7th Workshop on Energy for Sustainable Science at Research Infrastructures

Wednesday 25 September 2024 – Friday 27 September 2024

Final program and Abstracts

Website: https://agenda.ciemat.es/e/ESSRI2024

Centro de Investigaciones Energéticas Medioambientales y Tecnológicas, CIEMAT- Madrid

Contents

1. Foreword

In the current decade, after contrasted indications of dwindling and instable energy resources, energy cost rises and severe evidences of climate change, the sustainability of technical infrastructures has been confirmed as an unavoidable demand. New medium and large dimension research infrastructures are forced to face this challenging scenario.

Extreme performance operation and cutting-edge technologies often lead to high power consumption. The development of next generation research and technological infrastructures and the upgrade of existing ones demand new concepts in terms of sustainability, affecting both to new technological concepts and reconsidering the operation of the facilities.

Besides, the clear increase of carbon-free, renewable energy sources, energy-efficient systems, more advanced energy storage integration and smart grids can reduce strain on the energy supply. But this cannot be an excuse for delaying the transition to sustainable infrastructures. In this regard, collaboration among scientists, engineers, environmental experts and scientific policy makers is crucial for devising long-term strategies for sustainable research infrastructure.

Sustainable development and operation of research infrastructures does not limit to energy efficiency considerations; it also encompasses circular economy concepts and a proper life cycle of materials and components, concluding with a responsible management of wastes. Embracing transformative changes towards sustainability means progress and innovation. Research facilities must take a leading position in environmental consciousness and the pursuit of efficient energy solutions, inspiring other sectors.

Renewable energy sources offer hope for a greener future, including solar, wind, and geothermal technologies. Energy-efficient systems and smart grids can mitigate power demand and reduce strain on traditional energy grids. Integrating energy storage and management systems is essential for a stable power supply.

The main goal of this event is to identify the challenges, technical and strategical, to develop and implement sustainable solutions at research infrastructures. This includes sharing experiences on new energy-efficient technologies, energy management at research infrastructures, review how the energy sustainability is faced on the current research projects, analyse life cycle, and discuss about future aims and trends, among other topics. Specific interest will be paid to involve predoctoral students into the workshop discussions, to promote the involvement of the young research staff on the event topics.

To stimulate exchanges and foster contacts and cooperation among the participants, the format of the event has been selected to be in-presence, although speakers from non-European institutions will be exceptionally allowed to participate on-line.

2. Committee

2.1 Organising Committee

Carlo Bocchetta	ESS
Frederick Bordry	ESSRI Honorary member
Serge Claudet	CERN
Roberto Losito	CERN
Juergen Neuhaus	TUM, ERF-AISBL rep
Jose Manuel Pérez	CIEMAT
Jean-Luc Revol	ESRF, ESSRI past chair
Thomas Roser	BNL, ICFA rep
Mike Seidel	PSI, I-FAST rep.
Lali Tchelidze	ESS
Denise Völker	DESY

2.2 Local Committee

Concepción Oliver	CIEMAT
Diego Obradors	CIEMAT
Joan Casas	ALBA
Luis García-Tabarés	CIEMAT
Sergio Santiago	ADCOMM CENTURY

3. General Information

3.1 Congress Venue

The venue is strategically located at the heart of the city, precisely at:

> Universidad Carlos III de Madrid, Campus Puerta de Toledo
> Ronda de Toledo 1
> 28005, Madrid, Spain

This central setting provides accessibility and convenience for all participants. The Carlos III University of Madrid Campus serves as an ideal backdrop for inspiring and productive conferences, harmonizing a strategic location with purposefully designed facilities to cater to the diverse needs of our attendees. Google maps.

3.2 Internet

Wi-fi internet connection is provided in the venue. Please, note that it is a complimentary and a basic service:
Network: XXX
User: XXX
Password: XXX

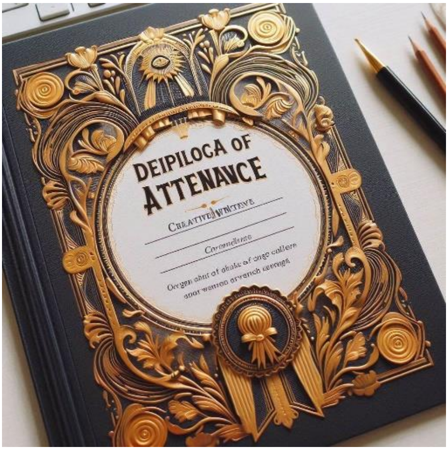
3.3 Registration desk and bags pick up

The registration desk is located on level -1 of the main entrance. Opening hours are as follows:

- Thursday, 25 September: 12:00 h – 14:00 h

All registrants must visit the conference registration desk to receive their delegate bag.

3.4 Certificate of attendance



We are pleased to offer certificates of attendance and presentation for those who require them. If you need a certificate for attending the event or for your presentation, please request it by contacting us by email us with the following details:

1.Your full name.
2.The name of the session or presentation you attended or delivered.
3.Your affiliation

We will process your request and issue the certificate accordingly

3.5 Coffees

Coffees during breaks will be served in the hall of the auditorium area. Please refer to the schedule for dates and times.

3.6 Reception cocktail

Date: Wednesday, 25th from 18:30 to 20:30
Location: Coffee break area
Admision: All registered delegates

At the end of the day, we will delight in a welcome cocktail, where selected students will have the opportunity to present their posters. This moment will be a special occasion to exchange ideas, experiences, and establish relationships among the attendees. In a collaborative atmosphere, guests will be able ask questions and share their own perspectives.

3.7 Walking Tour

Date: Thursday, 26th from 18:30 to 20:00
Location: Conference venue
Admision: All registered delegates

Our walking tour through the streets of Madrid is an opportunity to explore the highlights of this historic city as we make our way to the gala dinner restaurant. During our journey, we will guide you through the most emblematic places and provide relevant information about the history and culture of Madrid. Our aim is to offer an informative and enriching experience before enjoying a special dinner at the selected restaurant.

3.8 Banquet dinner

Date: Thursday, 26th at 20:30

Place: Posada de la Villa

Location: Calle Cava Baja, 9. 28005, Madrid. +34 913 661 860

Admision: All registered delegates.

As part of the workshop, a special dinner will be held. It will be an excellent opportunity to continue professional interactions and relationships in a relaxed and pleasant atmosphere. We look forward to your presence and enjoying this experience together, which will undoubtedly enrich our collaboration and learning.

3.9 CIEMAT tour

Date: Friday, 27th at 13:15

Place: CIEMAT, Av. Complutense 40

Location: Shuttle service from conference venue.

Admision: Those interested in the tour must indicate their preference during the registration process.

A guided tour will be conducted at CIEMAT at the TJ-II thermonuclear fusion device, a helical-axis "stellarator" that produces magnetically confined high-temperature plasmas

3.10 Exhibition

Booths are in the coffee break area. Attendees are encouraged to spend time visiting booths and interacting with the exhibitors.

3.11 Non-liability

The organisation has the right, for any reason beyond their control, to modify or cancel, without prior notice, the sessions or any of the arrangements, timetables, plans or other items. The organisers will not be responsible for any loss, damage, expenditure or inconvenience caused to participants, and their belongings, either during or because of the conference.

Programme

3.12 Program Schedule

3.12.1 September 25th, Wednesday

Time	Event
12:00 – 14:00	**Open registration**

Plenary Session 1: *Auditorium*
Chairman: **J. M. Pérez**

Time	Event	Page
14:00 – 14:10	**Y. Benito** *Welcome Address*	21
14:10 – 14:20	**F. Bordry** *Introduction to the workshop*	22
14:20 – 14:30	**C. Oliver** *Practical Information*	24
14:30 – 15:00	**O. Renn** *The role of Natural and Social Sciences for Transdisciplinary Research and Implementation in the Energy Transition*	25
15:00 – 15:30	**J. R. Ayuso** *Research and testing platforms and technology demonstrator projects in Spain on offshore wind and marine energy*	27

Time	Event	Page
15:30 – 16:00	**Coffee break**	

Plenary Session 2: *Auditorium* Chairman: **J. L. Revol**		
Time	Event	Page
16:00 – 16:20	**A. Weeks** *Challenges in Energy Management (ESRI Forum)*	29
16:20 – 16:40	**B. Schiraldi, A. Emrick** *Energy Management at Brookhaven National Laboratory and other US Science Laboratories*	31
16:40 – 17:00	**T. Roser** *ICFA Strategy on Sustainability*	33
17:00 – 17:20	**F. Pérez** *Sustainability for European Light Sources*	34
17:20 – 17:40	**C. Hidalgo** *Fusion energy for society: challenges and opportunities to make our dreams a reality*	35
17:40 – 18:00	**R. Mahbubani** *Environmental sustainability in basic research: a perspective from HECAP+*	37
18:00 – 18:30	*Discussion Session*	

Time	Event
18:30 – 20:30	**Welcome Reception & Student Poster Session**

3.12.1 September 26th, Thursday

Plenary Session 3: *Auditorium*
Chairman: **L. Tchelidze**

Time	Event	Page
9:00 – 9:30	**A. Pautz** *SMR, Small Modular Fission Reactors*	38
9:30 – 10:00	**J. D´Hondt** *ISAS Project*	40

Parallel Session 1: Energy-efficient technologies. Experiences. (***Auditorium***)
Chairman: **S. Claudet**

Time	Event	Page
10:15 – 10:35	**B. Auchmann** *Superconducting Magnet Technology for Future Sustainable Accelerators*	42
10:35 – 10:55	**T. Winkler** *High Temperature Superconducting Magnets for Sustainability Upgrades of Accelerators*	43
10:55 – 11:15	**C. Pira** *Developments towards energy efficient superconducting RF systems*	45
11:15 – 11:35	**C. Haberstroh** *Cryogenic refrigeration efficiency over a large range of temperature*	47
11:35 – 12:05	**Coffee break & Photo – Venue Entrance Hall**	
12:05 – 12:25	**S. Brooks** *Permanent Halbach magnets for ERLs and synchrotron light sources*	48
12:25 – 12:45	**M. Statera**	49

	High power (GW range) modular superconducting transmission line cables	
12:45 – 13:05	**K. Kahle** *Efficient Powering at CERN: Past, Present and Future*	50
13:05 – 13:25	*Discussion Session*	

Parallel Session 2: Life Cycle evaluation. (***Classroom-1A.01***)
Chairman: **D. Völker**

Time	Event	Page
10:15 – 10:35	**D. Völker** *Introduction of the Session* **-** *overview assessment approaches*	51
10:35 – 10:55	**R. Losito** *Life Cycle Assessment at CERN*	52
10:55 – 11:15	**M. Titov, C. Bloise** *General Life cycle analysis in EU colliders* **-** *Working Group on "Sustainability Assessment of Accelerators"*	54
11:15 – 11:35	**E. Nanni** *Sustainability Strategy for the Cool Copper Collider*	56
11:35 – 12:05	**Coffee break & Photo – Venue Entrance Hall**	
12:05 – 12:25	**B. Shepherd** *Accelerator Impact Report: RUEDI*	58
12:25 – 12:45	**J. Völker** *Decreasing the footprint for a new SR facility (Bessy III)*	59
12:45 – 13:05	**A. Klumpp** *Detailed life cycle assessment for a power supply*	60
13:05 – 13:25	*Discussion Session*	

