



Main findings of the first joint workshop on
Energy management for large-scale research infrastructures

13–14 October 2011 Lund, Sweden

Volatile energy costs, a tight budget climate and increasing environmental concerns are all inciting large-scale research facilities across the globe to develop mid- and long-term strategies aimed at achieving for the future a reliable, affordable and sustainable energy supply that is carbon neutral.

The European Organization for Nuclear research CERN, European Spallation Source ESS and the European Association of National Research Facilities ERF joined efforts in organizing in Lund, Sweden (on 13-14 October 2011) the first workshop entirely dedicated to appropriate Energy Management in large scale research infrastructures¹.

¹ The homepage of the workshop can be found at <http://ess-scandinavia.eu/energyworkshop>. The ERF member organizations that participated in the workshop organization were DESY (Germany), Elettra-Trieste (Italy), SOLEIL (France) and STFC (UK).

Executive Summary

- Research Infrastructures (RIs) are at the centre of science-driven technological, educational and managerial innovation. They are instrumental for R&D in the energy field, for instance through development of advanced materials and energy efficient processes and products (e.g. photovoltaic, fuel cells, catalysers);
- Despite severe budget constraints, the operation of RIs demonstrates that more exchange of best practices, more cooperation in joint projects and training are possible and can be started on technical as well as on administrative levels, especially new business models in close interaction with providers e.g. on grouped procurement or grid connection;
- As the European Union is, thanks to the ESFRI approach, at a turning-point of its strategy regarding the RIs, there is a strong opportunity to set up a coordinated and supportive action program on European level to deal with energy management for large-scale RIs;
- RIs can particularly train young researchers, operators and managers to face the upcoming energy challenges in order to cooperate on R&D, exchange on best practices and provide know-how; a program similar to the RAMIRI² scheme could further foster cooperation and education on energy themes among the European RIs;
- The workshop has shown that several RIs are able to mobilize their unique resources and technical skills to respond to the Energy Grand Challenge and can already act as a test bed for implementing appropriate energy supply and procurement schemes as well as efficient energy use. There is a strong consensus that this can be expanded to help further develop and demonstrate methods and techniques for the sustainable use of energy.

² RAMIRI: Realizing and Managing International Research Infrastructures (<http://www.ramiri.eu/>);

Introduction

Big science for a big societal challenge

World-class RIs are a crucial dimension and prerequisite for forefront R&D, education and innovation in modern knowledge societies. As for society at large, large-scale research facilities are confronted with issues related to energy consumption and the associated environmental impacts. As a result, in recent years RIs have been developing mid- and long-term strategies for reliable, affordable and sustainable energy supply that is carbon neutral.

About 150 international experts on energy and representatives from research laboratories and future large scale research projects all over the world gathered for two days in order to identify the challenges and best practice for energy efficiency, optimization and supply at large research facilities and on how these capabilities could be better oriented to respond to this general societal challenge. More than 25 experts presented their views and experience at the workshop and involved the audience in stimulating discussions.

The contributions at the workshop included plenary talks on the overall world energy outlook and developing international policies to limit the global heating to below 2°C by eminent key people such as CEA High Commissioner Catherine Cesarsky and IASA Deputy Director Nebojsa Nakicenovic on world energy outlooks, Prof. Einar Hope, Prof. Helmut Dosch and former Research Minister of Sweden Dr. Tobias Krantz on the development of common multinational energy policies, including the development of sustainable resources between Europe and northern Africa.

Representatives and technical experts from national and international laboratories presented their energy and sustainability plans and the potential of present and future technological solutions in the energy field as well as the current R&D status and roadmaps for future renewable energies.

This document summarises the talks and the active feedback from participants in the form of questions, comments and answers to a distributed questionnaire.

Experiences and best practices from existing facilities

Energy quality and consumption levels are crucial for many research facilities. RIs are thus in the centre of major aspects of developing and applying energy savings and efficiency approaches, ranging from materials sciences to demonstrators/prototypes of energy efficiency.

