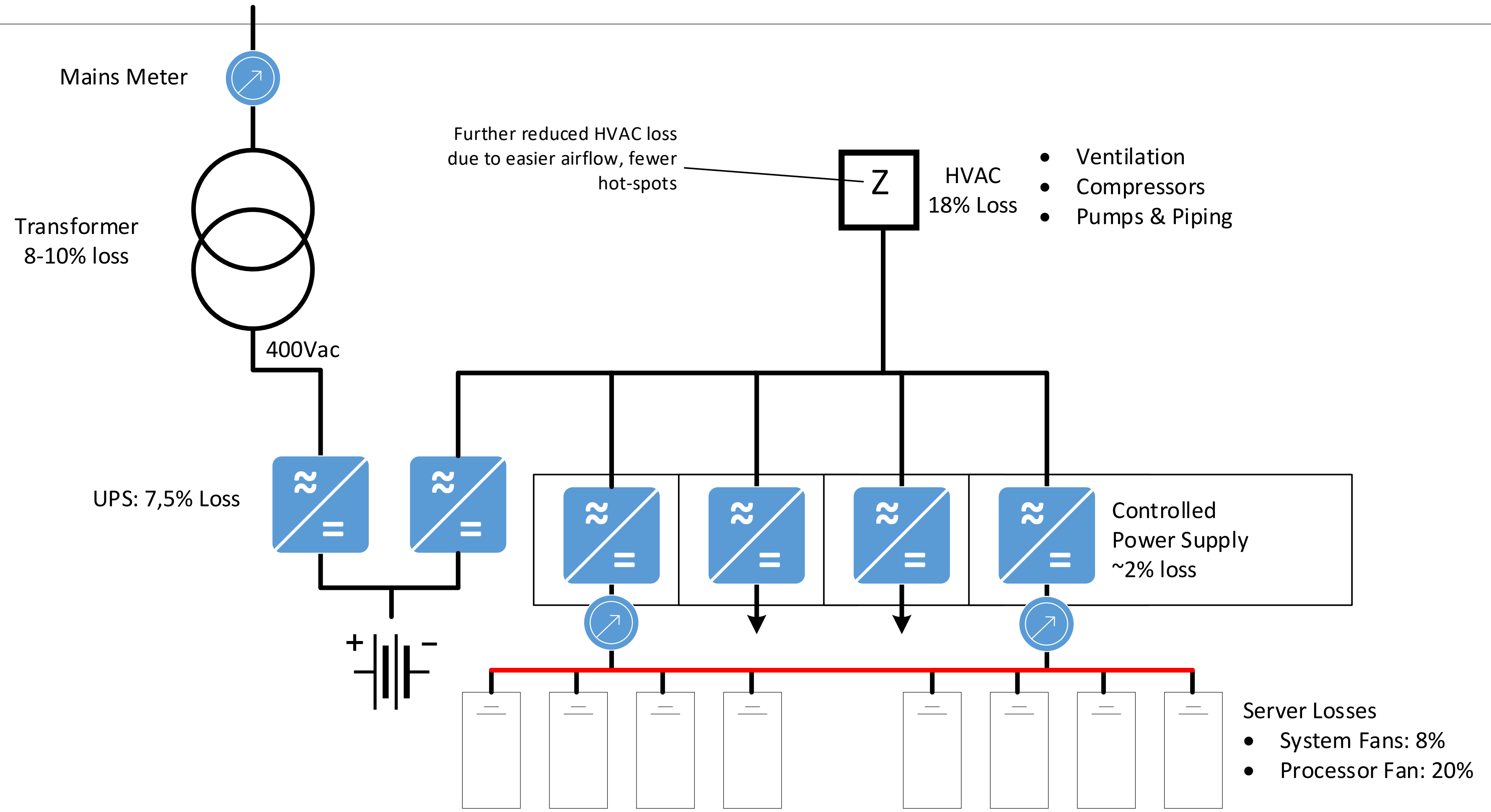
AC/DC converters are just 'power supplies' and although an efficiency improvement can be expected, this is still not optimized.

