CAETS 2021: THE FUTURE OF ENERGY - BUENOS AIRES, SEPTEMBER 21-23, 2021
SUMMARY

This document aims at offering a few **highlights** of three days of stimulating and enriching presentations and discussions of CAETS 2021, in full awareness that they may not be sufficiently comprehensive.

The **Opening Plenary** - on Energy and Global Warming - featured Fatih Birol, Thelma Krug and David Walt. Among others, their presentations left us the following messages:

- There are abundant energy resources but also big challenges. The target is to grow our economies while simultaneously reducing carbon emissions, taking into account diverse national and local circumstances.
- The global climate crisis and energy challenges - as well as increasing governmental commitments - set the scene for the International Energy Agency (IEA) to publish - last May - a "road map" to reach Net Zero Emissions by 2050. The viewpoint of the IEA is that this target is feasible, but faces a narrow path.
- The emissions reduction process is conceived as a 3-step process. Firstly, the next 10 years will strongly depend on the use of existing technologies, such as solar, wind, electric mobility, nuclear, hydro, and energy efficiency improvements. Second, an accelerated development of those technologies to be deployed after 2030 - such as hydrogen, Carbon Capture and Storage (CCS), or Small Modular Reactors (SMRs) for nuclear power generation, among others – will be required. Thirdly, a gradual but steady reduction in fossil fuels emissions - between 2021 and 2050 - is key.
- The cumulative emissions of the last 100 years pose a moral obligation for the developed countries to facilitate and finance clean energy use in developing countries. International collaboration among countries is "a must", and COP 26 (the Conference of the Parties) - that will convene in Glasgow, in November - needs to send strong signals to investors regarding the imperative of greater involvement in clean energy development.
- Based on the work of the International Panel on Climate Change (IPCC), a detailed analysis of the recent evolution of Greenhouse Gas (GHG) emissions, as well as climate change adaptation and mitigation plans and actions, were reviewed. The impact of projected global temperature increases on future energy systems was also discussed.
- The Covid pandemic received special attention, with focus on the various engineering contributions that helped provide concrete solutions. The analysis covered the global development and manufacturing of vaccines; the importance of massive testing, data analytics and contact tracing; and the relationship between supply chains and geographic location.

Technical Session 1 - focused on New Trends in Energy Demand - featured Yves Bamberger, Andrea Heins, Chang Hwan Kim, Lachlan Blackhall and Seung Ill Moon. Among others, their presentations left us the following messages:

- Regarding energy demand and decarbonization, there is no limit in low carbon resources. Therefore, the challenge lies in how to decouple the growth in consumption from emissions. This raises issues

- such as the choice of the right indicators, the limits of focusing solely on efficiency on the demand side, and the combination of different vectors on the supply side.

- The use of the best available technologies - without awaiting the new ones - seems highly advisable.

- Energy efficiency and electrification are the two main drivers of de-carbonization of the buildings sector in the 2050 Net Zero Emissions scenarios. Key enablers include laws and regulations; financial and economic incentives for energy efficiency and zero emissions investments; labelling and public awareness campaigns to foster behavioral change; and increasing cooperation between governments, private sector and civil society.
- Concerning energy use for mobility, governments around the world have tightened CO2 emission regulations for new vehicle models by 4-5 % per year since 2015. As a result, the Electric Vehicles (EV) market is rapidly expanding, and so is the need for advanced battery technology. The development of low carbon footprint batteries is required for sustainable mobility.
- Grid edge technology is increasing with - and, in turn, promoting - the decentralization of electricity systems. In the case of Australia, it is expected that - by 2040 - its grid will be the most decentralized in the world, with close to 50% of total capacity installed "behind the meter" in customer premises. There is an increasing prevalence of local and community energy models and Virtual Power Plants (VPPs), alongside the rapid development of electric vehicle use. Customer preferences - and related social aspects - are key to the development of grid edge technologies.