Experience gained in operating research facilities show that:

- The development and demonstration of co-generation plus renewable energy, go hand-in hand with the improvement of the electrical power quality and a better use of the transmission lines (peak-shaving and storage), while decreasing instrumental black-outs,

- It is important to maximize the re-use of thermal energy generated in the various systems both for heating and cooling (e.g. with heat pumping and absorption refrigerators) – thus decreasing the use of primary energy,
- The design of systems should allow to recover heat at higher temperatures than in usual design standards, to allow a better re-use, allowing also interaction with the local communities to develop district heating if not yet available,
- While the newly designed RIs are in the position to introduce energy-saving approaches, there is the need of a special support to allow existing RIs to re-fit and increase efficiency, but this could be a driver for improved returns to the hosting territory, by increased technology and knowledge transfer.

Recommendations for research infrastructure projects

The choice of energy options in the design phase of new research facilities and the up-grade of existing ones requires a particular attention regarding:

- The design and the construction of the facilities should aim at optimizing the scientific performances while including the best energy use approach;
- The optimal balance between investment and operation costs must have a long-term view. A total cost of ownership approach is required;
- A clear and objective assessment of the global energy consumption: equipment, buildings and associated Information and Communication Technologies (ICT), must be available;
- The use of relative fine-grained monitoring and active feedback control tools (including modelling), as well as the presence of a specific function of Energy Manager, are required.

Including energy efficiency and recycling requirements at the design stage opens many possibilities and initiatives to all stakeholders. Equipment manufacturers are rarely asked if high temperature cooling water can be used to cool their equipment. High temperature wastewater can be recovered with high efficiency.

It is of major importance to investigate non-technical aspects with a long-term perspective:

- Government legislation: tax exemptions, permits and licenses;
- Contracts with energy suppliers (spot price forecast, inter-communication for pulsed loading);
- Understanding of energy load profile; contracts for steady state and peaks;
- Multi-source supply of energy, including supporting the installation of 'green' energy from renewable sources;
- Innovative financing, e.g. construction costs offset by operational savings;
- Socio-economic and environmental impacts and benefits at the host site, e.g. potential use of excess heat in local district heating applications.

A stimulating environment for technical and structural innovations

An increase of efficiency in the use of energy will be the major contributor to limit the carbon emissions. Energy efficiency will be driven by introducing and demonstrating appropriate methods and breakthrough technologies, including the recycling of waste heat into useful applications.

Large Scale research infrastructures are able to generate very innovative solutions that can be used profitably elsewhere and be at the base of win/win partnerships with industries through a smart specialization approach.

They employ some of the best technicians and applied researchers in the world, who are continuously trained in cutting edge technology by responding to technical challenges, brought to them by the best researchers at a world level. RIs could be the test bed for completely innovative research-based solutions as, e.g. the use of superconducting lines to manage different energy flows, the installation of Superconducting Magnetic Energy Storage (SMES) for energy quality control, the transformation of energy between radio-frequency and direct current, and other novel schemes involving advanced concepts.

Important contributions to supply RIs with sustainable energy sources in the future will come from renewable energies. RIs are instrumental in supporting renewable energy research and technological development through new and improved materials (e.g. for photovoltaics, fuel cells, improved motors and turbines etc.), the development of environmentally friendly biofuels, new and safe methods of carbon capture etc.

The RIs capabilities and staff could be mobilized also for large international projects, e.g., the development of solar power generated in the sun-rich regions of North Africa and the Middle East (MENA). This could cover up to 15% of Europe's energy needs by 2050 as advocated by DESERTEC. Technologies to exploit this potential, such as concentrated solar power, exist and are proven. Realizing such ambitious projects however, need a new energy and science partnership between Europe and MENA and a closer integration of MENA into the European Research Area.