System Efficiency

- UPS losses: 6-12% loss
- Larger, more efficient DC PDU: 3-5% loss
- Cooling losses
- losses still >10%

>15% realistic for changing server loads

Typical DC – Optimized PSU layouts

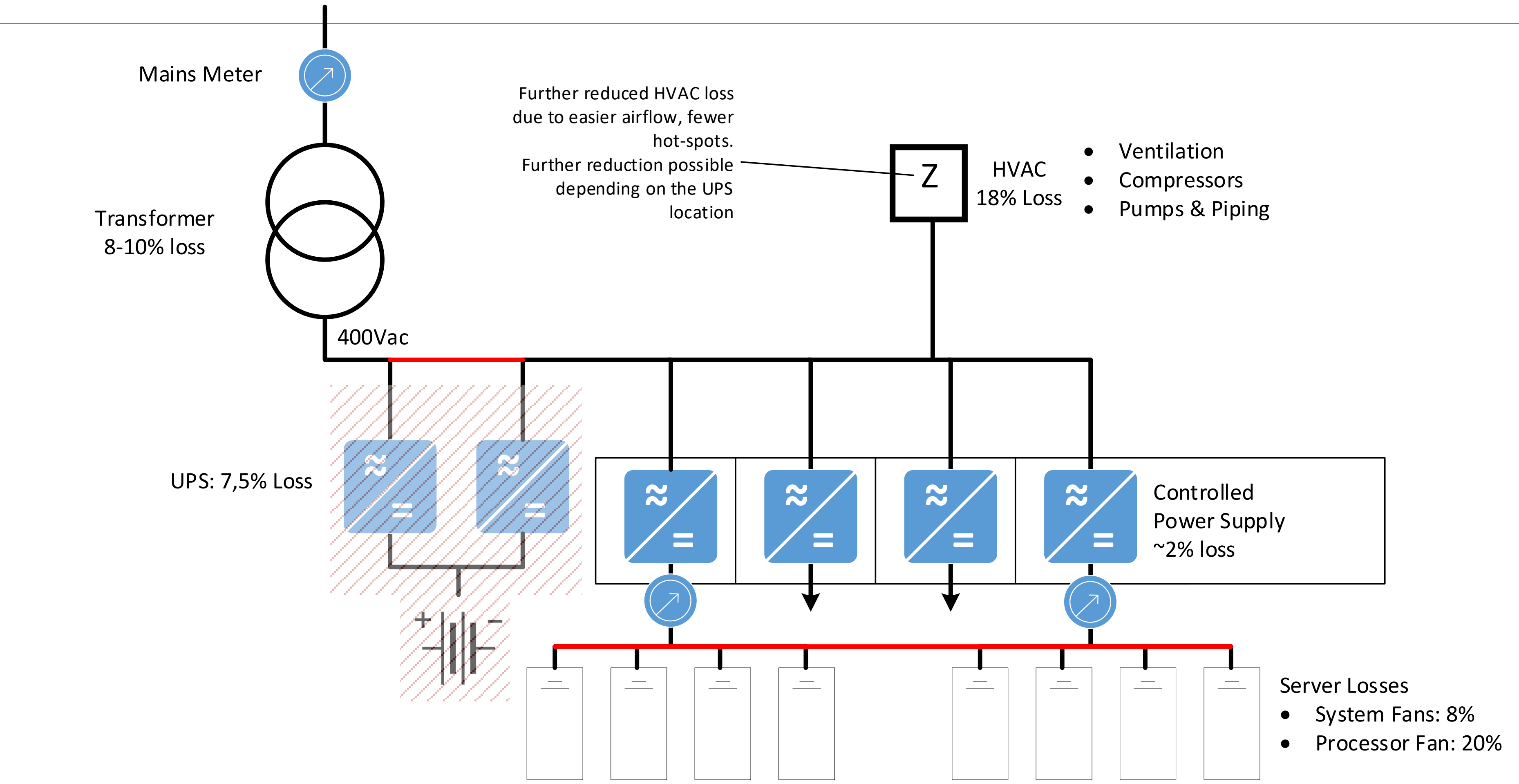


AC/DC converters are controlled and one or more can be switched off depending on actual server load.

