Summary – conventional systems p-driver energy efficiency workshop

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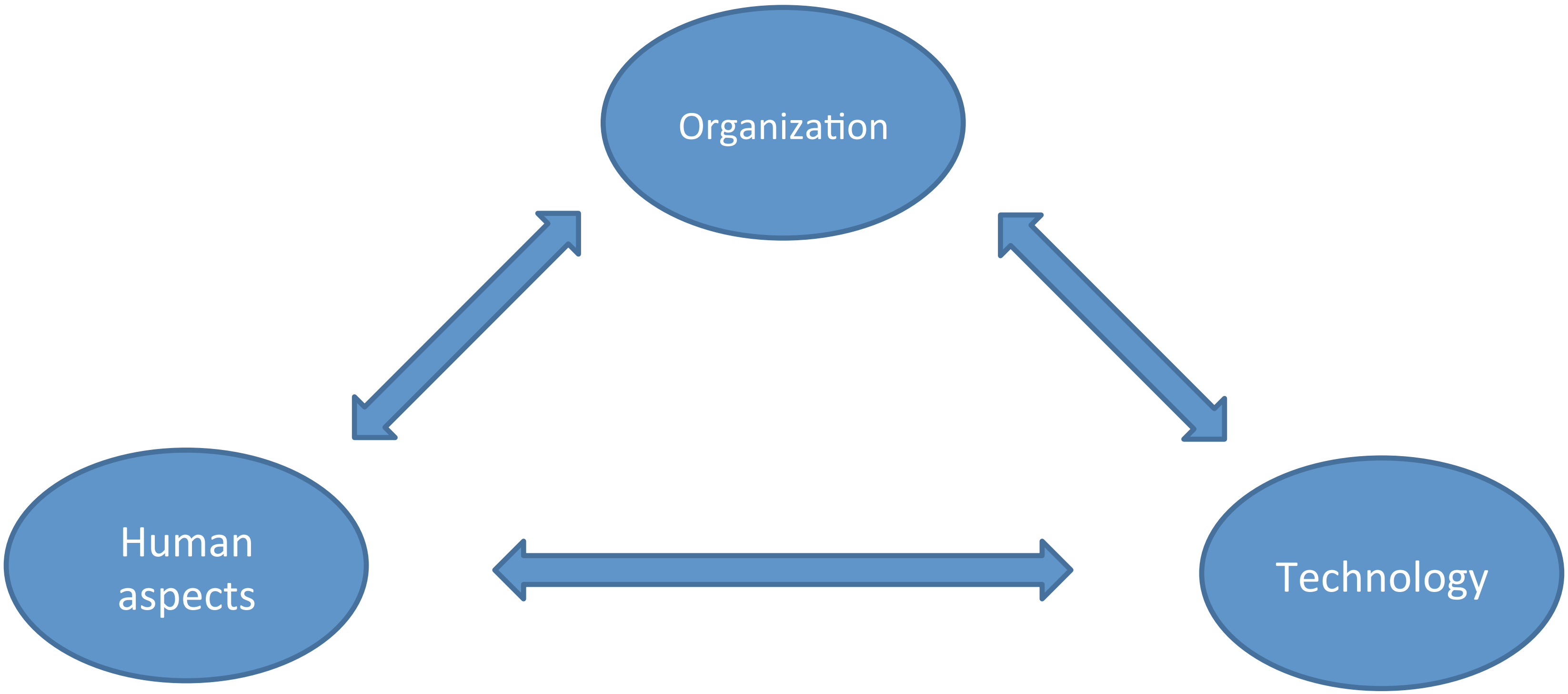
Introduction

- Conventional systems is a vast topic covering many different systems
  - Electrical
  - Utilities (cryogenics, vacuum, cooling, etc.)
  - Buildings
- Workshop included three talks on various topics
  - Energy management (Piero Valente (ESS))
  - Cryogenics (Philipp Arnold (ESS))
  - Virtual power plant (Jens Stadlmann (GSI))