Conclusions

The challenge of energy efficiency and its impact on the environment have been clearly assessed as well as the increase of efficiency as a major contributor in limiting CO₂ emissions. Moreover, new ways of renewable energy supply schemes for existing or future planned RIs should be explored as technologies become more and more competitive. Several main actions lines of development have been identified:

- Reduction of primary electricity consumption through increased efficiency,
- Controlling/management functions at the RIs to better control and handle consumption,
- Increased energy education of managers and technical staff,
- Identifying and implementing new energy procurement methods,
- Better usage of waste heat by recovery and valorisation schemes,
- Exploiting RIs as test bed for novel developments and technological demonstrators,
- Exploring renewable energy solutions for existing and future RIs,
- Stronger mobilization of the capabilities and staff of the RIs to contribute to the Energy challenge also at an international level, for instance through enhanced scientific cooperation towards a European-MENA partnership.

The attendance and the conclusions from participants and organizers of the Workshop have indicated that this effort has to be supported by a follow up of the workshop. CERN has offered to host the 2nd workshop in 2013.

Frédéric Bordry – CERN
Thomas Parker – ESS
Carlo Rizzuto – ERF

November 2011

Programme

Thursday, 13 October

09:30 – First plenary session

Venue: Auditorium

(Chair: Colin Carlile, CEO ESS)

09:30 – Welcome and goals

Representatives from the organisers

10:00 – Energy and climate challenges for research infrastructures

Catherine Césarsky, High Commissioner CEA

10:30 – The energy future of large scale facilities

Jonas Abrahamsson, CEO E.ON Nordic

11:00 – Coffee

11:30 – Energy 2020: a strategy for competitive, sustainable and secure energy for Europe and the SET-Plan

Henrik Bindeslev, Vice Dean for research at the Faculty of Science and Technology, Aarhus University, and Chairman EERA

12:00 – World energy scenarios, perspectives from the Global Energy Assessment (GEA)

Nebojsa Nakicenovic, Deputy Director IIASA, Professor of Energy Economics, TU Wien and Director, Global Energy Assessment

12:30 – Buffet lunch

13:30 – National energy strategy for Norway

Einar Hope, Professor, Norwegian School of Economics, Bergen

14:00 – Implications for industry and government

Tobias Krantz, Director of Education, Research and Innovation Policy at the Confederation of Swedish Enterprise and former Minister for Research and Education

14:30 – Parallel sessions

Parallel session ONE

Venue: Auditorium

(Chair: Thomas Parker, ESS)

Energy supply: challenges in availability and quality

Energy management for high magnetic fields

Gert Rikken, LNCMI

Parallel session TWO

Venue: Afrodite

(Chair: Jean-Pierre Caminade, SOLEIL)

Energy supply: challenges in procurement issues, financing, grid regulation and investment choices

Energy supply for RI's in remote areas: a case study of the ESFRI's SKA facility in radio astronomy

Michael Kramer, MPI

Energy aspects – high performance computing
Kimmo Koski, CSC

Energy management for the large wind tunnels of Europe

Patrick Wagner, ONERA

16:30 – Coffee

17:00 Parallel sessions (continued)

Parallel session ONE

Energy management, storage and quality at ESRF using fly-wheel systems

Jean-François Bouteille, ESRF

On-site co-generation experience at ELETTRA

Andrea Galimberti, Sincrotrone Trieste ELETTRA

SMES present status and future

Pascal Tixador, Institut Neel G-INP Grenoble

OGEMA – an open source concept for energy management in small and large scale

Sina Pezeshki, Fraunhofer Institute for wind energy and energy system technology

Financing instruments for energy

Jean-David Malo, European Commission

Parallel session TWO

“Invest now vs supply later”: a necessary combined approach for the RIs' shareholders

Kurt Clausen, PSI

Strategic sourcing in a liberalised energy market

Jacques Adam, SUMMIT ENERGY

Energy management at ITER

Ivone Benfatto, ITER international organisation

18:00 – End of day one

18:45 – Refreshments and grand opening of the ESS exhibition, Stora Algotan 4

19:30 – Dinner and premier of the ESS energy movie at AF-borgen ‘Lilla Salen’