- Regarding the South Korean experience, governmental plans target the coverage of 20% of power generation with renewables by 2030. The Green New Deal Policy comprises four dimensions: (i) energy supply (large-scale offshore wind power and solar photovoltaic plants); (ii) infrastructure (micro-grid and green hub stations for renewable energy, and a flexible grid); (iii) customer preferences (100% renewable electronics by 2050); and (iv) market reforms and development.

Technical Session 2 - that dealt with Nuclear Energy - featured Rafael Grossi, Xiangeng Zhao, Nudurupati Saibaba and Sol Pedre. Among others, their presentations left us the following messages:

- The viewpoint of the International Atomic Energy Agency (IAEA) is that we must act quickly to combat climate change. For this purpose, all low carbon energy sources are required. As the use of wind and solar energy increases, nuclear should gradually replace thermal power generation that provides stability and flexibility to the electric systems. Currently, 51 reactors are under construction worldwide.
- Regarding the Chinese experience, the aim is to achieve carbon neutrality before 2060. By 2030, the use of renewables, natural gas and nuclear energy will increase, whereas the share of coal and oil will fall. In the next 5 years, China plans to build 6-8 nuclear reactors per year. Other nuclear applications - such as heating, sea water desalination and hydrogen production -, as well as new technologies - including SMRs, offshore floating platforms and low level radioactive waste disposal plants - will be developed.
- India has a 3-stage Nuclear Power Program based on thorium reserves. The first stage is focused on Pressurized Heavy-water Reactors (PHWR) using natural uranium, the second on

Fast Breeder Reactors (FBTR) using plutonium and thorium, and the third on Advanced Heavy-water Reactors (AHWR) based on thorium. The country currently has 18 PHWR reactors in operation and 5 under construction, and plans to reach installed 83 reactors by 2050.

- One of the presentations was devoted to CAREM, Argentina's Small Modular Reactor. This advanced reactor was completely designed and built in Argentina, including the local provision of 70% of its components, and is delivered to the final sites in modules. A prototype SMR with enriched uranium fuel is currently under construction (with an estimated work progress of approximately 60%).

Technical Session 3 - on Renewables - featured Ulrich Wagner, Atsuo Yamada, Masakazu Sugiyama, Eloy Alvarez Pelegri, Martín Pérez de Solay and Oscar Ferrreño. Among others, their presentations left us the following messages:

- In the context of the de-carbonization agenda, renewable energies play a pivotal role. This session aimed at providing an up-to-date view of the current and future development of the main renewable energy technologies, while also covering the supply requirements and prospects of certain minerals that will play a key role to support the transition towards cleaner energy systems.
- The use of complex energy systems models is key to optimize new technology selection and investment decision making, facilitate the accelerated integration of renewables into existing systems, and better project and manage CO2 emissions. Societal and political aspects are becoming increasingly important, posing new challenges to pre-existing modelling techniques.
- Even if energy storage is still in the "hunting era", the use of batteries has shown great progress. Demand for smart houses and electric vehicles (EVs) is of very large scale. The costs of secondary (or rechargeable) batteries still needs to be reduced significantly. Among existing technologies, the lithium-ion battery has experienced worldwide acceptance and success. Japan plays a leading role in the development of several categories of the so-called "next generation" batteries.
- The experience and plans of Japan, the European Union (EU) and Spain in the use and development of hydrogen was reviewed. Hydrogen is deemed to play a key role in the de-carbonization of energy systems, in the production, transportation, storage and utilization segments. Japan follows an ambitious development plan launched in 2017 and updated in 2021. The EU approved a Hydrogen Road Map in 2019, with a 2050 horizon. Spain is executing a 2021/2030 plan, within the EU framework. In all cases, cost reduction is the greatest challenge to ensure the successful adoption of hydrogen.
- Spain also has a long term plan for the development of biofuels, that should supply 10% of the energy requirements in the transportation sector by 2030.
- The Uruguayan experience provides an interesting case of massive contribution of wind and solar power generation. Examples of variability management and complementarity with hydroelectricity were shared.
- To broaden the context, the supply status and prospects of raw materials that are key for the development of renewables was also covered. With battery demand - especially, for electric vehicles - expected to increase by a factor of 13 in the next 10 years, the requirements for lithium, cobalt, nickel, manganese and phosphorus will experience a step change, with

foreseeable supply shortages in the short and medium term. This has resulted in commodity price increases and a quest for large capital commitments. South America has a key role to play, especially in lithium.

