EnEfficient – a networking activity for particle accelerators

M.Seidel, PSI

EuCARD-2 Workshop: Compact and Low Consumption Magnet Design, CERN, November 26-28, 2014

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EuCARD²

Integrating Activity Project for coordinated Research and Development on Particle Accelerators, 2013-17

Management and Communication

- WP1: Management and Communication (MANCOM)

Networking Activities

- WP2: Catalysing Innovation (INNovation)
- WP3: Energy Efficiency (EnEfficient)
- WP4: Accelerator Applications (AccApplic)
- WP5: Extreme Beams (XBEAM)
- WP6: Low Emittance Rings (LOW-e-RING)
- WP7: Novel Accelerators (EuroNNAc2)

Transnational Access

- WP8: ICTF@STFC
- WP9: HiRadMat@SPS and MagNet@CERN

Joint Research Activities

- WP10: Future Magnets (MAG)
- WP11: Collimator Materials for fast High Density Energy Deposition (COMA-HDED)
- WP12: Innovative Radio Frequency Technologies (RF)
- WP13: Novel Acceleration Techniques (ANAC2)

Energy: Order of Magnitude Examples

generation	consumption	storage
1d cyclist „Tour de France“ (4hx300W): **1.2kWh**	1 run of cloth washing machine: **0.8…1kWh**	car battery (60Ah): **0.72kWh**
1d Wind Power Station (avg): **12MWh**	1d Swiss Light Source (2.4GeV, 400mA): **82MWh**	ITER superconducting coil: **12,5MWh**
1d nucl. Pow. Stati. Leibstadt (CH): **30GWh**	1d CLIC Linear Collider @3TeV: **14GWh**	all German storage hydropower: **40GWh**

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1d nucl. Pow. Stati. Leibstadt (CH): **30GWh**	1d CLIC Linear Collider @3TeV: **14GWh**	all German storage hydropower: **40GWh**
1d Earth/Moon System E-loss: **77.000GWh**	1d electrical consumpt. mankind: **53.000GWh**	World storage hydropower: ***O*(1.000GWh)**
1d sunshine absorbed on Earth: **3.000.000.000GWh**	1d total mankind (inc.fuels): **360.000GWh**	