Friday, 14 October

9:00 – Parallel sessions

Parallel session THREE

Venue: Auditorium

(Chair: Frank Lehner, DESY)

Challenges in heat recycling systems and water savings

Challenges of reducing energy consumption at ISIS

David J S Findlay, RAL

High temperature cooling loops at ESS and Max IV

Martin Gierow, Lunds Energi and Jonas Lindhe, Sydtotal

Parallel session FOUR

Venue: Afrodite

(Chair: Roberto Saban, CERN)

Energy supply: challenges in future technical solutions

Radiofrequency energy recovery studies at CERN

Fritz Caspers, CERN

Turning TRIUMF accelerators into Green

Machines Orion Henderson, TRIUMF and the University of British Columbia

Concentrating solar power: technologies, dual applications and the EU project SOLARIS

Christoph Richter, DLR and Plataforma Solar de Almeria

Second law, energy, and consequences on low-temperature heat-recovery

Michel Pons, CNRS-LIMSI

LHC Cryogenics design and operation at LHC: optimisation and reduction of the energy consumption

Serge Claudet, CERN

A 60 MW power system with intermediate energy storage for a large pulsed load

Jean-Paul Burnet, CERN

11:00 – Coffee

11:30 – Second plenary session

Venue: Auditorium

(Chair: Beatrix Vierkorn-Rudolph, Chair ESFRI and BMBF)

11:30 – Reports on the parallel sessions

Wolfgang Hees, ESS (Session 1)

Keith Jeffery, STFC (Session 2)

Mats Lindroos, ESS (Session 3)

Philippe Lebrun, CERN (Session 4)

12:30 – Buffet lunch

13:30 – Third plenary session

(Chair: Frédérick Bordry, Head of Technology Department, CERN)

13:30 – DESERTEC energy/science partnership between Europe and North Africa/Middle East

Helmut Dosch, Chair of the Board of Directors, DESY

14:00 – The Argonne sustainable plan

Jerry Nolen, Director of ATLAS and Senior Scientist, Physics Division, ANL

14:30 – Energy sustainability at ESS

Colin Carlile, CEO ESS

15:00 – Joint conclusions of the workshop – Farewell

Carlo Rizzuto, Chair ERF, in collaboration with ESS, CERN

15:30 – End of day two

Registered participants

Name	Institution
Mr. ABRAHAMSSON, Jonas	E.ON
Mr. ADAM, Jaques	Summit Energy
Mr. AGERBæk, Peter	Balslev A/S
Mr. ANDERSSON-EK, Pierre	E.ON
Dr. AUGUSTIN, Ingo	Facility for Antiproton and Ion Research in Europe
Mrs. BACH, Martina	Inquiring Relations
Mr. BAJON, Edward	Brookhaven National Lab
Dr. BALLARINO, Amalia	CERN, European Organization for Nuclear research
Mr. BAURICHTER, Arnd	Danfysik A/S
Mr. BENFATTO, Ivone	ITER Organization
Mr. BENGTTSSON, Richard	E.ON
Ms. BERGENDAL, Anna	ABB
Mr. BERNARDO, Luis	Lund University
Mr. BINDSLEV, Henrik	Aarhus University
Mr. BLOCH RASMUSSEN, Leif	CBS
Dr. BORDRY, Frédéric	CERN
Dr. BOSCH, Hans-Stephan	MPI for Plasma Physics
Dr. BOUTEILLE, Jean-Francois	ESRF
Dr. BURCKHART, Helfried	CERN
Mr. BURNET, Jean-Paul	CERN
Mr. BäckSTRÖM, Peter	Sundrive Development
Mr. BÜRKMANN-GEHRLEIN, Klaus	Helmholtz Zentrum Berlin
Mr. CAMINADE, Jean-Pierre	Synchrotron SOLEIL
Prof. CARLILE, Colin	ESS
Dr. CARLSON, Stefan	MAX-lab, Lund University
Mr. CASPERS, Fritz	CERN
Mr. CASSEL, Mats	MGC Newsletter