Time	Event	Page
13:25 – 14:55	**Lunch break**	

Parallel Session 3: Energy and sustainability on Future Research Project. (***Auditorium***) Chairman: **T. Roser**		
Time	Event	Page
14:55 – 15:15	**J-P. Burnet** *Energy management and sustainability aspects for FCC*	62
15:15 – 15:35	**T. Vijaya Kumar** *Electron Ion Collider energy consumption and sustainability*	63
15:35 – 15:55	**P. Winkler, A. Maier** *Plasma-based injector for PETRA IV*	65
15:55 – 16:15	**M. Gibbs** (Videoconference) *Power consumption at SLAC*	67
16:15 – 16:45	**Coffee break**	
16:45 – 17:05	**G. De Carne** *Addressing Energy Responsibility in Particle Accelerators: Insights from the KITTEN Research Platform*	68
17:05 – 17:25	**W. Riegler** *Design of detectors for future colliders (FCC)*	70
17:25 – 17:45	**M. Marsella** *Sustainability in Einstein Telescope*	71
17:45 – 18:05	*Discussion Session*	
18:05 – 18:15	*Closeout*	

Parallel Session 4: Energy management at research infrastructures. ***(Classroom-1A.01)***

Chairman: **R. Losito**

Time	Event	Page
14:55 – 15:15	**F. Abusaif** *Key technologies for energy efficient and sustainable accelerators: a survey from shareholders*	72
15:15 – 15:35	**T. Warnecke** *Optimized tunnel climatization for PETRA IV*	74
15:35 – 15:55	**P. Petagna** *CO2 for detector cooling at CERN*	76
15:55 – 16:15	**S. Claudet** *Heat recovery at CERN, from a first multi-MW case to a generalised approach*	78
16:15 – 16:45	**Coffee break**	
16:45 – 17:05	**N. Sapountzoglou, R. Vasapollo** *Fast measurement systems: how to increase the power quality in accelerator energy grids*	79
17:05 – 17:25	**R. Van Der Meer** (Videoconference) *A perspective talk on decarbonisation of the cement industry*	81
17:25 – 17:45	**F. Ferrand** *Helium management as part of sustainability*	82
17:45 – 18:05	**S. Ücer** *FlexRICAN EU Project: Flexibility for Research Infrastructures for global CArbon Neutrality*	83
18:05 – 18:15	*CloseOut*	

Time	Event
18:30 – 18:45	Group formation for Guided Tour
18:45 – 20:30	Walking Tour
20:30 – 23:00	**Social dinner: Posada de la Villa**

3.12.2 September 27th, Friday

Plenary Session 4: *Auditorium* Chairman: **J.M. Pérez**	
Time	Event
9:00 – 9:15	**S. Claudet** *Summary: Energy-efficient technologies. Experiences*
9:15 – 9:30	**D. Völker** *Summary: Life cycle evaluation*
9:30 – 9:45	**T. Roser** *Summary: Energy and Sustainability on Future Research Projects*
9:45 – 10:00	**R. Losito** *Summary: Energy management at Research Infrastructures*
10:00 – 10:30	**D. Obradors** *Summary: Outcome from the students view*

Time	Event
10:30 – 11:00	**Cofee break**

Plenary Session 5: *Auditorium* Chairman: **M. Seidel**		
Time	Event	Page
11:00 – 11:30	**M. Lafoz** *Energy Storage: an alternative to increase reliability in power systems and facilities*	84
11:30 – 12:00	**L. Blanco** *To be defined*	86
12:00 – 12:15	*Closing remarks and next workshop*	

Time	Event
12:15 – 13:15	**Stand-up lunch**
13:15 – 15:15	CIEMAT guided tour: TJ-II thermonuclear fusion device, “Stellerator”

4. Wednesday, 25 September

4.1 Plenary Session 1

4.1.1 Welcome Address

Y. Benito

Director
Centro de Investigaciones, Energía, Medioambiente y
Tecnología - CIEMAT, Spain

Lecturer biography: Y. Benito

Yolanda Benito leads CIEMAT, a Public Research Organization attached to the Ministry of Science and Innovation through the General Secretariat of Research, Spain, whose activities are developed in the fields of energy, the environment, and technological developments.

Between 2010 and 2022, she has held the position of Director of the Environmental Department at CIEMAT, working on the study of the environmental consequences associated with the energy generation, industry, and transportation sectors, as well as the development of technologies to mitigate these effects.

Between 2008 and 2010, she worked in the field of R&D management as Head of the Sustainability Area in the General Directorate for Technology Transfer and Business Development at the Ministry of Science and Innovation.

Additionally, she has published numerous research and outreach papers in international journals and has participated in scientific talks and courses.

25 Sep

4.1.2 Introduction to the Workshop

F. Bordry

ESSRI Honorary member
Former Director for Accelerators and Technology – CERN, Switzerland

Lecturer biography: F. Bordry

Frédérick Bordry (born in 1954, French) was the Head of the Technology Department before being appointed as CERN's Director for Accelerators and Technology.

In 1978, Frédérick Bordry graduated with a PhD in electrical engineering from the Institut National Polytechnique in Toulouse and went on to gain his higher doctorate in science, from the same institute in 1985.

Bordry's early career was spent teaching and conducting energy conversion research. Then he moved to Brazil, where he spent two years as a professor at the Federal University of Santa Catarina (Florianópolis). In 1981 he was appointed senior lecturer at the Institut National Polytechnique in Toulouse.

Bordry came to CERN in 1986, joining the group working on power converters for the Large Electron-Positron Collider (LEP) before moving in 1988 to the Operations Group as an engineer in charge of the Super Proton Synchrotron and LEP.

In 1994, the year that the LHC was approved, he joined the Power Converter Group as the Head of Power Converters Design and Construction for the LHC. He was appointed leader of the Power Converter Group in 2002, a position he held until December 2008.

In 2009, Bordry was promoted to Head of the CERN Technology Department - responsible for technologies specific to existing particle accelerators, facilities and future projects – where he has remained until 2013.

From 2014 he acted as the Director for Accelerators and Technology, where he is responsible for the operation and exploitation of the whole CERN accelerator complex, with particular emphasis on the LHC and for the development of new projects and technologies. He was re-appointed CERN’s Director for Accelerators and Technology.

4.1.3 Practical Information

C. Oliver

Centro de Investigaciones, Energía, Medioambiente y Tecnología - CIEMAT, Spain

Lecturer biography: C. Oliver

Head of the Particle Accelerators Unit at CIEMAT

4.1.4 The role of natural and social sciences for transdisciplinary research and implementation in the energy transition

Corresponding Authors: O. Renn

Former Scientific Director at the Institute for Advanced Sustainability Studies and the Research Institute for Sustainability - Helmholtz Center Potsdam, Germany

Based on the discussion of the role of science as an orientation for social transformations, the lecture will first explore the basics of a transdisciplinary scientific approach combining and integrating classic curiosity driven research with goal oriented (advocacy) knowledge and catalytic, process-oriented expertise. This integration leads to process of co-generation aimed at merging different knowledge pools and providing orientation for collective action.

The new transdisciplinary approach has several policy implications: a) it requires an interdisciplinary cooperation between technical, physical and social science expertise; b) it suggests having stakeholders participate not only in the interpretation of the results but also in shaping the research design from the beginning; and c) it requires a rigid monitoring system for assessing impacts and outcomes.

In a second step, the lecture will explain how these concepts have been applied to case studies to promote energy transitions in Germany The first example describes a transdisciplinary approach to design and prioritize climate protection and energy policies in the German State of Baden-Württemberg. It included roundtables with stakeholders, expert workshops with scientists, citizen panels with randomly selected participants and an internet forum. The process was instrumental for deigning a state climate protection plan in 2015. A second example will be the German Citizen Assembly on Climate Change Policies which was conducted in 2022. The process included an expert forum and a large assembly of randomly selected citizens. Stakeholder group representatives served as consultants to the two bodies of deliberation. The lecture will draw some general lessons from these two case studies and explore further possibilities for transdisciplinary studies in climate protection and energy transitions.

Lecturer biography: O. Renn

Prof. Ortwin Renn served as Scientific Director at the Institute for Advanced Sustainability Studies (IASS) from February 1, 2016, to December 31, 2022, which became the Research Institute for Sustainability - Helmholtz Center Potsdam in 2023. He also worked as a full professor for environment and technology assessment at the University of Stuttgart until his retirement. Renn is a visiting professor at Beijing Normal University and the University of Stavanger. Alongside Dr. Rainer Kuhn and Agnes Lampke, he directs Dialogik, a non-profit research institute focused on innovative science communication and participation.

At the IASS, Renn led research projects on energy transition, global systemic risks, and the impact of digitalization on sustainable development, aiming to establish the IASS as a leading center for transdisciplinary sustainability research. He holds degrees in economics, sociology, and social psychology, including a master's and Ph.D. from the University of Cologne. Renn has worked in Germany, the USA, and Switzerland and is a member of several prestigious academies, including the German National Academy of Sciences Leopoldina and the Berlin-Brandenburg Academy of Sciences and Humanities.

Renn has served on numerous policy advisory commissions, including chairing the Sustainability Advisory Board of the State of Brandenburg and the Federal Government's Science Platform for Climate Protection. He also chaired the scientific board of trustees of the Citizens' Climate Council from 2021. He has received several honors, including the Federal Cross of Merit, First Class, honorary doctorates from ETH Zurich and Mid-Sweden University, and an honorary professorship from the Technical University of Munich. Renn has authored over 30 books and more than 250 scientific articles, with his notable work "Risk Governance" published in 2008 o be done.

4.1.5 Research and testing platforms and technology demonstrator projects in Spain on offshore wind and marine energy

Corresponding Authors: J.R. Ayuso

Instituto para la Diversificación y Ahorro de la Energía – IDAE, Spain

The presentation will give an overview of the infrastructures for research and technological development of offshore wind and marine energy projects in Spain, those already available in a real marine environment, as well as the actions under development. The RENMARINAS DEMOS Programme of the Ministry for Ecological Transition and the Demographic Challenge, managed by the IDAE, has granted 147 million euros in aid from Next Generation EU Funds to around twenty projects for the creation of new test platforms, the reinforcement of existing ones and for technological prototypes.

Ongoing actions are due to be completed by early 2026, starting multiannual experimental research activities involving field trial projects on the interaction between offshore renewable technologies and the sustainability of biodiversity in the marine environment. These activities generate employment opportunities for the technological, academic, and scientific community in an international strategic sector, such as Offshore Wind and Marine Energy, in real testing platforms in different coastal environments in the Canary Islands and in the marine sub-regions of the Iberian Peninsula

Lecturer biography: J. R. Ayuso

Team manager with a proven experience in the Public Administration, close to Renewable Energy Industry and stakeholders. Expert in Renewable Energy Regulation and Planning in Spain, supporting wind energy deployment for +23 years. Industrial Engineer by the Polytechnic University of Madrid (UPM). Executive MBA by the EOI Business School.

Technical responsible for wind and marine energy projects in IDAE. Member of inter-ministerial and intra-ministerial working teams. In charge of -among others- the technological development Aid Program called 'Renmarinas Demos' (NextGenerationEU Funds) managed by IDEA.

4.2 Plenary session 2

4.2.1 Challenges in Energy Management (ESRI Forum)

Corresponding Authors: A. Weeks

The extreme Light Infrastructure ERIC- ELI, Czech Republic

25 Sep

The recent ESFRI report on “Energy and Supply Challenges of Research Infrastructures” addresses the severe impact of recent geopolitical events, particularly the Russian invasion of Ukraine, coupled with the aftermath of COVID-19, on the operations of European research infrastructures (RIs). These crises have led to soaring energy costs, resource shortages, and supply chain disruptions, threatening the continuity of critical RIs.