System Efficiency

- UPS losses: 6-12% loss, the UPS becomes efficiency bottle neck,
- Controlled, efficient DC PDU: 2-3% loss →can be disconnected if not used. Due to large capacitance they can ride-trough brown-outs too
- Cooling losses are reduced
- Additional redundancy
- losses still around 10%.

Typical DC – Optimized PSU layout



System layout without UPS, relying on the ride-trough of the power supplies…

System Efficiency

- ~~UPS losses: 6-12% loss~~
- Controlled, efficient DC PDU: 2-3% loss →can be disconnected if not used. Due to their large capacitance they can ride-trough brown-outs too
- Cooling losses are less due to less UPS heat generation ☺
- Energy losses are greatly reduced ☺
- Reduced availability ☹

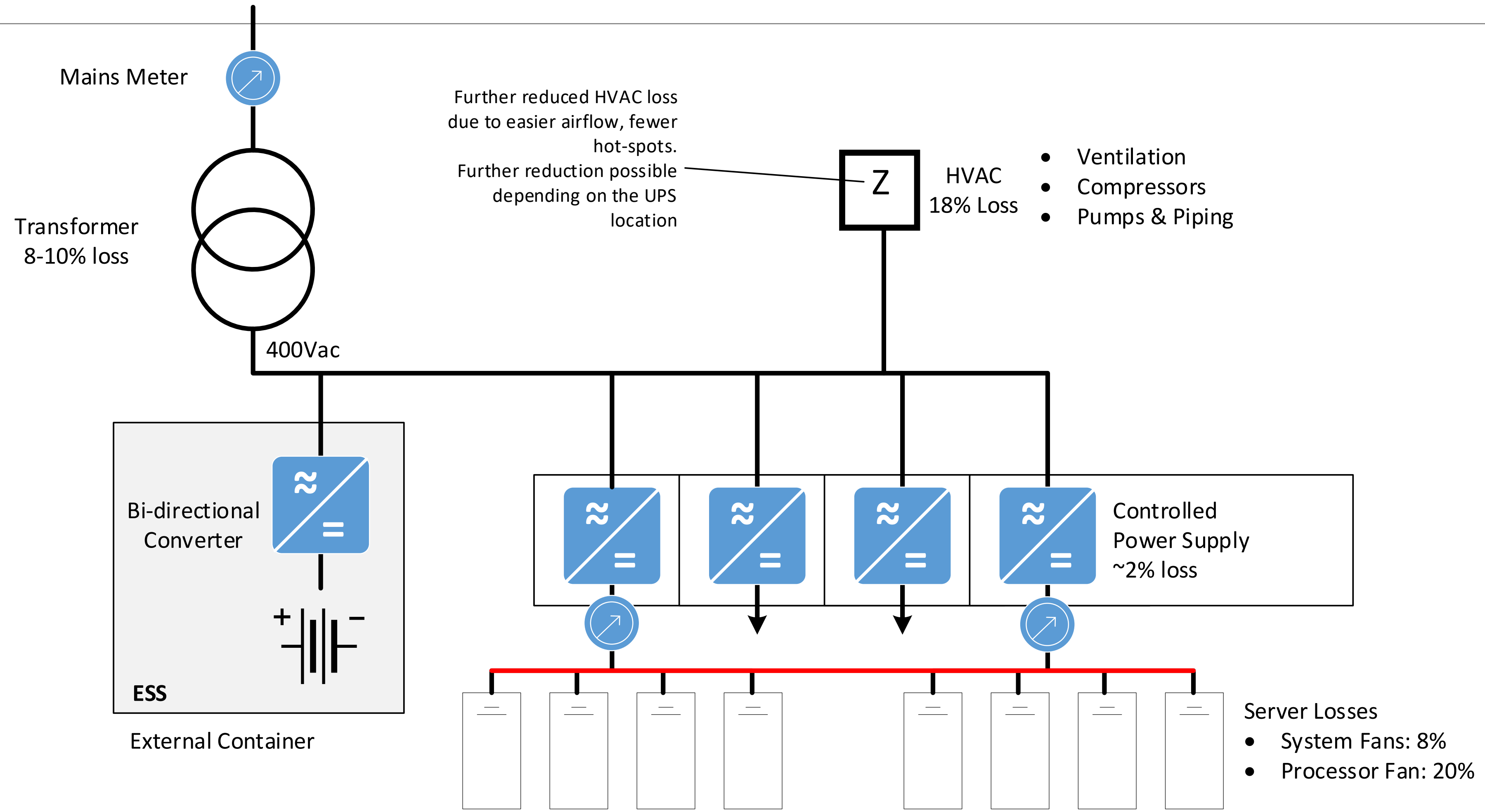
A hybrid design with an ESS

- Energy Storage Systems and Data Centers
  - Store and use PV- and/or Wind energy
  - Makes uncontrollable renewable energy controllable
  - Peak shaving functionality
- Reduced energy cost, regardless of the UPS and PDU losses ☺