Mrs. CESARSKY, Catherine	CEA/SACLAY
Mr. CHESTA, Enrico	CERN
Prof. CHOROWSKI, Maciej	Wroclaw University of Technology
Mr. CLAUDET, Serge	CERN
Dr. CLAUSEN, Kurt	Paul Scherrer Institut
Dr. D. RAD, Farhad	Lund University
Dr. DAILLANT, Jean	Synchrotron SOLEIL
Mr. DAVIDSSON, Henrik	Energy and Building Design
Mr. DENIS, Bernard	CERN
Mr. DORE, Vincent	CERN
Prof. DOSCH, Helmut	DESY
Mr. DUVAL, François	CERN
Dr. EICKHOFF, Hartmut	GSI
Mrs. EKDAHL, Marianne	ESS
Mr. ELDVALL, Björn	Sydtotal AB
Mr. ERIKSSON, Roger	ESS
Mr. FERNANDES TAVARES, Pedro	MAX-lab
Dr. FINDLAY, David	STFC
Mr. FLEISCHMANN, Wilhelm	Paul Scherrer Institut
Dr. FORNERIS, Juliette	Risø DTU
Mr. FREDRIKSSON, Mattias	Schneider Electric
Dr. GALIMBERTI, Andrea	Sincrotrone Trieste
Dr. GENSCHE, Ulrich	DESY
Mrs. GIAMPIETRO, Marina	CERN
Dr. GIANNINI, Mario	Sincrotrone Trieste
Mr. GIEROW, Martin	Lunds Energi
Mr. GLIKSOHN, Florian	Extreme-Light-Infrastructure
Mr. GOUEZ, Yann	ESRF
Prof. GRIMMEISS, Hermann	Lund University
Prof. GRUNWALD, Armin	Institute for Technology Assessment and Systems Analysis (ITAS) at the Karlsruhe Institute of Technology

Prof. GUDOWSKI, Waclaw	Kungliga Tekniska Högskolan
Mr. GUILLAUME , Kasperski	Embassy of France
Mr. HALVARSSON, Per	ABB
Mr. HEES, Wolfgang	ESS
Mr. HENDERSON, Orion	University of British Columbia
Mr. HOPE, Einar	Norwegian School of Economics
Mr. HOPPE, Andreas	DESY
Prof. HÖÖG, Victoria	Department of Philosophy and History of Science
Dr. IVAN, Constantin	"Horia Hulubei" National Institute for R&D in Physics and Nuclear Engineering (IFIN-HH)
Prof. JEFFERY, Keith	STFC Rutherford Appleton Laboratory
Dr. JENSEN, Erk	CERN
Dr. JENSEN, Jens-Peter	DESY
Mr. JOHANNESSON, Håkan	Lunds Energikoncernen
Prof. JÄRVIK, Jaan	Tallinn University of Technology
Mrs. KLEINER, Sonja	CERN
Dr. KOSKI, Kimmo	CSC - IT Center for Science Ltd.
Prof. KRAMER, Michael	Max-Planck-Institut for Radio Astronomy
Mr. KRANTZ, Tobias	Confederation of Swedish Enterprise
Dr. KRELL, Ute	DESY
Mr. LARSSON, Thomas A	ABB AB
Dr. LARSSON, Tomas	ABB
Dr. LEBRUN, Philippe	CERN
Dr. LEHNER, Frank	DESY
Mr. LINDHE, Jonas	Sydtotal AB
Dr. LINDROOS, Mats	ESS
Mr. MAGNIN, Frederic	CERN
Mr. MALO, Jean-David	European Commission
Mr. MARNERIS, Ioannis	Brookhaven National Lab
Mr. MARTEL, Christophe	CERN
Prof. MARTINS, Carlos A.	Université Laval

