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Impact of Climate Change on Energy System and Technology Choices (Keynote speech)

Global climate change has shaken up our energy and economic systems. The fossil fuels, which helped us through the last century, starting with coal and followed by oil and gas have led to accumulation of 1500 billion tons of CO2 in the atmosphere and disturbed the earth’s ecosystem balance significantly. It includes hydro cycle, temperature rise, oceans warming and hence ocean currents, disturbances in forests, arctic and antarctic ecosystems, mountain systems and also human habitats. Thus, transition to renewable energy has become imperative. However, sun, wind, hydro power are relatively low energy density energy sources compared to fossil fuels and nuclear power which can give us high density source to reach 600 C degrees and beyond, needed for generating high voltage electricity in a continuous manner so as to ensure 24 hour reliability. It is also indispensable for manufacturing steel, aluminum, cement, chemicals, fertilisers etc. Moreover, lightweight energy carriers such as liquid and gaseous fuels are needed to run cars, trains, ships and planes. The fossil fuels provided a high intensity energy source to produce electricity in a predictable manner and meet our fluctuating demand throughout the 24 hours. as needed. On the other hand, solar, wind and hydro energy are low density, unpredictable and intermittent energy sources. Yet, through ingenious ways, it is possible to combine technologies such as solar, wind, hydro, batteries, nuclear, pumped hydro and hydrogen as carriers of energy and digital technologies to ensure the same services and functions. This is the challenge that we have to meet as we chart out a new course, taking net zero emissions pathway. The lecture will cover the techno socio economic challenges associated with this transition.

Tackling the hidden costs of computational science: GREENER principles for environmentally sustainable research

From genetic studies and astrophysics simulations to AI, scientific computing has enabled amazing discoveries and there is no doubt it will continue to do so. However, the corresponding environmental impact is a growing concern in light of the urgency of the climate crisis, so what can we all do about it? Tackling this issue and making it easier for scientists to engage with sustainable computing is what motivated the Green Algorithms project. Through the prism of the GREENER principles for environmentally sustainable science, we will discuss what we learned along the way, how to estimate the impact of our work and what levers scientists and institutions have to make their research more sustainable. We will also debate what hurdles exist and what is still needed moving forward.

ARUP Life Cycle Assessment of the tunnelling of CLIC and ILC

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The Climate Emergency: can Particle Physics ever be sustainable?

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We live in a climate emergency and consequently all countries are putting in place measures to reduce their carbon emissions in order to reach a so-called “net zero emissions” by 2050. All aspects of economic life will be affected by such measures, including particle physics research. I will present some examples of sources of carbon emissions within the field of particle physics. This will include emissions associated with building and running accelerators, detector operations, high-performance computing and activities associated with our research life like travel. I will also present solutions being developed for addressing this in the near and long term as well as recommendations for the field.

Invited Talks / 6

On the environmental footprint of supercharged science

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Since the dawn of human social organization, the practice of science and engineering has been the primary defense against the forces of Nature that has allowed for the progress of civilizations. Yet the same progress has allowed for the unchecked growth of the burden on natural resources and the destabilization of the fragile balance on which the continuation of living forms, as we know them today, depends. Climate change is a direct consequence of the choices we have made over several millennia and, especially, the era past the industrial revolution. To attenuate the existential threat that climate change poses to our society a paradigm shift is necessary in the way we do science and the core objectives that we aspire for from its practice. We will discuss how supercharged science can be better optimized to mitigate climate change rather than be a determinant of climate change.

Invited Talks / 8

Overview on the sustainability of future accelerators

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Future accelerators must be assessed for sustainability during their life cycle, including construction, operation, and decommissioning, to meet the global goal of carbon neutrality by 2050. Accelerator scientists should strive to achieve performance with less electric power in the optical design phase of accelerators, and to improve power efficiency during the design and manufacture of accelerator components. Furthermore, we should understand CO2 emissions during the manufacturing of concrete, steel frame, and reinforcing bars, which are the main causes of CO2 emissions during construction, and cooperate in efforts with industries to reduce these emissions. The main source of CO2 emissions during accelerator operation is the electricity generated in the region where the accelerator is located. Therefore, we should understand the power composition of the region and ensure that accelerator operations are powered by “green (sustainable) power”. The low-grade waste heat emitted from accelerators should also be recovered as much as possible and returned to society. In addition, to reduce CO2 emissions in the entire region where the accelerator is located, efforts should be made to increase CO2 absorption throughout the agriculture, forestry, fisheries, and livestock industries, as well as to increase long-term CO2 fixation by incorporating more wooden structures in local housing and large public buildings, including accelerator-related facilities. As described above, there are not only issues that accelerator researchers should address, but also many items that can
be accomplished in cooperation with communities and companies where accelerators are located. I will discuss these items that should be addressed in these various areas.

Invited Talks / 17

**Sustainable Accelerator R&D in the UK (Contribution from the IOP PABG)**

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**The psychology of Climate Change**