As Vice-Chair of the ERIC Forum and a co-author of the report, I will present key findings and recommendations. Energy-intensive RIs, such as synchrotrons and computing centers, are at risk of operational shutdowns due to rising costs. The report advocates for urgent financial support, the creation of crisis response plans with a focus on sustainable practices, and the inclusion of key raw materials in European regulations to prevent future supply shortages.

Additionally, the report calls for coordinated European efforts to support the Ukrainian research community, whose infrastructures have been devastated.To be done

Lecturer biography: A. Weeks

Allen Weeks was appointed as the new Director General of the ELI Delivery Consortium, effective 24 July 2018. Formerly the Associate Director for Members and Stakeholders Relations, Allen took over Carlo Rizzuto, who had been in the post since December 2015.

In his new role, Weeks is given responsibility for managing the transition from ELI DC to ELI ERIC (European Research Infrastructure Consortium), which is expected legally in place in the first half of 2019.

Allen Weeks began working with research facilities in 2005 where he got involved in the construction project of the Free-Electron

Laser ‘FERMI’ at Elettra in Trieste, Italy. He was then Director of Business Development at Instrumentation Technologies, a leading company making instrumentation for the world’s most state-of-the-art accelerators.

From 2012-2017, he was the Head of Communications, External Relations, and In-Kind at the European Spallation Source (ESS) in Lund. He joined ELI in November 2017 to make use of his experience in starting up a leading European research infrastructure and ERIC membership negotiations.

4.2.2 Energy Management at BNL and at US Science Labs

Corresponding Authors: A. Emrick, B. Schiraldi

Brookhaven National Laboratory -BNL, USA

Brookhaven National Laboratory has been a leader in energy and water conservation for decades. Currently the Laboratory is managing the dual challenges of meeting clean energy goals while providing for the increased electric power demand of the Electron Ion Collider (EIC), its new nuclear physics accelerator facility currently being developed. The presentation will provide a summary of energy management achievements and cover current plans for meeting the EIC power demand including expanding the electric distribution infrastructure, increasing onsite solar generation, geothermal facilities, and preliminary studies on capturing low grade waste heat from the EIC and using it to supplement the Lab's district heating system, offsetting fossil fuels at the Central Steam Facility. Plans for achieving 100% Carbon Free Electricity by 2030 and a brief overview of sustainability initiatives at other US agencies and US Department of Energy laboratories will also be presented.

Lecturer biography: A. Emrick

Ann Emrick is the Deputy Laboratory Director for Operations/Chief Operating Officer at Brookhaven National Laboratory (BNL) located on Long Island in New York State. BNL is a US Department of Energy multi-program national laboratory with an annual budget of $800 million USD and 2,900 employees. BNL operates two major accelerator facilities – the Relativistic Heavy Ion Collider (RHIC) and the National Synchrotron Light Source-II (NSLS-II) and is the home of the future Electron-Ion Collider (EIC).

Ann has been at BNL for 37 years and has served in progressively more impactful leadership roles across Brookhaven, the Battelle-affiliated labs, and the DOE complex. Ann was the directorate chief operating officer for the Lab's Environment, Biology, Nuclear Science & Nonproliferation Directorate, the Computational Science Initiative, and the Advanced Technology Research Office. Energy management, sustainability, and resilience have been a part of many of Ann's previous positions and assignments. Currently, Ann is leading the Laboratory's planning for the projected increase in electric power demand and path to sustainable operations.

Lecturer biography: B. Schiraldi

Benedetto is the Energy and Sustainability Manager at Brookhaven National Laboratory. He began his career as a climate scientist before returning to school to pursue formal engineering training. After several years as an engineering consultant, Benedetto transitioned to government work, applying his scientific and engineering expertise to broader sustainability initiatives.

In his former role with the City of New York, he was recognized with accolades for Excellence in Sustainability and received the peer-nominated award for Energy Manager of the Year. In his current role at BNL, Benedetto is focused on planning for the lab's future growth with a strong emphasis on sustainability. He is dedicated to helping BNL achieve U.S. government goals, starting with 100% carbon-free electricity and ultimately reaching net-zero laboratory operations.

4.2.3 ICFA Strategy on sustainability

Corresponding Authors: T. Roser

Brookhaven National Laboratory - BNL, USA

The ICFA Panel on Sustainable Accelerators and Colliders assesses and promotes developments on energy efficient and sustainable accelerator concepts, technologies, and strategies for operation, and assesses and promotes the use of accelerators for the development of Carbon-neutral energy sources. In this talk I will start with describing why energy efficiency and reduced energy consumption are a critical part of sustainability and addressing Global Warming and then give an overview of the world-wide efforts towards sustainable accelerators and colliders.

Lecturer biography: T. Rosser

Until his retirement in 2021, Thomas Roser was a Senior Scientist, Deputy Associate Laboratory Director for Accelerators and Chair of the Collider-Accelerator Department at Brookhaven National Laboratory with the responsibility for the operation of the Relativistic Heavy Ion Collider (RHIC). He received his Ph.D. in nuclear physics from the Federal Institute of Technology (ETH), Zurich, Switzerland, in 1984. Before joining BNL in 1991, he was an Assistant Professor at the University of Michigan, working on spin effects in high-energy elastic pp scattering and acceleration of polarized proton beams. At Brookhaven he oversaw the high intensity beam development at the Alternating Gradient Synchrotron (AGS) and led the effort to accelerate polarized protons in the AGS using compact partial Siberian snakes. Starting in 1999 he led the commissioning of the Relativistic Heavy Ion Collider (RHIC) and the development of polarized proton acceleration, resulting in the first 250 GeV on 250 GeV polarized proton collisions in RHIC.

4.2.4 Sustainability for European light sources

Corresponding Authors: F.Pérez

ALBA CELLS, Spain

Accelerators are high energy consuming infrastructures, and even though light sources in particular have not an extremely high-power requirement, its continuous routine operation has an impact on the yearly required energy. Recent events have impacted the operation of some of the light sources, forcing in some cases the reduction of the operating hours. This has been a reminder that sustainability is an important aspect to consider, not only at the design stage but also during the planning of the operation modes. We will review the different actions and proposals underway at the European Light Sources -the operating ones, the upgrades and the new projects-, in order to make them more sustainable. Aspects that include technical improvements, like the use of permanent magnets and the optimisation of the RF systems, but also operational ones, like reducing the energy at shutdown periods or optimising the requirements from basic infrastructures.

Lecturer biography: F. Pérez

Dr. Farncis Pérez is the Head of the Accelerator's Division of the ALBA Synchrotron, Barcelona, Spain.

PhD in Physics, in Materials Science, Magnetism and Superconductivity.

With 30 years' experience in accelerators, having contributed to the design, construction, commissioning and operation of two synchrotron light sources: ANKA in Germany and ALBA in Spain.

He has also been involved in the organization of many international meetings, workshops and conferences, as member of the organizing committees, as well as member of several advisory committees, nowadays member of: Elettra, Petra IV, Canadian Light Source, SESAME, and HZB Scientific/Technical Advisory Committees.

25 Sep

4.2.5 Fusion energy for society: challenges and opportunities to make our dreams a reality

Corresponding Authors: C. Hidalgo

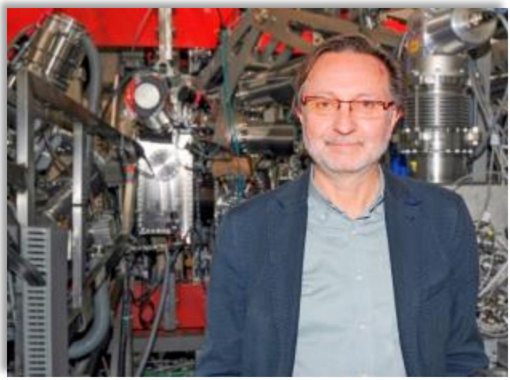
Centro de Investigaciones, Energía, Medioambiente y Tecnología - CIEMAT, Spain

Recent record results of fusion energy production, using both inertial and magnetic confinement, are the clearest demonstration of the potential for fusion energy to deliver a safe and sustainable low-carbon energy source. These breakthroughs indicate that the once-distant dream of harnessing controlled fusion within earth-based laboratories is now a reality. These advancements bring us one step closer in the quest of fusion energy for our society, which stands as our next paramount objective.

Thanks to these groundbreaking achievements, interest in fusion has grown enormously and industries and private investors have become part of the fusion effort. At the same time, the perception of urgency for sustainable energy has grown, driven by the realization of the urgency to fight climate change and by evolving social and economic conditions.

The integration of current fusion science and technology programs is imperative to tackle the remaining challenges for the deployment of fusion energy for society. While the ITER project continues to be a central focus, addressing critical open issues such as the validation of fusion materials, tritium breeding technologies, power exhaust management and integrated plasma reactor scenarios is essential for moving forward towards Fusion Power Plants. This will require continued innovation, multidisciplinary collaboration and persistent commitment. An overview of these challenges and opportunities to make our dreams a reality will be presented.

Lecturer biography: C. Hidalgo



Carlos Hidalgo is the Director of the National Fusion Laboratory at the Research Center for Energy, Environment and Technology (CIEMAT), a department in charge of research on nuclear fusion science and technology.

He has a Doctorate in Physics from the Complutense University of Madrid, is President of the Science and Society Group of the European Physical Society (EPS) and teaches the Erasmus Mundus Masters' Degree in Plasma and Nuclear Fusion Physics.

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4.2.6 Environmental sustainability in basic research: a perspective from HECAP+

Corresponding Authors: R. Mahbubani

Rudjer Boskovic Instittute - Zagreb, Croatia

The climate crisis and the degradation of the world’s ecosystems require humanity to take immediate action. The international scientific community has a responsibility to limit the negative environmental impacts of basic research.

The HECAP+ communities (High Energy Physics, Cosmology, Astroparticle Physics, and Hadron and Nuclear Physics) make use of common and similar experimental infrastructure, such as accelerators and observatories, and rely similarly on the processing of big data. Our communities therefore face similar challenges to improving the sustainability of our research. In this talk we will reflect on the environmental impacts of our work practices and research infrastructure and make recommendations for positive changes, identifying opportunities and challenges that such changes present for wider aspects of social responsibility.

Lecturer biography: R. Mahbubani

After an undergraduate degree at the University of Bristol, Rakhi headed to the US for a PhD at Harvard, followed by a postdoc with the Particle Theory group at Fermilab.

In October 2009, she moved back to Europe for postdocs at CERN and EPFL and is now permanently employed as research staff at the Rudjer Boskovic Institute in Zagreb, Croatia. Her research focuses on teasing out signals of physics beyond the standard model, at particle colliders, and dark matter detection experiments.

5. Thursday, 26 September

5.1 Plenary Session 3

5.1.1 Small Modular Reactors: A Paradigm Shift in Nuclear Technology?

Corresponding Authors: A. Pautz

Paul Scherrer Institute - PSI, Switzerland

Advanced nuclear reactors with rated electric power of less than 300 MW are commonly referred to as Small Modular Reactors (SMR); for power levels even below 20 MW, the term “Microreactors” has been established. The recently returning appeal of this class of reactors stems from the believe that the “economy-of-scale”, which had long been dominating the nuclear market and clearly favoured the construction of larger and larger nuclear power plants, will be in the near future increasingly replaced by “economy of production”, i.e. factory-built small modules yielding simpler construction sites, with costs per kWh in the same range as large power plants.