Energy management
3 aspects of Energy Management

EUROPEAN SPALLATION SOURCE



Energy Management Conclusions

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- Broader approach: not only engineering driven but strategic value driven
- Defined roles within the organization: top management shall back up the efforts
- Communication is a key factor
- Look at the bigger picture: not only technical systems !
- Continuous improvement strategy

Energy efficiency considerations in cryogenics Summary

- Normalising to 4.5K is not scientific!
  - Decent exergy analysis is better but comparison then trickier (different liquefaction loads, shield load, etc.)
- Power consumption for 2K load roughly 3 times that of 4.5K load
- Helium compressors actually acts as large oil pumps (≈ 78% of total input power goes into the oil)
- LN2 pre-cooling much more effective at liquefaction compared to refrigeration
- Shield temperature should be optimized looking at the entire cryogenic system, not only the best COP of single cryomodule. The cryomodule shield heat load is usually only a small part of the whole cryogenic load
- At ESS the total heat load depends strongly on the number of cryomodules, but not so much on beam power
- Heat recovery from oil and gas coolers is definitely feasible. No increased oil temperatures compared to standard non-recovery systems

Energy efficiency considerations in cryogenics Summary

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Conceptual phase

- Cryogenics is expensive and energy demanding
- Select carefully the operation temperature → by far the biggest impact
- Keep in mind that a large load portion is static → always substantial energy consumption regardless of beam
- Talk early to cryoplant vendors to define best technology (cold compression, LN2, 2K heat exchanger position)
- Consider heat recovery if clients are around