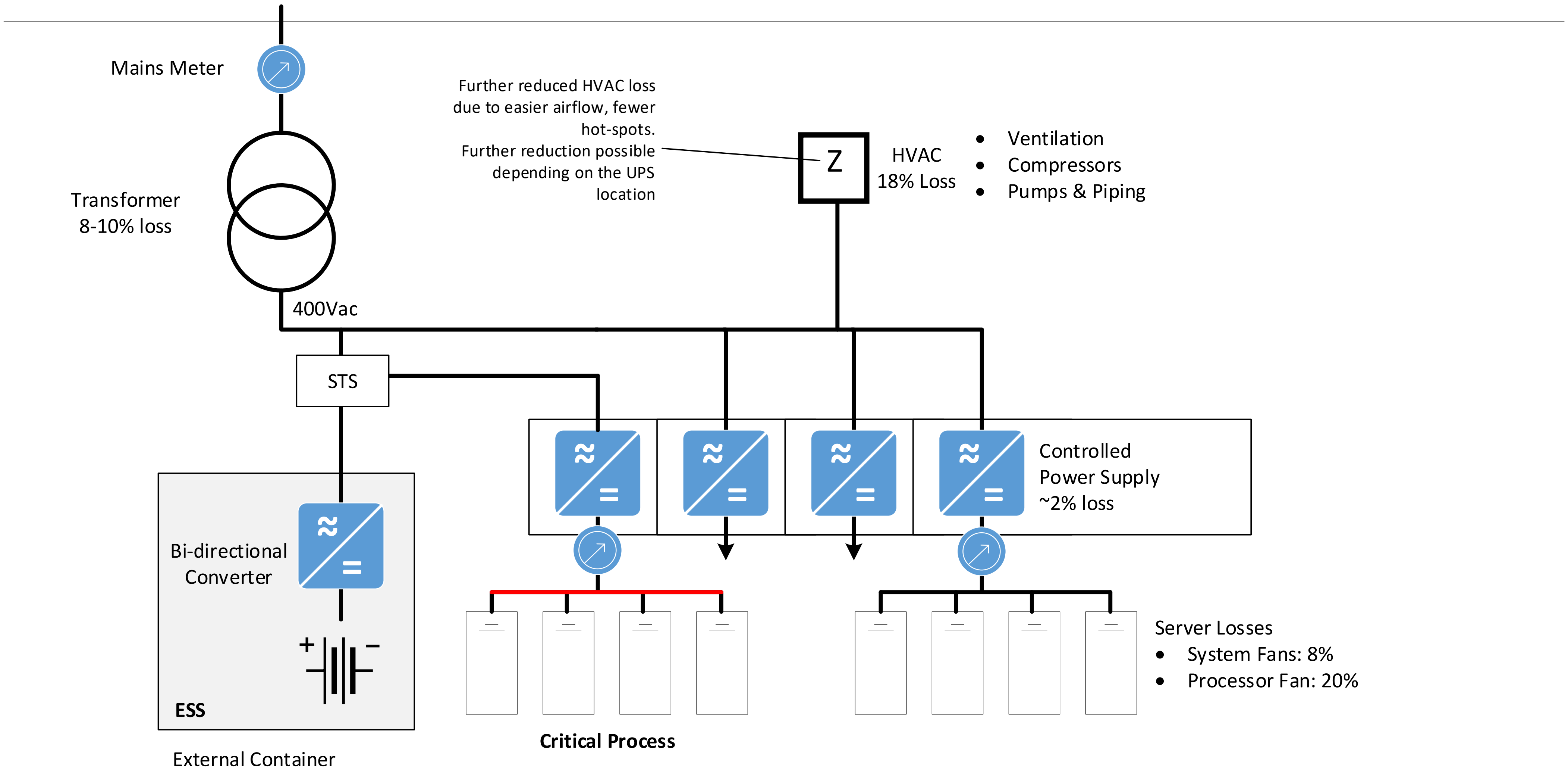
A hybrid design with an ESS

- Further optimization can take place depending on the primary function of the data center:
- Ensure power availability for the time and data intensive parts of the process only
- Allow for some down-time in the secondary processes
- Use the ESS to generate R.o.I. on the APX/Imbalance and FCR markets while providing emergency power too.

A hybrid design with an ESS



Optimized hybrid design with an ESS



R.o.I. with APX/Imbalance

- kWh prices not constant but vary per hour
- Power imbalance on the grid can generate € 0,10 - € 0,40/kWh during feed-in; ~€ 85.000/MW/Year
- This functionality can work very well next to providing emergency power to the data center
- It is expected that we will see an increasing kWh price due to volatile ‘Green Energy’ 15 minutes pricing for bigger users

- Other side effects:
  - Reduced dependency on actual kWh price
  - CO2-effects from storage

R.o.I. with FCR

- TenneT pays for the stabilization of the Grid Frequency since this is more important than the voltage
- Bidding for this market is on a daily basis, so can be adapted to actual core business.
- Average gross proceeds: € 125.000/MW/year

Conclusion

- High power DC is more difficult than AC, however, the efficiency gains are substantial.
- Consideration of primary and secondary processes will improve efficiency due to reduced UPS power needed.
- ESS has a better economical efficiency than an UPS due to reduced energy cost and earning potential at the APX and FCR.