The presentation will shed a light on some of the recent developments and discuss some of the claimed advantages of SMR, i.e. the significantly lower initial capital costs due to the smaller size of the plant, shorter construction times because of the shift to factory production, the increased flexibility for load-following operation that makes SMRs easier to integrate with intermittent renewables sources, and the strongly enhanced passive safety concepts, yielding an unprecedented level of reactor core damage prevention. Some attention will also be attributed to Microreactors, as they have been identified quite recently by several US companies like Microsoft and Amazon as viable power sources for large data centers, operating practically non-stop for periods of several years at rated power of around 20 MW, and with a footprint of not more than the size of a few ISO containers.

Lecturer biography: A. Pautz

Andreas Pautz is head of the Center of Nuclear Engineering and Sciences at Switzerland's Paul Scherrer Institut (PSI), and professor for nuclear engineering at the École Polytechnique Fédérale de Lausanne (EPFL). He received a M.Sc. in theoretical physics from Manchester University in 1995, a master degree in experimental quantum optics from University of Hannover in 1997, and obtained a PhD in nuclear engineering from Technical University of Munich in 2000. After working for the German state nuclear regulator at TÜV Nord, where he was responsible for the reactor physics oversight of two large German 1300 MW nuclear power plants, he joined AREVA NP, Europe's largest Nuclear Power Plant vendor, as scientific software developer and group leader for the development of AREVA's next-generation reactor core simulator in 2003. In 2007, he joined GRS (Gesellschaft für Anlagen- und Reaktorsicherheit), the German Federal expert organization for nuclear safety, as department head for reactor core behavior, and was promoted director of GRS' reactor safety research division and member of its management board in 2010. In 2012, he entered PSI and EPFL as full professor and lab head of the two Laboratories for Reactor Physics and System Behavior (LRS) and became head of PSI's Center of Nuclear Engineering and Sciences and member of its directorate in 2016. Andreas Pautz represents Switzerland in several high-level international nuclear safety panels at the OECD and the IAEA

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5.1.2 ISAS project

Corresponding Authors: J. D´Hondt

Vrije Universiteit Brussel, Belgium

With the ambition to maintain competitiveness of European accelerator-based research infrastructures, the Horizon Europe project Innovate for Sustainable Accelerating Systems (iSAS) has the objective to develop, prototype and validate new impactful energy-saving technologies so that SRF accelerators use significantly less energy while providing the same, or even improved, performance. With 17 academic and industrial partners and aligned with the European accelerator R&D roadmap, the project focusses on three key technology areas connected to SRF cryomodules: the generation and efficient use of RF power, the improved cryogenic efficiency to operate superconductive cavities and optimal beam-energy recovery. The most promising and impactful technologies will be further developed to increase their TRL and facilitate their integration into cryomodules at existing research infrastructures and/or in the design of future accelerators.

Lecturer biography: J. D´Hondt

After obtaining a PhD in 2003 at the Vrije Universiteit Brussel (VUB) and a postdoctoral fellowship, professor D'Hondt has been a leading scientist at the VUB where he is now full professor and VUB-director of the Inter-university Institute for High Energies (IIHE) with about 100 members. He is the coordinator of a center of excellence for experimental and theoretical high-energy physics, which currently includes 23 professors. Initially, he measured properties of the W boson with the LEP collider at CERN. About 30 PhD students have graduated or are working towards graduation with him as a promotor with research mainly at the LHC collider at CERN. With the CMS experiment at this particle collider, he initiated top quark research related to the heaviest fundamental particle we know and took responsibility to successfully deliver detector modules for the Silicon Tracker of the experiment. Shortly after the discovery of the Higgs boson in 2012, he was elected chair of the CMS Collaboration Board (2014-2017) where all major decisions of this 4000-person international collaboration are made.

Meanwhile, he was invited for keynote talks at the most prominent conferences worldwide and received individual prizes from the World Economic Forum, the National Academy and the university.

For the period 2018-2020 he was elected chair of the European Committee for Future Accelerators (ECFA). In this role he represented the European community of particle physicists (above 10000 persons strong) and played an instrumental role in updating the European Strategy for Particle Physics.

In 2022 he became the spokesperson for the LHeC/FCC-eh programs to further develop the scientific potential and possible technical realization of a high-energy ep/eA collider and the associated detector at CERN. In the context of the European Accelerator R&D Roadmap, he coordinates the developments for Energy Recovery Linac systems for future particle physics colliders. To enable Europe’s Green Deal, he initiated the Horizon Europe project to Innovate for Sustainable Accelerating Systems (iSAS) with the aim of minimizing the energy consumption of future accelerators.

5.2 Parallel Session 1: Energy-efficient technologies. Experiences

5.2.1 Superconducting Magnet Technology for Future Sustainable Accelerators

Corresponding Authors: B. Auchmann

Paul Scherrer Institute - PSI, Switzerland

Considering the imperative need for sustainability in future accelerators, the role of superconducting magnets typically falls into two categories: high-field magnets, which extend the physics reach while striving for optimal efficiency, and low-field magnets, which enhance overall sustainability and aim to provide additional value to physics production. In this presentation, we discuss both types of developments in the context of the FCC integrated program (FCC-ee and FCC-hh), and mention synergies with the needs of accelerator infrastructure at PSI.

Lecturer biography: B. Auchmann

Bernhard Auchmann was born in Vienna, Austria, in 1979. He received his diploma and PhD degrees in Electrical Engineering from the Vienna University of Technology in 2001 and 2004, respectively.

Since 2005 he is scientific staff at CERN, working on systems of superconducting accelerator magnets for the LHC. Among others, his responsibilities covered the development of software for the electromagnetic simulation of accelerator magnets, the electro-mechanical design of high-field prototype magnets, and the development and exploitation of multi-physics simulation software to model safety-critical transient processes in superconducting accelerator magnets.

Since 2016 he is leading the CHART MagDev laboratory at PSI for the development of superconducting-magnet technology, with a focus on magnet for the Future Circular Collider.

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5.2.2 High Temperature Superconducting Magnets for Sustainability Upgrades of Accelerators

Corresponding Authors: T. Winkler[1], S. Busatto[2], S. Mariotto[3], L. Rossi[3], P.Spiller[1]

[1]GSI Helmholtzzentrum für Schwerionenforschung GmbH, Germany
[2]Istituto Nazionale di Fisica Nucleare, Sezione di Milano- INFN, Univ. of Roma
[3]Istituto Nazionale di Fisica Nucleare, Sezione di Milano- INFN, Univ. of Milano

The normal-conducting magnetic beam guidance and steering systems are major power consumers in accelerator centres. Therefore, reducing the power consumption by upgrading existing normal-conducting magnets with superconducting coils offers a promising way to enhance the centres sustainability. We present two concepts for upgrade programs, investigate potential sustainability advantages and give details of the electric, thermal and mechanical design for HTS magnets.

Lecturer biography: T. Winkler

Tiemo Winkler is a staff scientist at GSI Helmholtz Centre for Heavy Ion Research (GSI), where he is responsible for the Quadrupole Doublet Module Integration for the new heavy ion synchrotron SIS100 for the Facility for Antiproton and Ion Research (FAIR) research center currently under construction in Darmstadt, Germany. In the I.FAST project, Dr. Winkler leads the task 8.6, which aims to develop a round HTS cable suitable for fast-ramped applications. Additionally, Dr. Winkler investigates the feasibility of ramped HTS beam transfer magnets.

Dr. Winkler has a long-standing interest in the application of superconductivity: During his joint PhD studies at CERN and the University of Twente from 2013-2017, Dr. Winkler has investigated the transient heat transfer in He II in LHC dipole magnets experimentally and has participated in the Helium Spill experiment in the LHC tunnel. Between 2017 and 2019, he worked on the EcoSwing project (PostDoc at University of Twente, then R&D engineer at Theva Dünnschichttechnik GmbH), where he coordinated the superconducting rotor construction, generator testing on the test bench and later on performed the on-site commissioning of the superconducting generator on the wind turbine in Thyborøn, Denmark.

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5.2.3 Developments towards energy efficient superconducting RF systems

Corresponding Authors: C. Pira

Istituto Nazionale di Fisica Nucleare, National Laboratories of Legnaro- INFN LNL, Italy

Cryogenics is one of the major energy costs in modern SRF accelerators because of the need to lower the operating temperature to 2K. Substituting Nb with a higher critical-temperature superconductor, such as Nb_3Sn, allows operations to be moved up to 4.5 K with a reduction in cryogenic costs by a factor of 3. The European collaboration I.FAST, has the ambitious goal of producing the first prototype of 1.3 GHz Nb_3Sn on Cu thin-film elliptical cavity. Through the collaboration between 12 different European research institutes, the different R&D activities cover the entire cavity production chain. In this work the main results obtained by the collaboration will be shown, in particular concerning the development of superconductive coatings of Nb_3Sn by Magnetron Sputtering. The scalability from small flat samples to elliptical cavity prototypes and the goals of the new European ISAS project will be also discussed.

This project has received funding from the European Union's Horizon-INFRA-2023-TECH-01 under GA No 101131435 – iSAS and from the European Union's Horizon 2020 Research and Innovation programme under GA No 101004730 – I.FAST. Work supported by INFN CSN5 experiment SAMARA and INFN CSN1 experiments SRF and RD_FCC.

Lecturer biography: C. Pira

Cristian Pira, technologist and head of the Surface Technology and Superconductivity Service at INFN's Legnaro National Laboratories.

He received his PhD in physics in 2018 from the University of Padua. In INFN since 2007, in the first 7 years he was mainly involved in technology transfer and then since 2014 he moved full-time to SRF, becoming coordinator of SRF activities at LNL since 2018. He is a Materials Scientist, mainly involved in the development of superconducting coatings and innovative polishing treatments. He has designed and managed several INFN experiments for improving the performance of thin-film SRF cavities and is currently involved in the I.FAST and ISAS collaborations, where he coordinates the development of the 1.3 GHz Nb3Sn on copper thin-film SRF cavity prototype.

5.2.4 Cryogenic refrigeration efficiency over a large range of temperature

Corresponding Authors: C. Haberstroh

Technische Universität Desden – TU Dresden, Germany

Current research facilities regularly come along with a large energy demand. Often cryogenic equipment, i.e. low-temperature components are involved, requiring appreciable energy for refrigeration. An example for this are particle accelerators. As a standard today these are based on superconducting accelerator cavities and superconducting magnets with working temperature as low as 1.8 K. In a similar way NMR magnets require cryogenic cooling, moreover material characterisation and basic research covering a wide temperature range. High temperature superconductors (HTS) offer the option for working temperatures at e.g. 50…80 K. Different kinds of respective cooling principles and cooling machines are available today. A minimum energy demand is given unavoidably by the Carnot fraction. Moreover, for a number of reasons, all realistic refrigeration machines exceed this theoretical energy demand by factors. In the presentation different cryogenic cooling solutions are presented. Specific efficiencies are highlighted, and options for further improvement are discussed.

Lecturer biography: C. Haberstroh

Ch. Haberstroh originally studied physics, later in 1994 joined the engineering department of the TU Dresden (affiliation: Chair of Refrigeration, Cryogenics and Compressor Technology). The professor's title was bestowed there in 2016. He now is the person in charge for all cryogenics teaching and respective activities there.