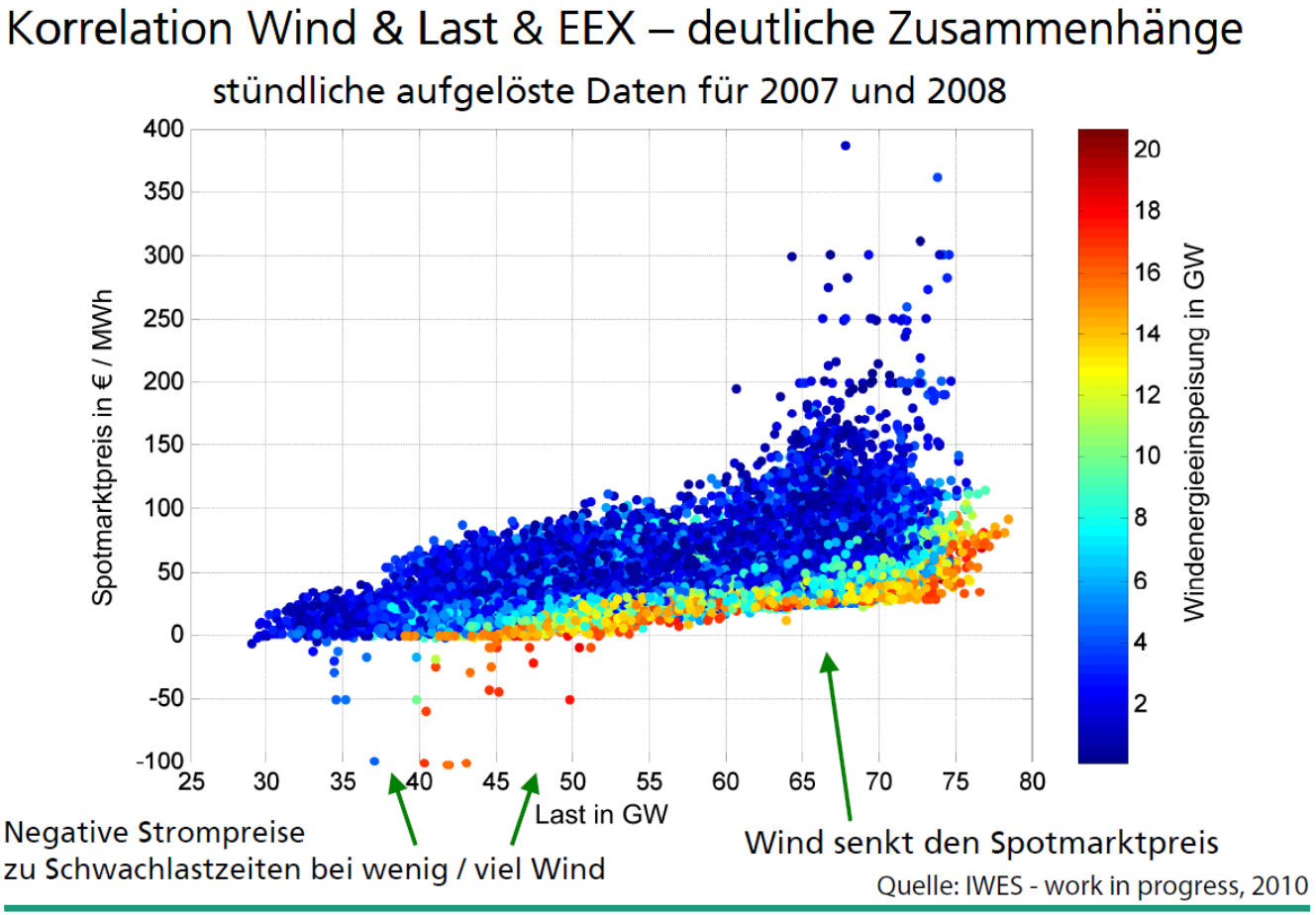
1.) accelerators are in the range were they become relevant for society and public discussion
2.) desired turn to renewables is an enormous task; storage is the problem, not production
3.) fluctuations of energy availability, depending on time and weather, will be large

energy spot market prices (DE)

→ energy managment, virtual power plant

renewables cause strong variations

Impact on accelerators?