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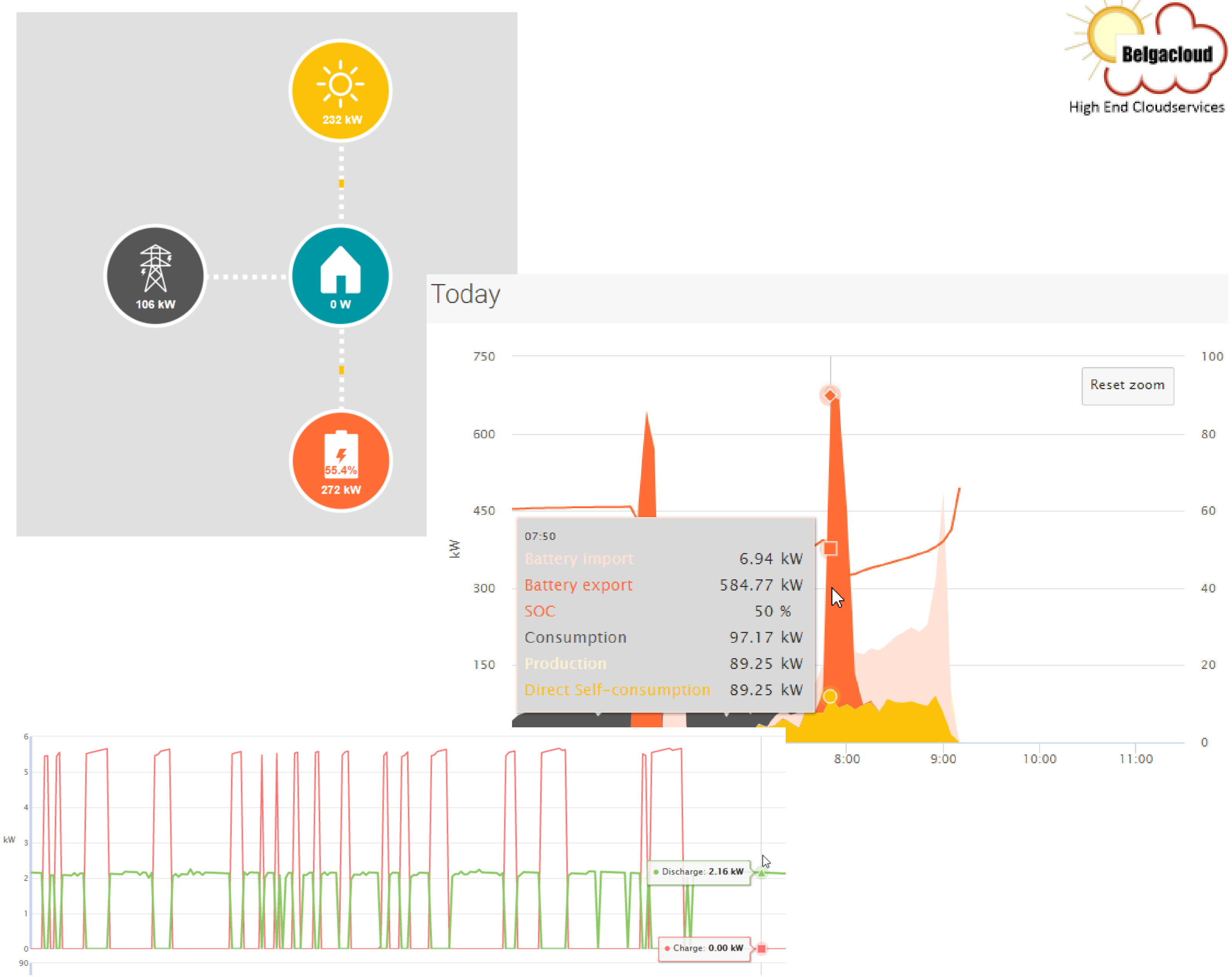
Remote monitoring

Via 3rd-party ‘energy trader’:

- Market information

Via de ATEPS interface:

- Technical system information
- Log files
- Analysis
- Maintenance
- Automatic SMS/eMail in case of any warnings or errors