Original and sustained focus of work is helium refrigerators and liquefier plants. He was involved in many national and international projects on this. Meanwhile, the focus point more and more shifted towards low temperature hydrogen. Thermodynamics of liquid hydrogen tank systems, liquid hydrogen implementation, material quests and ortho/para conversion are main topics of his team.

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5.2.5 Permanent Halbach magnets for ERLs and synchrotron light sources

Corresponding Authors: S. Brooks

Brookhaven National Laboratory - BNL, USA

The original circular Halbach magnet design creates a strong pure multipole field from permanent magnet pieces without intervening iron. This design was modified for the CBETA 4-turn ERL, whose return loop includes combined-function (dipole+quadrupole) Halbach-derived magnets, plus a modular system of tuning shims to improve all 216 magnets' relative field accuracy to better than 10^-3. This talk also describes further modifications of the design enable a larger range of accelerator applications, such as open-midplane designs to allow synchrotron radiation to escape and magnets with an oval aperture to allow larger gradients, including in hadron therapy machines.

Lecturer biography: S. Brooks

Stephen Brooks is a physicist at Brookhaven National Laboratory in the United States, and previously worked at Rutherford Appleton Laboratory in the United Kingdom until 2013. His doctorate thesis was on particle capture from the neutrino factory target and he later moved on to the design of fixed-field accelerators. These accelerators require custom magnetic field profiles, which led to an interest in magnet design. In 2018, he designed and supervised the construction of the permanent magnets for the CBETA 4-turn fixed-field ERL at Cornell University and participated in its commissioning. A common theme throughout his research is optimisation and automatic design techniques.

5.2.6 High power (GW range) modular superconducting transmission line cables

Corresponding Authors: M. Statera

Istituto Nazionale di Fisica Nucleare, Sezione di Milano- INFN MI, Italy

INFN is developing in Italy an environment to develop and test GW-rated superconducting lines by the NextGenEU project IRIS (Innovative Research Infrastructure on applied Superconductivity). The design and construction of a full 130 m long GW-rated SC line based on MgB_2 technology and the manufacturing status are discussed. An overview of the solution selected for power transmission, insulation, cryogenics, and power leads is completed by a discussion on the sustainability of such a line and on potential direct applications.

The main features of a brand new test station under construction in Salerno premises are presented, focusing on the commissioning of the line that is foreseen in 2025. The test stand construction is aimed at facilitating the development and standardization of superconducting power transmission lines, an important step toward industrial use of superconducting power lines.

Lecturer biography: M. Statera

Marco Statera graduated with a degree in mechanical engineering in 2002 and earned a Ph.D. in Physics in 2006 from Ferrara University. He has contributed to various nuclear physics experiments at institutions such as DESY, FZ-Juelich, CERN, and JLAB, where he designed and operated superconducting and UHV systems. Currently, he is a senior research engineer at INFN Milano, LASA. He contributed to HiLumi LHC by delivering the High Order Correctors superconducting magnets. He is now leading the design and delivery of a 1GW-rated superconducting line, 130 m long, within the NextGenEU project IRIS. Additionally, he is involved in developing technologies associated with High Temperature Superconducting devices for applications in high-energy physics and society at large, including magnets, power transmission, and sustainable applications.

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5.2.7 Efficient Powering at CERN: Past, Present and Future

Corresponding Authors: K. Kahle

European Organization for Nuclear Research
- CERN, Switzerland

As part of CERN's commitment to managing energy responsibly, the Organization obtained the ISO 50001 certification for energy management in 2023. This international standard requires systems and processes to be in place to continuously improve energy performance. With this in mind, improving energy efficiency is integrated into the design and operation of CERN's accelerators and experimental areas. This talk summarises past and present efforts at all levels (organisational, system and equipment) to improve energy efficiency. Looking to the future, studies are ongoing to develop the efficient powering for future accelerator designs.

Lecturer biography: K. Kahle

Karsten Kahle is head of the High-Power Converter section at CERN, responsible for the design, installation, operation and maintenance of CERN's large power converter systems between 10 MW and 150 MW.

Karsten studied electrical engineering in Berlin and Manchester, and his fields of expertise are high-power systems, electrical networks, power quality and Static Var Compensators.

5.3 Parallel Session 2: Life cycle evaluation

5.3.1 Introduction: Overview Environmental Footprint and Life Cycle Assessments

Corresponding Authors: D. Völker

Deutsches Elektronen-Synchrotron DESY, Germany

Footprints, LCAs or environmental impact studies help to understand the impact science has on global challenges like climate change and others. They help to identify the fields for improvement and make progress countable. Is also help raising awareness amongst scientists and stirs more attention to better solution already in the design process of new and updated RIs.

Many evaluations have been conducted lately and there is a common understanding and motivation to develop these approaches further and to design science specific methodologies. So far, some evaluations look at everything - others focus on the big parts. Some look only at Co2 – others at all Greenhouse Gases and yet others take the whole environmental footprint into account or even sustainability measures outside of the ecological realm. And everybody is using different databases and sources for the respective conversion factors.

This session is dedicated to give an overview of what has been done so far and analyses the approaches in terms of methodology, scope, parameters and databases used in order to stir the discussion on and development of metrics and processes to facilitate the evaluation of proposals and allow a fair comparison between them.

Lecturer biography: D. Völker

Denise Völker (*1973) has been active in the environmental and sustainability business since 1999. She is not only an engineer but also holds a doctorate in political science. Her work for Greenpeace has taken her to the Amazon Basin and the depths of Siberia. She leads DESYs sustainability and energy management unit since 1999.

5.3.2 Life Cycle Assessment at CERN

Corresponding Authors: R. Losito

European Organization for Nuclear Research - CERN, Switzerland

CERN established a Sustainable Accelerators panel to address all the aspects of sustainability in future accelerators. The panel is used to share information about projects and technologies and in this way harmonise the approach to sustainability across the Organisation. One important aspect is the Lifecycle assessment of accelerator components and infrastructure. Lifecycle assessment is being introduced in the design process through two channels. For large projects, we rely on consultants to perform assessment of large infrastructures, such as the tunnels of CLIC and the FCC, but also the main components such as magnets and RF. On the other hand, we are introducing a systematic training for everyone at cern in order to raise awareness, and in particular designer can follow a specific training in order to be able to perform simple assessments on their own, in order to optimize their design from the beginning. In order to remain compatible with international standards, we started using OpenLCA with the ECOInvent databases, and follow the prescriptions of ISO 14040/14044 and specific standards if necessary (e.g. EN 17472 for civil engineering structures).

Lecturer biography: R. Losito

Roberto Losito graduated in Electronics engineering at the University Federico II in Naples and started his career at the Laboratoire de l'Accelerateur Lineaire in Orsay (now IJCLab). He arrived at CERN in 1995 and participated initially to the upgrade of the RadioFrequency (RF) systems for the injector complex to the LHC for the acceleration of the LHC beams, and then joined the Superconducting RF team in charge of designing and building the LHC SuperConducting RF cavities. After the installation of the cavities in LHC, he coordinated several projects for the design and construction of photoinjectors, mechatronic systems and of advanced control systems. As head of the Sources, Targets and Interactions group, he initiated a 150 MCHF project for the mitigation of radiation effects on Electronics in the LHC and created a group for robotic interventions at CERN. He was also head of the Engineering Department for five years, managing the Technical Infrastructure groups, shutdown coordination and the experimental areas of CERN, and is now advisor for R&D and Technology for the Future Circular Collider (FCC) and the Muon Collider Studies, and chair of the Sustainable Accelerators Panel at CERN.

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5.3.3 General Life cycle analysis in EU colliders - Working Group on "Sustainability Assessment of Accelerators"

Corresponding Authors: M. Titov[1], C. Bloise[2]

[1]CEA Saclay, France
[2]Istituto Nazionale di Fisica Nucleare, National Laboratories of Legnaro- INFN LNL, Italy

The European Laboratory Directors Group that coordinates European programme of accelerator R&D, took recently the decision to establish a working group on sustainability assessment of future accelerators. Working group mandate is to develop guidelines and a minimum set of key indicators pertaining to the methodology and scope of the reporting of sustainability aspects for future HEP projects. A panel of 15 people has been endorsed by LDG and is currently committed to preparing an input document for the Update of the European Strategy for Particle Physics, by Spring 2025. The working group includes representatives of the projects of future accelerators and experts on sustainability of large research infrastructures, involved in initiatives like CERN Sustainability Panel, IFAST, EAJADE, iSAS, STFC Sustainability Task Force, ESS on Green Facilities.

The talk is intended to summarize the current status and receive feedback on the initiative from the HEP community.

Lecturer biography: M. Titov

Maxim Titov was born on May 6, 1973 in Kyiv, Ukraine. He received his PhD in 2001, having carried out his research at DESY, Hamburg, Germany and completed his Habilitation in 2013 from University Pierre and Marie Curie (Paris VI), France. Today, he is a Director of Research at CEA Saclay, France. A nuclear and particle physics researcher for his more than 30-years carrier, Dr. Titov worked in both the development of advanced detector concepts and physics data analysis at collider experiments, inevitably within large international collaborations: HERA-B Experiment at DESY, Germany; D0 Experiment at FERMILAB, USA; ATLAS, CMS Experiments as well as RD51 and DRD1 Collaborations at CERN, Switzerland; and International Linear Collider Project

(ILC) in Japan. An important component of Dr. Titov experience includes management of large-scale international scientific collaborations and involvement into science-policy matters. He was the founding member and the Spokesperson (2007-2015, 2023) of the CERN-RD51 collaboration ("Development of Micro-Pattern Gaseous Detector Technologies (MPGD)". He was recently elected as the Spokesperson of the CERN-DRD1 ("Development of Gaseous Detectors Technologies") for the term 2024-2025. Since last year, Dr. Titov also serves as the Co-Chair of the Accelerator Panel on "Sustainability Assessment of Future Accelerators", being appointed by the European Laboratory Directors Group.

Lecturer biography: C. Bloise

Caterina Bloise is Director of Research at the Frascati Laboratory of the INFN, Italy, since January 2007. She graduated in physics at the Rome University, "La Sapienza" in 1984 with a thesis on particle detectors for large underground experiments. She worked on the design, installation and data reconstruction and analysis of the MACRO (Monopole, Astroparticle and Cosmic Ray Observatory) experiment at the Gran Sasso laboratory (1984-2004). In 1990 began elaborating the proposal for KLOE (KLong experiment) at the Frascati phi-factory. She developed the MonteCarlo for the experiment, worked on data reconstruction and to the procedures for the optimization of the integrated online-offline computer resources during data taking [2001-2002;2004-2006] and simulation campaigns. She became the INFN responsible of the experiment and the Frascati group leader in year 2005 (2005-2014) when established the analysis board of the experiment to coordinate the activity for data reconstruction, simulation, analysis with the study and the preparation of the detector upgrades for the second long data taking campaign (2015-2018). Italian Representative in P-ECFA from 2009-2014. During 2015-2018 served as member of the LHC committee (LHCC) at CERN when the progress of Phase-I upgrades were reviewed and the proposals for Phase-II scrutinized.
Since 2017 has collaborated to the preparatory phase of the Mu2e experiment at Fermilab, working to the construction and test of the CsI-crystal calorimeter and from 2023 serves as member of the Mu2e Executive Board. In 2024 has been appointed by the European Laboratory Directory Group as co-chair of the working group on the sustainability assessment of future accelerators.