Powerflow in Accelerators

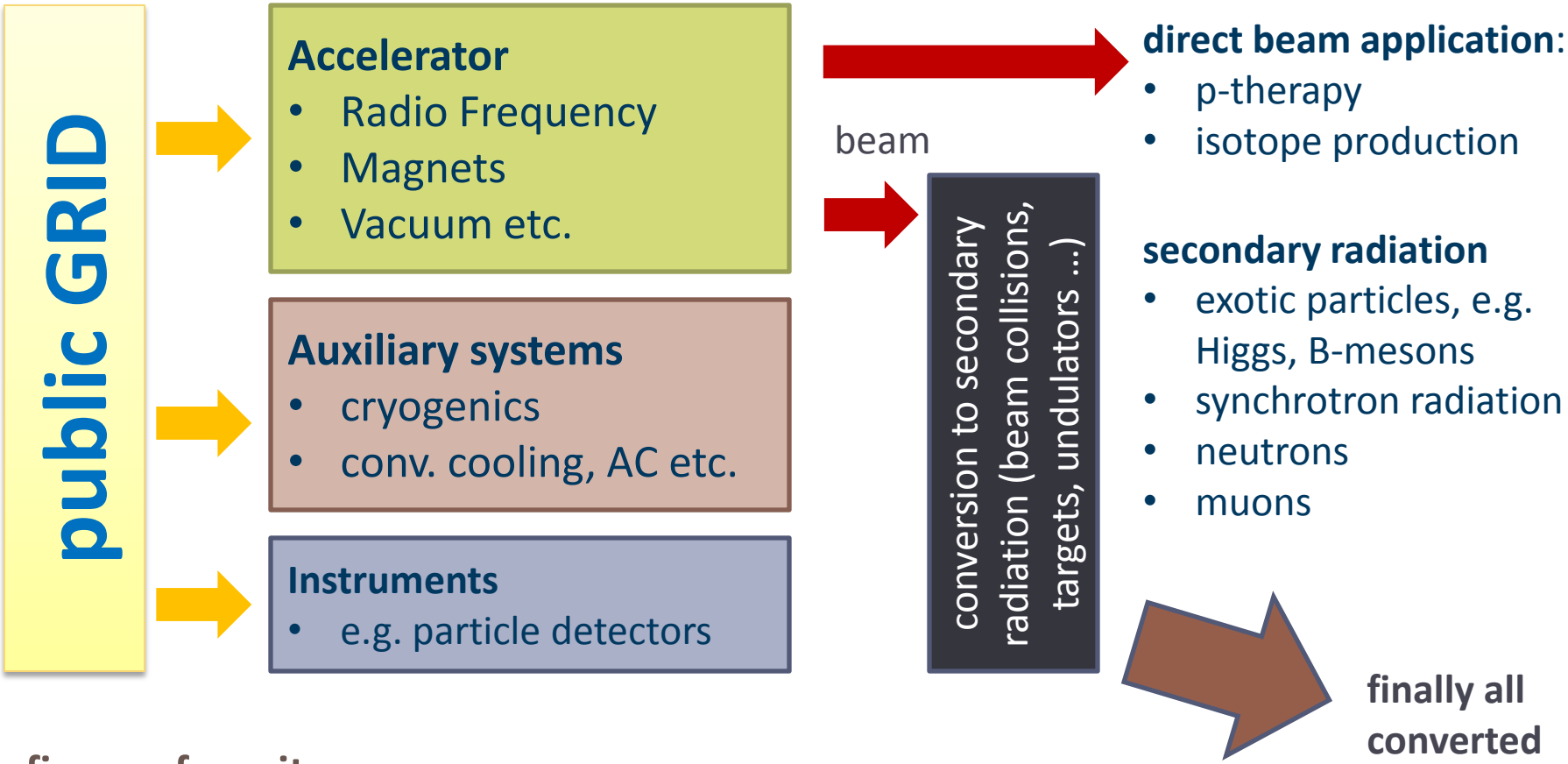


figure of merit:
secondary particles, X-rays on sample per KWh

tasks within EnEfficient

task 1: energy recovery from cooling circuits, Th.Parker, E.Lindström (ESS)

[workshop April 14, survey of European Labs, applications of heat, T-levels etc.]

task 2: higher electronic efficiency RF power generation, E.Jensen (CERN)

[workshop Daresbury in June, e.g. Multi Beam IOT's]

task 3: short term energy storage systems, R.Gehring (KIT)

[non-interruptable power, short term storage, wide spread of time scales …, workshop 2015]

task 4: virtual power plant, J.Stadlmann (GSI)

[adaptation of operation to grid situation – context renewables…, possibly backup power generator …, ongoing survey of Labs]

task 5: beam transfer channels with low power consumption, P.Spiller (GSI)

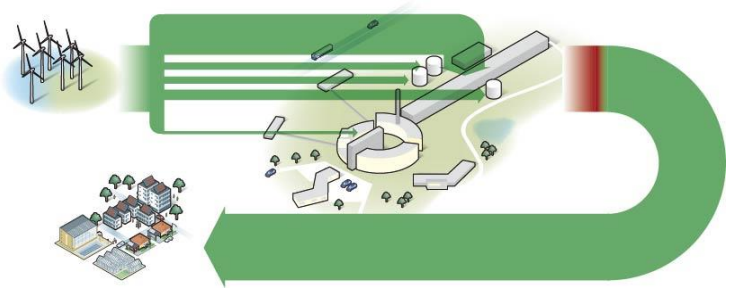
[pulsed magnets, low power conventional magnets, permanent magnets, parameter comparison etc., workshop Nov 14, CERN]

EnEfficient: collaboration with Universities

in this workpackage we are receiving support through several Master and PhD Students, associated with Universities:

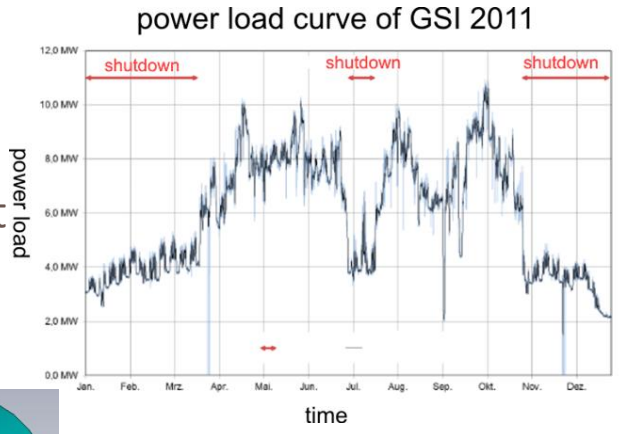
1) Christopher Ripp, GSI, Analysis of GSI Energy consumption, Master thesis
2) Johanna Toberntsson, Lund University: Master thesis on Heat Recovery in Accelerator based Research Facilities
3) Damian Batorowicz, Henning Zimmer, TU Darmstadt, Survey on consumption volatility in accelerators; dynamic behavior of distribution networks
4) Philip Gardlowski, GSI, comparison of energy-efficient beam transport systems; Carmen Tenholt, GSI, pulsed quadrupoles

EnEfficient examples

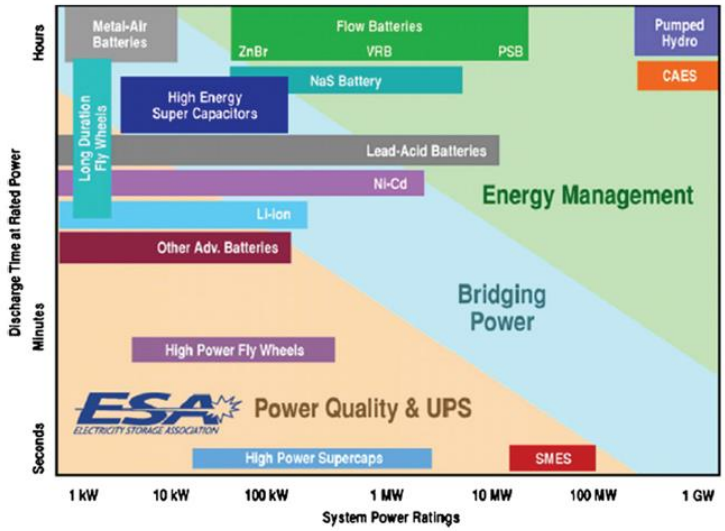


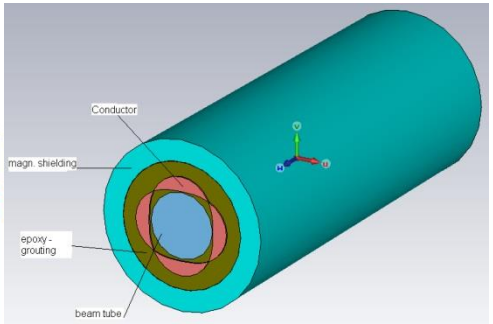
heat recovery at ESS

need for energy management

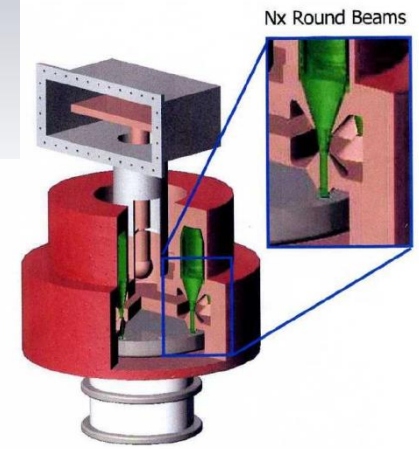


energy storage systems





pulsed quads [GSI]



multi-beam IOT by company CPI

EnEfficient: summary and outlook

EnEfficient is a **new networking activity** related to efficient utilization of electrical power in accelerator based facilities

at present participating institutes and interested partners: CERN, ESS, GSI, KIT, PSI, DESY

next workshops:

November 26-28, 2014: Compact and Low Consumption Magnet Design for Future Linear and Circular Colliders, at CERN.

2015: storage systems for accelerators, KIT, Heidelberg

Oct/2015: 3rd workshop for energy efficiency in research infrastructures, DESY, Hamburg

2015: virtual power plant, GSI, ?

interested colleagues are very welcome to participate in this network, or to make proposals for workshops

information and contact under: www.psi.ch\enefficient