Mr. MAZZOLINI, Fabio	Sincrotrone Trieste S.C.p.A.
Mr. MCFAUL, Karl	ESS
Dr. MCGINNIS, David	ESS
Mr. MIRALLES, Lluís	CELLS
Mr. MÖLLER, Kjell	ESS
Prof. NAKICENOVIC, NEBOJSA	IIASA and TU Wien
Dr. NEUHAUS, Jürgen	Forschungs Neutronenquelle Heinz Maier-Leibnitz, TUM
Dr. NIELSEN, Bjarne Roger	DANFYSIK A/S
Prof. NILSSON, Lars J	LTH at LU
Mr. NILSSON, Mikael	Lunds Energi AB
Mrs. NILSSON, Monica	ESS AB
Mr. NOLEN, Jerry	ANL
Mr. NONIS, Mauro	CERN
Mr. O'BRIEN, Mike	ECMWF
Mr. PARKER, Thomas	ESS
Mr. PERSSON, Jörgen	ESS
Mr. PETTERSSON, Thomas	CERN
Mr. PEZESHKI, Sina	Fraunhofer IWES
Dr. PONS, Michel	CNRS - LIMSIS
Prof. PYRKO, Jurek	Lund University-LTH, Energy Sciences
Mr. RAMAKERS, Heinz	GSI
Mr. REINHARD, David	Paul Scherrer Institut
Mr. RENNTUN, Mats	E.ON
Dr. RICHTER, Christoph	DLR (German Aerospace Center, Solar Research)
Ms. RICKARDSSON, Åsa	ABB AB
Dr. RIKKEN, Geert	LNCMI-CNRS
Prof. RIZZUTO, Carlo	Sincrotrone Trieste
Dr. ROASTO, Indrek	Tallinn University of Technology
Dr. ROSÉN, Per	E.ON Värme Sverige AB
Mr. ROUILLÉ, Gérard	IPNO

Mr. SABAN, Roberto	CERN
Prof. SANDNER, Wolfgang	German Physical Society
Ms. SCHOW, Inger	Danish Agency for Science Technology and Innovation
Dr. SCHRÖDER-SMEIBIDL, Birgit	Helmholtz-Zentrum Berlin
Dr. SEIDEL, Mike	Paul Scherrer Institut
Ms. SOBOTKA-DEMIANOWSKA, Katarzyna	National Contact Point
Dr. SOUREK, Zbynek	Institute of Physics, Academy of Sciences of the Czech Republic
Mr. STRÅTH, Niklas	E.ON
Mr. STRÖMBERG, Sonny	E.ON
Mrs. SWARTLING-JUNG, Maria	E.ON
Mr. THOMASSON, Jan	Schneider Electric
Ms. THOUZEAU, Clarisse	CEA / French embassy in Sweden
Mr. THYSELL, Magnus	Modity Energy Trading AB
Ms. TIBBELIN, Anna	ESS
Prof. TIXADOR, Pascal	Grenoble INP
Dr. TRAEHOLT, Chresten	nkt cables a/s
Prof. VAN WALLE, Eric	SCK CEN
Prof. VIAROUGE, Philippe	Université Laval
Mrs. VIERKORN-RUDOLPH, Beatrix	Federal Ministry of Education and Research
Dr. VISTICOT, Jean-Paul	CEA
Prof. VLIEG, Elias	Radboud University Nijmegen
Mr. WAGNER, Patrick	ONERA
Dr. WAGNER, Vladimir	Nuclear Physics Institute of ASCR
Mrs. WEISS, Brigitte	Directorate-General for Research - European Commission
Mr. WELKER, Horst	GSI
Mr. WILLEN, Dag	nkt cables a/s
Mr. WILSON, Ian	Schneider Electric
Mr. WINGREN, Jorgen	ABB AB
Prof. ÅKESSON, Torsten	Lund University