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5.3.4 Sustainability Strategy for the Cool Copper Collider

Corresponding Authors: E. Nanni

Stanford Linear Accelerator Center – SLAC, USA

The Cool Copper Collider (C3) is a new concept for a Higgs Factory based on cryogenic-copper distributed-coupling accelerator technology that promises efficiency and high gradient. In this talk, we will discuss the ongoing sustainability studies for C3, which. will be operated at 250 and 550 GeV center-of-mass energy. We introduce several strategies to reduce the power needs for C3 without modifications in the ultimate physics reach. We also propose a metric to compare the carbon costs of Higgs factories, balancing physics reach, energy needs, and carbon footprint for both construction and operation, and compare C3 with other Higgs factory proposals – ILC, CLIC, FCC-ee and CEPC – within this framework. We conclude that the compact 8 km footprint and the possibility for cut-and-cover construction make C3 a compelling option for a sustainable Higgs factory. More broadly, the developed methodology serves as a starting point for evaluating and minimizing the environmental impact of future colliders without compromising their physics potential.

Lecturer biography: E. Nanni

Nanni received his B.S. in Electrical Engineering and Physics from Missouri University of Science and Technology in 2007. After graduating he worked for the NASA Marshall Space Flight Center developing non-destructive evaluation techniques for applications related to the US space program. He completed his PhD in Electrical Engineering from the Massachusetts Institute of Technology in 2013 where he worked on high-frequency high-power THz sources and the development of Nuclear Magnetic Resonance spectrometers using Dynamic Nuclear Polarization. His thesis was on the first photonic-band-gap gyrotron travelling wave amplifier which demonstrated record power and gain levels in the THz frequency band.

He completed his postdoc at MIT with a joint appointment in the Nuclear Reactor Lab and the Research Laboratory for Electronics at MIT where he demonstrated the first acceleration of electrons with optically generated THz pulses. He joined the Technology Innovation Directorate at SLAC in August of 2015 where he continues his work on high power, high-frequency vacuum electron devices; optical THz amplifiers; electron-beam dynamics; and advanced accelerator concepts.

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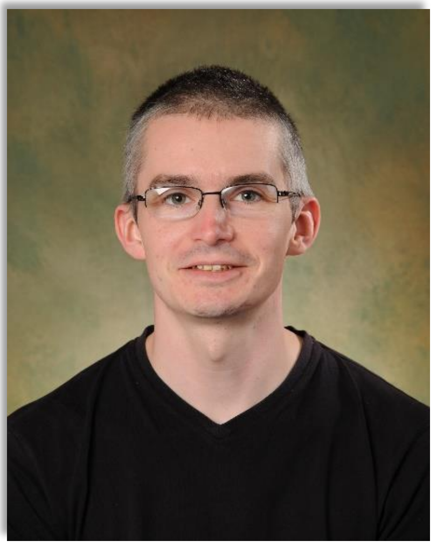
5.3.5 Accelerator Impact Report: RUEDI

Corresponding Authors: B. Shepherd

Science and Technology Facility Council - STFC UKRI, UK

STFC's Accelerator Science and Technology Centre (ASTeC) aims to be a world leader in the field of sustainable accelerators. We have instigated a Sustainable Accelerators Task Force to carry out R&D into sustainable technologies. This talk describes some of the work of the Task Force. We have produced a report looking at the carbon emissions in building and operating a particle accelerator, focusing on a small facility, RUEDI, which will be built in the UK in the next few years. The report highlights several areas to concentrate on in order to reduce manufacture and operating emissions, and we have developed a toolkit which can be used for future projects.

Lecturer biography: B. Shepherd



Ben Shepherd is the group leader of the Magnetics and Radiation Sources Group, and chairs ASTeC's Sustainable Accelerators Task Force. He has over 20 years of experience designing, building and testing novel magnetic systems for accelerators. He is passionate about sustainability and is keen to ensure that we build and operate future accelerators in the most efficient way possible.

5.3.6 Decreasing the footprint for a new SR facility (Bessy III)

Corresponding Authors: J. Völker

Helmholtz-Zentrum Berlin – HZR, Germany

HZB is developing a fourth-generation light source BESSY III, as successor source to BESSY II. Due to a complete redesign of the accelerator building on a green field and the accelerator itself, an attempt should be made to reduce the invested resources, as well as the initial and running carbon footprint of BESSYIII as much as possible. Here it is necessary to identify the parameters with the most impact and find ways to avoid or to reduce them, like the massive amount of concrete that can be reduce by an optimized floor plate design. Additionally, the running energy cost of accelerator components can be reduced by using dedicated amplifier and Permanent Magnets. In this presentation we will discuss the actual values for the project and new ideas to reduce them.

Lecturer biography: J. Völker

Jens Völker was born in 1984 in Berlin, Germany and studied physics @ Humbold Universtity Berlin from 2006 to 2012.

- PhD 2017 @ HZB in the context of beamline, diagnostics and magnet development.
- PostDoc with focus on normal conducting and superconducting magnets, as well as commissioning of bERLinPro.
- Since 2021 project leader for the development of Permanent Magnet based accelerator magnets at HZB in the context of BESSYII and especially for BESSYIII.

His main motivation in this topic is to combine high precision requirements for magnets and accelerator constructions for fourth generation light sources with sustainable aspects.

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5.3.7 Detailed Life cycle assessment for a power supply

Corresponding Authors: A. Klumpp

Deutsches Elektronen-Synchrotron DESY, Germany

A holistic view of the life cycle of a piece of equipment, a component or a project is an important tool to assess its sustainability aspect, to make decisions on feasibility and also to improve a design in terms of sustainability.

In the course of the planned PETRA IV upgrade of our light source PETRA III, a large part of the infrastructure, but above all the whole machine (magnets, RF technology and much more) will be renewed.

One of the most commonly used components is the power supply. Power supplies are indispensable for controlling the magnets, but also in other areas, and are almost like consumables. Due to the special requirements of PETRA IV, it was decided to use a specially developed device. The Sustainability Department has carried out a detailed life cycle analysis of this device to assess the costs and benefits of a comprehensive LCA, but also to identify development potential for the device.

The Life Cycle Assessment that we will be presenting considers the entire life cycle of all individual components, such as resistors, capacitors, cables, screws and much more, from cradle to grave.

Sustainability criteria such as GWP, but also soil acidification, human toxicity, ecotoxicity and eutrophication were analysed.

Lecturer biography:

Andrea Klumpp (*1975) studied physics at the University of Kaiserslautern and completed her PhD at the Centre for Optical Quantum Technologies in Hamburg in 2018.

She has been responsible for technology in the PETRA IV Project at DESY in the Sustainability Unit since 2022.

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5.4 Parallel Session 3: Energy and sustainability on future research projects

5.4.1 Energy management and sustainability aspects for FCC

Corresponding Authors: J-P. Burnet

European Organization for Nuclear Research - CERN, Switzerland

The Future Circular Collider is under study and its sustainable development is a major focus toward its approval. Sustainability is introduced at all levels, from renewable energy sources, and energy management, down to the design of accelerator system devices and technical infrastructures. The technology research and developments to reduce energy consumption will be highlighted. The potential usage of the fatal heat for the local communities will also be developed. The collaborative works performed in the framework of the European Project, Research Infrastructure 2.0, will demonstrate the commitment of the physics community toward sustainable research.

Lecturer biography: J-P. Burnet

Jean-Paul Burnet is a graduate of the Ecole Normale Supérieure Paris-Saclay and the Institut Polytechnique de Grenoble. In 1996, he joined CERN and worked on the development of the power converters of the Large Hadron Collider (LHC) and then worked in the field of energy conversion and power supplies for different particle accelerators. From 2009 to 2020, he was the head of the Power Converters Group, responsible for designing and operating the power systems for all CERN accelerators and experiments. In 2021, he became deputy head of the new Accelerator Systems department. Since 2023, he has joined the Future Circular Collider team where he is leading the Accelerator Technical Design.

5.4.2 Electron Ion Collider energy consumption and sustainability

Corresponding Authors: T. Vijaya Kumar

Brookhaven National Laboratory - BNL, USA

The Electron-Ion Collider (EIC) to be constructed at Brookhaven National Laboratory will likely be the only major collider project worldwide in the next two decades. The project will leverage the existing 4 km circumference Relativistic Heavy Ion Collider with the addition of 15 accelerator support buildings, power distribution, and mechanical cooling systems. When its three accelerator rings and supporting accelerator equipment are operational, the machine will utilize approximately 60 MW of electrical power and produce 50 MW of low-grade heat. A sustainability initiative was launched with the funding support of the Assisting Federal Facilities with Energy Conservation Technologies (AFFECT) Grant to research heat recovery from evaporative cooling loads. The potential redistribution of heat to the BNL site during the winter season will help offset emissions from the Central Steam Facility onsite. The new buildings are also being analyzed for compliance with the high-performance sustainable buildings guiding principles, as outlined by the Department of Energy. As a further commitment to Brookhaven Lab's sustainability goals, the EIC will also not use any fossil fuels and will aim for net-zero emissions. Constructing the EIC with the latest in energy efficient technologies and enabling and advancing energy recovery methods will provide a positive example for future large scientific facilities worldwide.

Lecturer biography: Thea Vijaya Kumar

Thea Vijaya Kumar is an Associate Staff Engineer for the Electron-Ion Collider project at Brookhaven National Laboratory (BNL) in Upton, NY – United States of America. She is part of the Infrastructure Division and is designing the Mechanical Cooling Systems for the accelerator and support equipment. She is responsible for providing cooling water, HVAC, and compressed air for the accelerator support equipment. As part of her responsibilities, Thea designed a hydraulic model of all EIC cooling systems to perform fluid dynamic network analysis and sensitivity analysis. Prior to being an engineer at BNL, Thea participated in the Department of Energy (DOE) Science Undergraduate Laboratory Internships (SULI) program for two years and then a Supplemental Undergraduate Research Program (SURP) in her third internship with BNL. Thea received her B.E. and M.S. in Mechanical Engineering and a minor in Business Management from Stony Brook University in 2021 and 2022, respectively. She also is an Engineer in Training (E.I.T.).

5.4.3 Plasma-based injector for PETRA IV

Corresponding Authors: A.Maier, P.Winkler

Deutsches Elektronen-Synchrotron DESY, Germany

Laser-plasma acceleration (LPA) will be at the core of next-generation accelerators. Advancing LPA core technolgies, including the development of high average power drive lasers, is an integral part of DESYs accelerator R&D. Recently, we started to investigate a plasma based injector as an alternative technology option for our future PETRA IV synchrotron. Here, we will discuss the basic concept of the plasma injector and update on its progress and future plans.

Lecturer biography: A. Maier

Andreas Maier is lead scientist at DESY heading a group of about 50 scientists, engineers, postdocs and students in the area of beam- and laser-driven plasma acceleration. He is currently leading the KALDERA project, which aims to achieve laser plasma acceleration at particularly high repetition rates to demonstrate reliable plasma electron beams through the application of active stabilisation. Deploying feedback systems will be key to mature plasma accelerator technology for future applications. Recently, the group started to investigate plasma acceleration as a technology option for an alternative electron beam injector into DESYs future PETRA IV synchrotron.