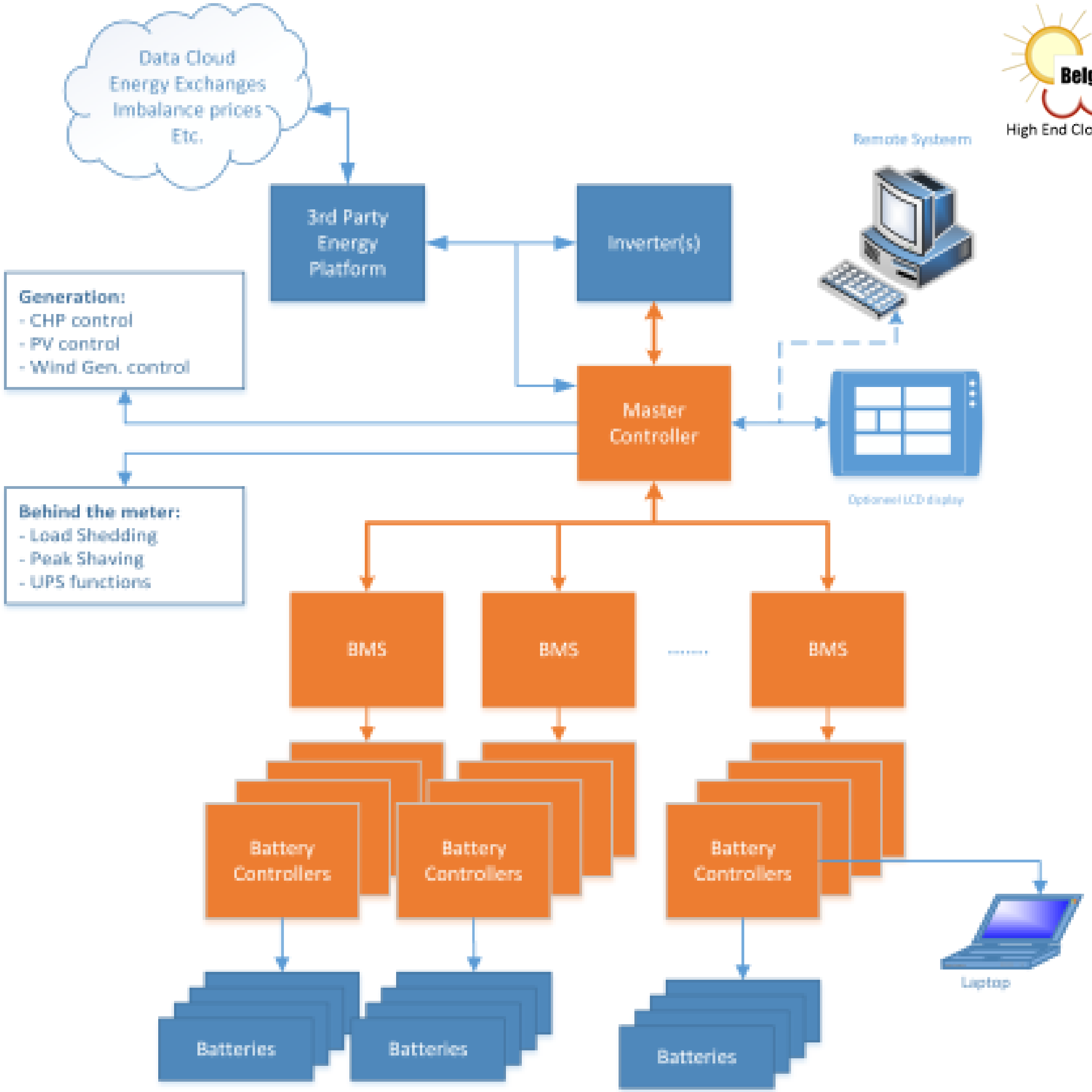
System overview

Safety first!

- High voltage +
- High current =
- **A lot of power!**

System sustainability:

- State of Charge
- Data logging
- Expandable
- Open communication



300kWh – 350kW system

- Left: Detail filters of the converter
- Right: batteries left, converters right
- Background: battery-cabinets

Examples

Odoorn: 300kWh/350kW

Woensdrecht: 300kWh/350kW

Zeewolde: 300kWh/350kW

Bleiswijk: 800kWh/450kW

Rijsenhout:
140kWh/125kW
Neighbourhood battery

Examples

Eindhoven: 300kWh/350kW
PV-enery storage and EV chargers

32,5kWh/30kW

Examples

Jungheinrich: Charge Buffers
30kW peak-shavers

Univ. Trondheim
Converter test-bed

Aspilsan – Turkey
30kW on- and off-grid systems

Questions / Remarks?