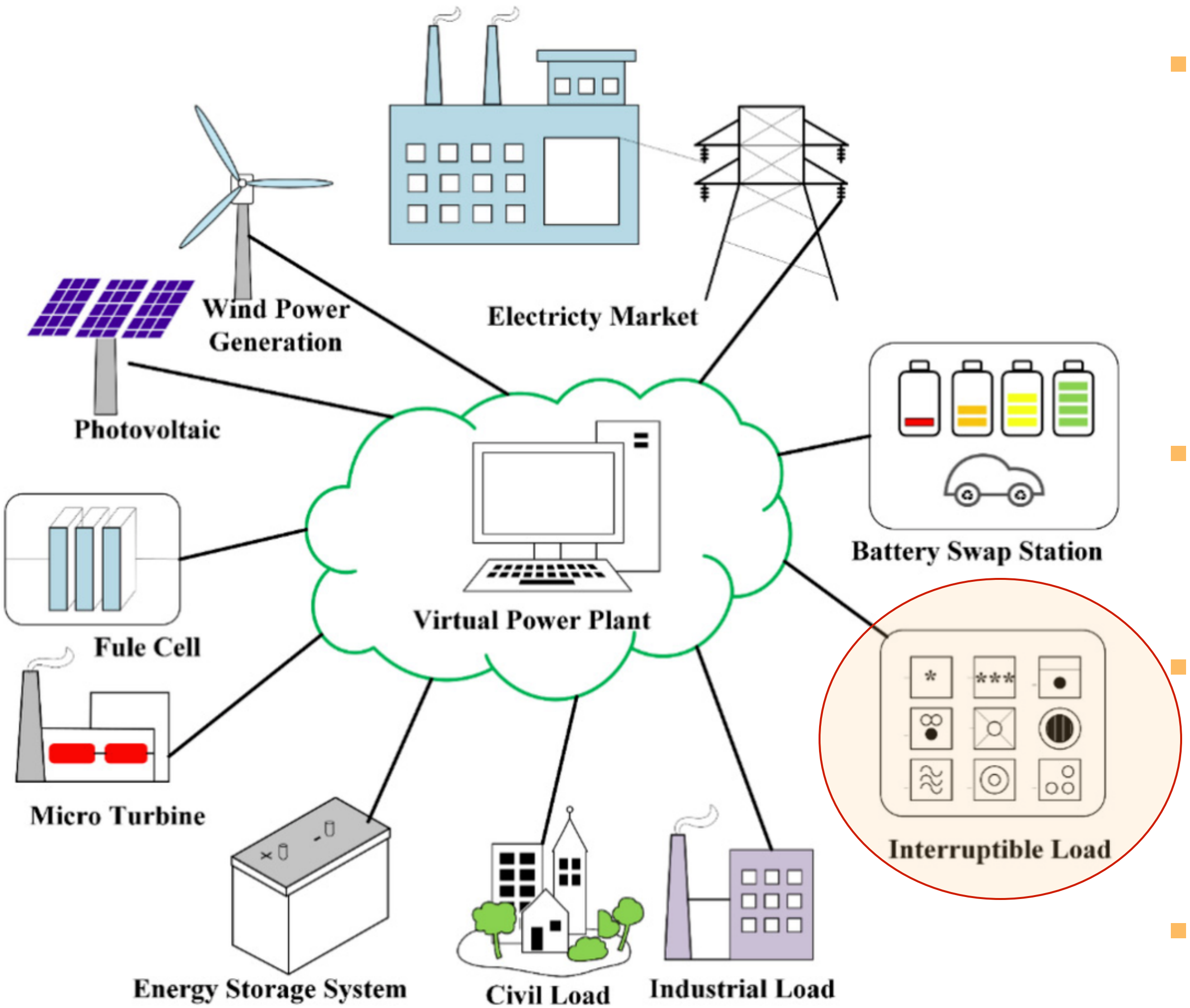
Purchasing the cryoplant

- Consider OPEX over several years
- Consider OPEX particularly for turn-down scenarios
- Define shield conditions w.r.t. overall efficiency
- Think about flexibility (VFDs, staging)
- Specify exactly LN2 and heat recovery set-up
- Consumption measurement and penalisation
- Acceptance tests of turn-down automation