Lecturer biography: P. Winkler

I was leading the undulator radiation experiments at the LUX Laser plasma accelerator at DESY, which was build and is operated by Andi Maiers group. Since this year, I am a staff scientist in Andis group and hired as the technical coordinator for the PETRA IV plasma injector. Currently, we are working on a demonstrator experiment for a plasma injector energy compression beamline at LUX.

5.4.4 Power consumption at SLAC

Corresponding Authors: M. Gibbs

Stanford Linear Accelerator Center – SLAC, USA

SLAC National Accelerator Laboratory operates three one kilometer-long linear accelerators, and one synchrotron light source. These facilities, as well as the support infrastructure, use more than 30 MW of power when running simultaneously, and this figure is expected to grow as capabilities are added in the next few years. This talk will discuss the site's electrical power consumption, some of the challenges and constraints on our electrical power infrastructure, and a few projects (some successful and others unsuccessful) to reduce site power usage and utilize renewable energy sources.

Lecturer biography: M Gibbs

Matt Gibbs works in the Accelerator Operations and Safety Division at the SLAC National Accelerator Laboratory. He focuses on the coordination and planning of operation and maintenance of the LCLS accelerators.

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5.4.5 Addressing Energy Responsibility in Particle Accelerators: Insights from the KITTEN Research Platform

Corresponding Authors: G. De Carne, A-S. Müller, F. Abusaif, E. Bründermann, A. Santamaría-García, J. Gethmann, M. M. Zadeh

Karlsruher Institut für Technologie – KIT, Germany

Particle accelerators are known for their high energy consumption and dependence on stable energy supply. The KITTEN (KIT Test Center for Energy Efficiency and Network Stability) test center addresses these challenges by exploring and implementing innovative solutions to optimize energy use in accelerators.

This presentation highlights the latest advancements from our research at the Karlsruhe Institute of Technology. We will introduce a novel open-access monitoring board designed to track accelerator energy consumption, showcasing its transformative potential. Additionally, we will share preliminary results from our high-bandwidth measurement and communication infrastructure, crucial for developing digital twins of accelerators. Future research directions and upcoming projects will also be outlined.

Lecturer biography: G. De Carne

Giovanni De Carne received the B.Sc. and M.Sc. degrees in electrical engineering from the Polytechnic University of Bari, Italy, in 2011 and 2013, respectively, and the Ph.D. degree from the Chair of Power Electronics, Kiel University, Germany, in 2018.

He is currently W3 (full) professor at the Institute for Technical Physics at the Karlsruhe Institute of Technology, Karlsruhe, Germany, where he leads the “Real Time Systems for Energy Technologies” Group and he is the head of the "Power Hardware In the Loop Lab".

In 2020, Prof. De Carne has been awarded with the highly-competitive Helmholtz "Young Investigator Group" for the project "Hybrid Networks: a multi-modal design for the future energy system". He is leading the Horizon Europe Project “Research Facility 2.0”, targeting an improved energy efficiency and sustainability of particle accelerators.

He has authored/coauthored more than 90 peer-reviewed scientific papers. His research interests include power electronics integration in power systems, real time control of power grids, and power hardware in the loop.

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5.4.6 Design of detectors for future colliders (FCC)

Corresponding Authors: W. Riegler

European Organization for Nuclear Research - CERN, Switzerland

This talk will review aspects of energy consumption and carbon footprint of present detectors at the LHC and projections for detectors at future colliders.

Lecturer biography: W. Riegler

Werner Riegler is an experimental particle physicist at CERN, where he worked on the development, construction and operation of detectors at the Large Hadron Collider. Between 1994 and 2000 he did his Ph.D. and Post.Doc. within the ATLAS collaboration. He then joined the LHCb collaboration and in 2004 he joined the technical coordination team of the ALICE experiment. Since 2015 Werner also coordinates the detector and experiment studies for the future FCC-hh accelerator. Besides these activities Werner is very interested in fundametals of particle detection and he made numerous contributions to questions of detector simulation, signal theorems and principal limits of detector resolution.

5.4.7 Sustainability in Einstein Telescope

Corresponding Authors: M. Marsella

Università di Roma La Sapienza, Italy

The "Preliminary sustainability plan" is a key Milestone within the framework of the ET-PP Project, which is funded by the European Commission to support the ESFRI preparatory phase of the Einstein Telescope (ET) project. This presentation addresses in detail all the sustainability questions that will be included as pillars in the design of a large and durable future research infrastructure. Emphasis is placed on the relevant sustainability figures of merit in the different phases of the ET project for which sustainability will be a critical factor. Finally, the main goals of the ET sustainability plan are discussed.

Lecturer biography: M. Marsella

Maria Marsella is a Full Professor at the Faculty of Engineering of the University of Rome. She graduated in Physics and obtained a PhD in Geodesy and Surveying from the University of Bologna. She teaches and conducts research projects in the field of environmental and civil engineering, focusing on land monitoring, earth observation by remote sensing, and hazard assessment.

She has coordinated numerous research projects and participated in many international collaborations and technology transfer projects, as well as R&D projects in cooperation with public bodies, enterprises, and national and international research centers. She is involved in the Gravitational Wave scientific collaboration to support the civil and environmental engineering studies on the design of the Einstein Telescope (ET), the future European underground infrastructure.

Professor Marsella is the Leader of the Civil Engineering team in the Engineering Department of the ET Organization (ETO). She is also the coordinator of the Work Package on Sustainability strategy for ET in the ESFRI EU Preparatory Phase project for ET (ET-PP) and of the team on Sustainable Design within the ETIC research infrastructure, which is funded in Italy by the National Recovery and Resilience Plan (NRRP).

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5.5 Parallel Session 4: Energy management at research infrastructures

5.5.1 Key technologies for energy efficient and sustainable accelerators: a survey from shareholders

Corresponding Authors: F. Abusaif[1], G. De Carne[1], M. Gasthuber[2], Y. Kemp[2]

[1]Karlsruher Institut für Technologie – KIT, Germany
[2]Deutsches Elektronen-Synchrotron DESY, Germany

Over the past few years, the accelerators operations energy consumption has caught the attention of the facilities operators. The increasing energy cost and the higher attention to sustainability highlighted the importance of implementing and operating efficient and sustainable technologies and systems.

The Horizon Europe project Research Facility 2.0 (RF2.0) envisions a common work of academia, large particle accelerator facilities and high-tech industries towards sustainable and energy-efficient large research infrastructures.

In this work we present a summary of the first results of the RF2.0 project, based on some dedicated surveys on energy solutions and systems with high sustainability potential, that were sent to both the RF2.0 project partners as well as to worldwide accelerator's facilities. The summary introduces a set of high-level sustainability metrics developed for a performance assessment methodology for energy efficient solutions of research infrastructures as accelerators and data centers. These metrics consider not only the well-known factors of the energy consumption and energy costs, but they include also the impact of the raw material consumption and the carbon footprint during the accelerator's lifetime. In addition, inputs on components and systems with high energy saving potential prepared as a part of an assessment of existing materials, components and technologies for improving energy efficiency in accelerators will be discussed in conclusions.

Lecturer biography: F. Abusaif

After finishing her masters degree in Palestine, she moved to Germany and started there her PhD in Physics at RWTH Aachen University. She did her PhD work at Jülich Forschungszentrum on the hardware development of compact inductive beam position monitors.

She started her postdoctoral position at Karlsruhe Institute for Technology (KIT) and has been involved in different research groups and institutes. Her research activities and interests include superconductor magnet technologies, the hardware development of new insertion devices and accelerator technologies. Within the Research Facility 2.0, a Horizon Europe project towards sustainable infrastructures, she has a role of science and coordination.

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5.5.2 Optimized tunnel climatization for PETRA IV

Corresponding Authors: T. Warnecke

Deutsches Elektronen-Synchrotron DESY, Germany

DESY is upgrading its storage ring X-ray light source PETRA. The entire machine is being replaced, but the old tunnel will continue to be used and requires a stable ambient temperature. The optimize thermal design parameters, the energy consumption, as well as the related operation cost and co2-emissions, of the Petra IV's tunnel climatization have been investigated for different tunnel temperatures from 21 up to 30°C as well as different cooling water temperatures (25 and 30°C). Additionally, the influence of the extended shut down period in winter versus an extended shut down period in summer have been compared.

For the study, the different tunnel sectors have been modelled and simulated by using simple energy conservation laws. With the use of a sensitivity analysis of the ecological and economic parameters, an appropriate tunnel temperature has been chosen.

Lecturer biography: T. Warnecke

In 2021, Torben Warnecke received his MSc degree in Renewable Energy Systems in Mechanical Engineering. Since then, he is employed at DESY in the MKK3 department, specializing in HVAC (Heating, Ventilation, and Air Conditioning) systems and has been working as an assistant lecturer for a course on advanced control systems and optimization tools.

At DESY, he focuses on the design and operation of thermal energy systems, collaborating with planning offices, construction companies, and researchers. He has developed expertise in the conceptual design of energy systems using optimization tools.

Since 2023, Torben has been pursuing a PhD in Control and System Theory, concentrating on multilinear modelling and model-based control of multivalent energy systems. In collaboration with Fraunhofer ILES (Integration of Local Energy

Systems) and HAW Hamburg, he co-developed the MTI-Toolbox for MATLAB to simulate, analyze, and control multilinear systems.

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5.5.3 CO2 for detector cooling at CERN

Corresponding Authors: P. Petagna

European Organization for Nuclear Research - CERN, Switzerland

At the end of the third "long shut down" of the LHC (LS3) the ATLAS and CMS experiments will start operating the largest silicon-based detectors ever built, featuring a cumulated power dissipation in the order of 800 kW and the requirement of keeping several hundreds of m2 of silicon surface at temperatures well below 0 °C. The thermal management of such detectors will be ensured by a cascade of a transcritical R744 refrigeration cycle coupled to pumped loops circulating pure CO2 in the detector evaporators. This environmentally sustainable approach is the outcome of a collaboration between the EP and the EN departments of CERN, and marks a solid step towards the abandon of synthetic refrigerants and the transition to natural fluids. The talk will highlight the major technical points connected to this development and the opportunities it opens towards the general adoption of a more environmentally-aware approach to detector refrigeration in the future.

Lecturer biography: P. Petagna

Paolo Petagna received the MSc degree in Aeronautical Engineering with honours in 1989 from the University of Pisa with a thesis on numerical simulations of the aerodynamic interactions between two lifting surfaces.

From 1989 to 1995 Paolo was contract researcher at the Dipartimento di Ingegneria Aerospaziale (DIA) of the University of Pisa, and was Founder Partner of ARIA, an applied research spin-off of DIA. In this context, he complemented his scientific research on turbulent flows and mixing with a consulting activity on specific applied R&D problems c/o several industrial partners: Ferrari Auto, Brembo, Piaggio, ENEL, among others.

In 1996 Paolo joined CERN collaborating to the conception, design and construction of the Central Tracker of the CMS experiment, the largest full-silicon tracker ever built until then.

From 2009 he leads the Detector Cooling Project of the CERN Physics Department, and from 2020 he is also the Section Leader of the Fluidic Section in the Detector Technology Group, including approximately 80 members.

Paolo leads and actively collaborates in R&D activities related to physics detector design, both internal to CERN and within EC-funded international collaborations. Among the subject treated:

- CO2 boiling flows;
- optical fibre sensors;
- detector cooling systems;
- micro-fabricated cooling plates;
- dynamic simulation of complex systems, and
- natural refrigerants in sub- and super-critical state.