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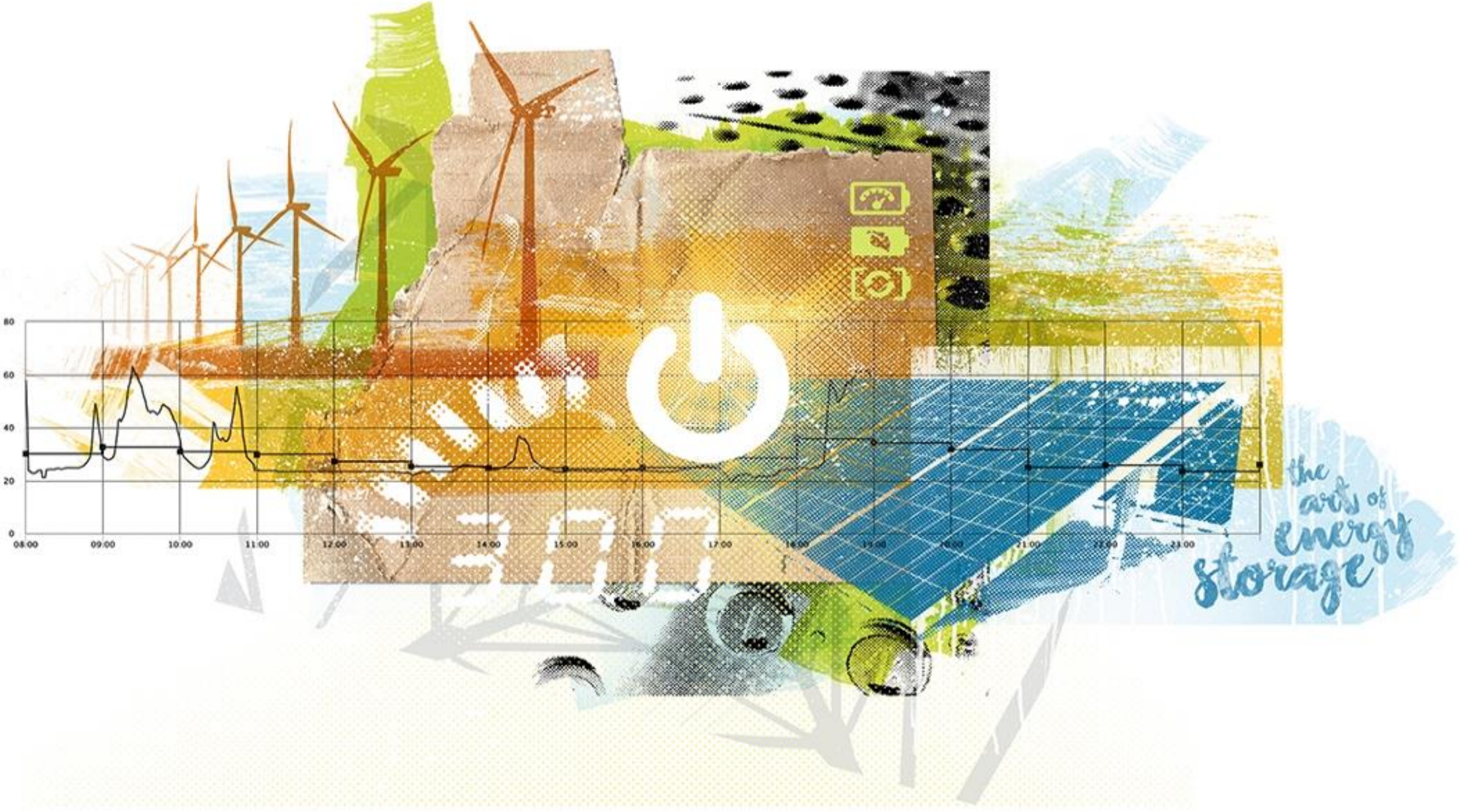
the art of energy storage