Start up and operations

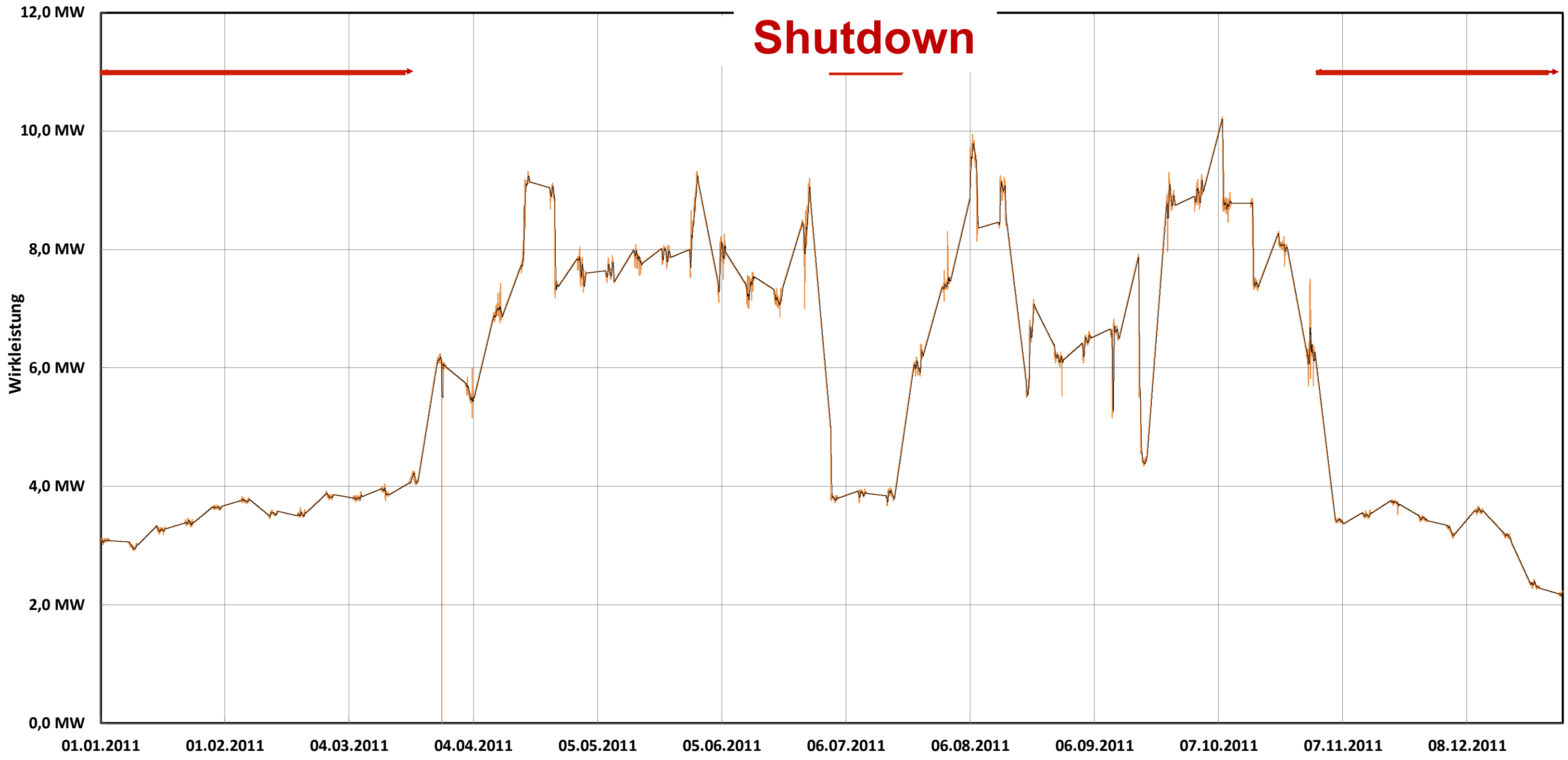
- Plan long acceptance testing
- Focus on stable controls, otherwise turn-down will be controlled with heaters for stability reasons
- Spend long time on initial drying and cleaning
- Try to adapt the plant to actual loads as good as possible (look for pressure drops, bypass valves, temperature mixing)
- Watch helium inventory closely (leaks)

Virtual power plants in general



- Different means of energy production and usage combined to appear as a more balanced load towards the power grid.
- Buzz word „smart grid“ .
- Can a large scale science facility which is a considerable load be „interrupted“ ?
- Some „normal“ examples...

GSI power consumption 2011



Difference during operation:

optimistic 10 MW to 6 MW

realistic 8 MW to 6 MW

FAIR's SIS100 example in summary

- Due to the very flexible operation at FAIR there is potential for load balancing
- To actually realize the lower energy consumption by the accelerator the magnets have to be hydraulically adjustable and the cryoplant has to be able to operate in the lower load area. Due to the high dynamics.
- Control system and operation scenarios get even more complicated
- Does reliability go down?
- Energy market situation is not our expertise and mission.
- In general scenarios for dynamic load balancing are not as easy as the food storage.
- Bad news: The overall energy consumption will rise.
- Additional technical complexity is required which is always a problem for machinery at the edge of technological development.
- Fun fact: Even with the (estimated) full operation cost it might be financial feasible (depending on future market situation)
- Flexible cryo plant R&D needed?!

Conclusion

- There are many (non) obvious energy consumers for load balancing hiding on our facilities' sites.
  Computing, Cryo (+ and -), parallel Operation, save power down ...
- Actually establishing a variable load requires additional investment and might even be ruled out by design decisions today.
- The obstacles we face at science facilities are most likely comparable to problems of general users with the exception of the most easy cases (“propaganda” projects). So we can gain general knowledge, which is our mission.
- Bad news: The overall energy consumption will most probably rise!
- Technical experts are for good reason reluctant to complicate systems and operation scenarios. But if is more or less save and cost savings are high enough it is worth trying.