Technical Session 4 - focused on Oil and Gas - featured Bassam Fattouh, Frank Behrendt, Andy Calitz, Michael Stoppard, Roberto Aguilera, Franklin Orr and Martín Fraguío. Among others, their presentations left us the following messages:

- The convergence to carbon neutral economies will vary by - and depend on - different political, economic and social circumstances at both regional and national levels.
- International regulations should not discriminate against certain technologies or fuels, and allow these to compete. Oil and gas exporters and importers should develop burden-sharing mechanisms, and integrate them into multilateral and bilateral frameworks. Oil and gas exporting countries need to show leadership in emissions mitigation technologies.
- Natural gas will become the second pillar of de-carbonization alongside renewable power, mostly through coal replacement, facilitation of electric vehicle adoption, power generation backup for wind and solar, carbon capture and storage (CCS), hydrogen manufacturing and methane emissions reduction resulting from clean air initiatives. Early action - based on existing technologies - is key. Gas and hydrogen are destined to become infrastructure partners.
- Nature Based Solutions (NBS) can create significant synergies in emissions reductions and carbon sequestration, without increasing energy costs to end-users.
- On the technology side, the present status and prospects of Carbon Capture, Utilization and Storage (CCUS) methods, as well as of low-carbon transport options, was reviewed in depth.

Technical Session 5 - that dealt with Education on Engineering - featured Nilay Shah, Nuria Oliver, Eduardo Fracassi and engineering students from four Argentine universities. Among others, their presentations left us the following messages:

- Engineering is one of the key professions that shape our world. Thus, engineers have a great responsibility - but also a great opportunity - to exert a positive influence on society. This session provided examples of how new disciplines - such as systems thinking, artificial intelligence and dynamic modelling - are forming new generations of engineers that are better prepared to face the complexities of our times.
- We learned how engineers can work with policy makers to achieve emissions reduction targets, through a systems approach and a practical experience that converge to net zero.
- We heard how artificial intelligence is changing both what and how we teach, with immense potential to improve learning and provide better support to teachers and administrators.
- The experience of training students with the En Roads Climate Action Simulator showed the effectiveness of these tools in raising climate change awareness.
- The engineering students explained why they chose this discipline, and which actions they propose to mitigate climate change. Their ideas and enthusiasm are a source of inspiration and hope, regarding the social contribution our profession can make.

Our **Closing Plenary** - that mostly focused on a Latin American Energy Overview - featured Helen Plume, Alfonso Blanco, Oscar Vignart, Mário Menel da Cunha, José Luis Fernández Zayas and Federico Ferrés. Among others, their presentations left us the following messages:

- Latin America is a region with abundant and diverse energy resources, characterized by dynamic market growth.
- Oil, natural gas and/or hydroelectricity play a key role in energy supply in most Latin American countries. Nuclear energy has been developed only in a few cases. Wind and solar energy are rapidly expanding, and need to be deployed at large scale, posing some technical and financial challenges.
- National energy policies vary according to local circumstances and needs. Institutional and governmental capabilities are not always ideal, and will be key to manage the energy transition.
- Throughout the region, there is large potential for international investment and cooperation.

Please note that the three days of recorded sessions of CAETS 2021 will be available until October 31st on the event platform (www.caets2021.org), and - more permanently - on the website of the National Academy of Engineering of Argentina (www.acading.org.ar).