He is co-author of approximately 150 publications.

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5.5.4 Heat recovery at CERN, from a first multi MW case to a generalised approach

Corresponding Authors: S. Claudet

European Organization for Nuclear Research - CERN, Switzerland

Heat recovery systems are seen as energy efficient actions and can reduce gas consumption by close to 80%, at the price of significant investments for existing systems. Close to 10 years ago, two multi MW cases were identified on existing infrastructure at CERN. A first project of 10 MW with a local community was studied, confirmed viable and launched with a convention signed in 2019 and now ready to be tested. Since, a new computing center was being considered, for which a possibility to consider heat recovery was added as an incentive in the tendering process. With economic criteria aligned with sustainability considerations, refurbishments of the two existing heating plants are now ongoing with multi MW heat recovery loops. With all teams now familiar with corresponding technologies and experienced gained, the possibility to include heat recovery in future projects is now the baseline and would be implemented if a synergy is found with internal or external users for heat.

The projects, key parameters and evolution of approach will be presented.

Lecturer biography: S. Claudet

At CERN since 1991 with helium refrigeration activities for projects, operation and maintenance. Former deputy to cryogenic group leader.

For the last decade, in charge of HL-LHC Cryogenics workpackage, and appointed (part-time) Energy Coordinator for the Accelerator and Technology sector at CERN.

5.5.5 Fast measurement systems: how to increase the power quality in accelerator energy grids

Corresponding Authors: N. Sapountzoglou[1], R. Vasapollo[2]

[1]European Organization for Nuclear Research - CERN, Switzerland
[2]Zaphiro Technologies, Switzerland

The electrical distribution systems in particle accelerator facilities, typically use standard SCADA systems characterized by slower dynamics. To improve the observability and responsiveness of these networks, the integration of Phasor Measurement Units (PMUs) is proposed. These devices are capable of monitoring voltage and current fluctuations in real time, providing critical data that can be utilized either by the control room or directly by power electronics actuators. This allows for immediate decision-making and actions based on real-time data. As part of the RF2.0 Horizon Europe project, CERN together with Zaphiro plan to install 22 PMUs across CERN's electrical network, significantly enhancing its monitoring capabilities.

Lecturer biography: N. Sapountzoglou

Nikolaos Sapountzoglou received his Diploma in Electrical and Computer Engineering, specializing in Electrical Power Systems, from the Aristotle University of Thessaloniki (AUTH) in 2015. He earned his Ph.D. in fault diagnosis on low-voltage distribution grids from the Université Grenoble Alpes (UGA) in 2019. Following this, he obtained a MSc in Management in 2021 from Vrije Universiteit Brussel (VUB) while at the same time working as a Postdoctoral researcher at VUB, focusing on vehicle-to-grid applications. Nikolaos has experience in the Innovation Section of ENTSO-E and is currently with CERN, where he transitioned from Electrical Project Management to his current role of Energy Engineer in September.

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Lecturer biography: R. Vasapollo

Riccardo Vasapollo earned his Bachelor's degree in Energy Engineering from the University of Bologna in 2018 and his Master's degree in Energy Science and Technology from École Polytechnique Fédérale de Lausanne (EPFL) in 2022.

He is currently a Project Manager at Zaphiro Technologies, a Swiss company specializing in real-time monitoring systems using phasor measurement units. Previously, he worked as an R&D Engineer at Hitachi Energy and as a Consultant at Accenture. His areas of expertise include smart grid technologies, power system analysis, and optimization.

5.5.6 A perspective talk on decarbonisation of the cement industry

Corresponding Authors: R. van der Meer

The European Cement Association - CEMBUREAU, Belgium

Cement is an intermediate product used for concrete and finally constructions, houses, utilities, etc. The cement industry on global level is producing a significant amount of cement, with major countries like China and India. The European cement industry is relatively small with a production volume of about 175 Mtonnes/a.

Challenging in the production of cement is the emission of CO2 as Green House Gas. Because of the use of raw materials with consequently process emissions of CO2, cement industry is seen as a hard to abate sector regarding climate change. The European cement association CEMBUREAU released in May 2024 an update carbon neutrality roadmap that shows that a net zero cement industry in Europe in 2050 is possible. As a result, the concrete constructions have the potential to become carbon negative, meaning absorbing more CO2 during the lifetime than emitting during production phase.

Lecturer biography: R. van der Meer

Rob van der Meer is Industrial Policy Director at CEMBUREAU, the European cement association.

As chemical engineer he started his career in public services as responsible for environmental permitting with focus on emissions to the air, at the Provincie Limburg in the Netherlands.

In 1996 he started in the cement industry as process engineer in the Maastricht plant of ENCI. In 2004 he was appointed CO2 coordinator for HeidelbergCement in Heidelberg (Germany). In 2007 his position on climate change was combined with policy issues in his new function as Director EU Public Affairs of HeidelbergCement in Heidelberg (Germany). Early 2021 he started in CEMBUREAU.

Rob van der Meer graduated in 1991 as a chemical engineer from the Technical University Twente in the Netherlands.

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5.5.7 Helium management as part of sustainability

Corresponding Authors: F. Ferrand, S. Claudet, L. Delprat

European Organization for Nuclear Research - CERN, Switzerland

Helium is a critical resource for various industries and scientific research infrastructures, including at CERN for operation of cryogenic systems for the Large Hadron Collider, associated detectors, and Testing Facilities. Despite its abundance in the universe, helium is a finite resource on Earth, mainly extracted from natural gas reserves. The increasing demand and limited supply require effective helium management strategies to ensure its availability for future generations. This talk will give an overview of the current state of helium sourcing, share good practices for inventory preservation and limitation of losses especially in the context of large scientific equipment. Finally, it will share insights to integrate helium management good practices and evaluate helium footprint for future scientific studies and projects.

Lecturer biography: F. Ferrand

Frédéric Ferrand graduated as a mechanical engineer from the Ecole Nationale Supérieure des Arts et Métiers (ENSAM) in 2002. He is currently the section leader of the Maintenance & Logistics section within the CERN cryogenics group.

He started his career in the private sector as a reliability engineer in the railway industry and held various roles as a maintenance engineer and technical lead in the gas and chemical industry for almost 12 years. In 2016, he joined CERN and supervised the preparation and coordination of the maintenance and logistics activities for cryogenics infrastructures during the Long Shutdown 2 of the CERN accelerator complex. He manages the team responsible for maintenance and gas supply contracts, essential for the operation of CERN's cryogenics systems, including the Large Hadron Collider (LHC) and its associated infrastructure.

5.5.8 FlexRICAN EU Project: Flexibility for Research Infrastructures for global CArbon Neutrality

Corresponding Authors: S. Ücer

European Spallation Source – ESS, Sweden

The FlexRICAN project, which started in March 2024, brings together three landmark ESFRI infrastructures that have different usages of energy: the European Spallation Source ERIC (ESS) in Sweden, the Extreme Light Infrastructure ERIC (ELI), with two running facilities (Czech Republic and Hungary) and the European Magnetic Field Laboratory AISBL (EMFL), with facilities in Grenoble and Nijmegen for DC fields and Dresden and Toulouse for pulsed fields (CNRS, SRU, HZDR). The RI's and partners involved in FlexRICAN unite their strengths to optimize their ongoing and future energy projects. They are to demonstrate that the RIs, as electro-intensive actors, are at a good scale to develop a global energetic approach to delivering services to the European electrical grid through optimized energy flexibility and to local heating networks by developing Waste Heat Recovery projects. Developing renewable energy capacity production and managing these developments in an integrated way thanks to energy-oriented modelization integrating RIs user communities and the new stakeholders appears like a promising solution.

Lecturer biography: S. Ücer

Serkan holds a master's degree from Middle East Technical University and a PhD from TOBB Economy and Technology University both in the Computer Sciences domain. His current research interests are in artificial intelligence and explainable machine learning fields. He currently works as the Grants Team Leader at European Spallation Source ERIC, developing research proposals and managing grants with his team.

6. Friday, 27 September

6.1 Plenary Session 5

6.1.1 Energy Storage: an alternative to increase reliability in power systems and facilities

Corresponding Authors: M. Lafoz

Centro de Investigaciones, Energía, Medioambiente y Tecnología - CIEMAT, Spain

The development of energy storage technologies alongside the mechanisms and tools to foster their integration in the electric power systems, stands as one of the key topics in the evolution of energy systems. plays a crucial role not only at the electric grid level, ensuring system stability and energy management, but also at the facility level (behind the meter), offering benefits such as reduced dependence on energy suppliers, backup power provision during outages, minimized power infrastructure, and potential savings on energy bills.

Scientific infrastructures with high electric power demands serve as compelling case studies where the incorporation of energy storage solutions can enhance the reliability and sustainability of power consumption schemes to support research activities. The forthcoming presentation will delve into various application scenarios within scientific facilities, showcasing both implemented technical solutions for ongoing experiments and those poised for feasibility in other contexts.

During the presentation, a range of energy storage technologies will be discussed, including batteries, supercapacitors, flywheels, and SMES (Superconducting Magnetic Energy Storage). Special emphasis will be placed on the utilization of hybrid energy storage systems as an alternative where the combination of various technologies brings added value to the storage solution.

Lecturer biography: M. Lafoz

Responsible of the Unit of Electric Drives at CIEMAT

Resarch activities: Use of electric drives in electric generation based on renewable energies, energy storage, grid integration and advances technologies for sustainable transportation.

6.1.2 To be defined

Corresponding Authors: L. Cano

Ministerio para la Transición Ecológica y el Reto Demográfico

To be done.

Lecturer biography: L. Cano

Deputy Assistant Director
SG for Energy Foresight and Statistics
Secretary of State for Energy.
Ministry for the Ecological Transition and the Demographic Challenge

7. Sponsors

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The annual production comes to a proximal 10 000 units, which are mounted and shipped from our facility in Kungens Kurva south of Stockholm, Sweden. A clear trend towards more sophisticated and elaborate models can be discerned.

Eletta Flow is certified according to ISO 9001 and ISO 14001 and manufactures Flow Monitors and Meters within three main groups:

- Flow Meters and Flow Monitors based on the differential pressure principle equipped with an orifice-plate.
- Flow Switches with variable area.
- Flow Switches of Paddle type.

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ineustar Asociación Española de la Industria de la Ciencia	The Spanish Association of the Science Industry, INEUSTAR, is a non-profit, private association comprised of Spanish companies that work with organizations dedicated to the conception, design, construction, operation, and maintenance of scientific facilities and instruments in any field. Its purpose is to contribute to the advancement of science and technology and to strengthen innovation. Its scope of action covers the entire territory of the State, and its working philosophy is that of network collaboration among companies, research centers, universities, and support organizations and institutions. Its horizon and working objectives encompass all scientific facility projects and programs worldwide, particularly those in which Spain participates with specific contributions.
uc3m | Universidad Carlos III de Madrid	The Universidad Carlos III de Madrid, often referred to as UC3M, is a prestigious public university located in the vibrant city of Madrid, Spain. Established in 1989, UC3M has quickly risen to prominence for its commitment to academic excellence and innovative research across various fields. Known for its modern campuses, diverse student body, and strong international presence, UC3M offers a wide range of undergraduate and postgraduate programs that provide students with a world-class education and opportunities for personal and professional growth. With its dedication to fostering creativity and critical thinking, UC3M continues to be a leading institution in Spain's higher education landscape and a global hub for intellectual exploration.

8. Notes

Notes