Position Paper

The important role of nuclear in a low-carbon world: the view of the European Nuclear Society's High Scientific Council

1. **Climate change is the most significant threat to our planet today**. We welcome the outcome of the COP21 where 174 countries and the European Union agreed to reduce their greenhouse gas (GHG) emissions so as to **keep a global temperature rise this century well below 2° C** above pre-industrial levels and **to pursue efforts to limit the temperature increase even further to 1.5° C**.

2. **We are concerned to see that Governments are still much too slow in implementing important measures that are needed to reach these vital targets**.

The commitments taken by countries through the Paris Agreement, the so-called Intended Nationally Determined Contributions will lead to a 3°C warming. The IPCC SR15 report [1] shows that a global 1.5°C warming may be reached by 2030-2050, with dire consequences. The report emphasizes that **Greenhouse Gas emissions need to be reduced with far more urgency than previously anticipated**: 1.5°C scenarios require **halving emissions by ~2030, and reaching net-zero by ~2050**..

We see no real evidence of change. **The global economy continues to grow faster than emissions intensity reduction**; CO_2 emissions from advanced economies even increased by 0.5% in 2018, for the first time in 5 years, reversing a declining trend.

3. In view of the stakes, **decarbonisation of the world economy must be a top priority**. Gigantic investments are urgently required to reach the COP21 goals. According to the IPCC report, the share of low-carbon energy investments should be increased from 2% to 2.8% of GDP and maintained at this level until 2050. In addition, 2.5% of world savings should be redirected towards low carbon infrastructures until 2035. **Delaying the investments will have dire long-term consequences that will be far more expensive to deal with.**

We recognize that channeling such huge investments to deliver the decarbonisation goals could have detrimental short-term impacts on other important societal goals; however these investments will generate new jobs and incentivize new technologies around the world.

4. **Choosing an economically sustainable, cost-efficient route towards decarbonation is therefore fundamental** to avoid unnecessary burdens for consumers and taxpayers. This calls for prioritisation of investments with highest GHG-reduction-to-cost ratio, for considering all available low-carbon technologies on the basis of their merits for reaching the goals. It also calls for financial mechanisms to reduce the risk premium of large-scale low-carbon investments which are currently all highly capital-intensive.

5. The world is behind schedule, and the more time it takes to fully engage the decarbonisation of the world economy, the higher the detrimental impacts and their costs to humanity will be. **There is no time to wait for and bet on unproven technology or hypothetical future technological**

breakthroughs (such as interseasonal electricity storage, or carbon capture and sequestration); procrastination must be brought to an end. We believe **the large-scale implementation of proven technology solutions should start now**.

6. **The first priority should be the decarbonisation of electricity generation**. It is **the easiest step** with **the highest initial GHG-reduction-to-cost ratio**, it is **accessible with existing technologies**, and it will **make the decarbonisation of other sectors easier.**

Electricity generation is currently dominated by fossil fuels with coal and gas responsible for 63% of total production. These fossil fuels contribute about 40% to the world's CO2 emissions. Low-carbon alternatives for electricity generation exist now in the form of nuclear power, hydroelectricity and other intermittent power generation that uses renewable solar and wind energies. Decarbonised electricity generation will enable the decarbonisation of other sectors such as, domestic heating, and transport via electrification of railways and the introduction of hybrid and electric vehicles.

7. Practically, where natural resources make new hydroelectric power schemes in limited supply like in most developed countries, **nuclear power and non-hydro renewable solar and wind power, are the only proven existing technologies available to decarbonise electricity generation**.

Today, nuclear power is the second largest source of low carbon electricity in the world after hydro. The world operable nuclear capacity surpassed 400 GWe for the first time in 2018 and 54 reactors are under construction worldwide in 18 countries. According to the IPCC, the median lifecycle emissions from nuclear power are 12g/kWh, as low as wind power. Nuclear powered electricity generation has avoided 60 Gt eq CO2 emissions since 1970, the equivalent of five years' worth of CO2 emissions from the world electricity sector. The European countries which have achieved significant reductions in emissions from electricity production (France, Sweden, Switzerland and the UK) are the ones with a large component of nuclear and / or hydroelectric power.

The IPCC report [1] noted that the "scalability and speed of scaling of nuclear plants have been high in many nations", highlighting the case of France, which successfully decarbonised much of its electricity mix in under 20 years by establishing a mix predominantly supplied by nuclear power. Recent work [2] concluded that, if many nations added nuclear capacity at the same rate per capita that France and Sweden achieved during their aggressive national expansion in the 70's-80's, the global share of fossil fuel electricity could be replaced in 25–35 years. Furthermore, nuclear power has the capability to load follow and thus complement the intermittent nature of wind and solar powered electricity generation, (as demonstrated by the French nuclear fleet over the last two decades and more recently by the German nuclear fleet).

In recent years, the use of solar PV and wind power for electricity generation have seen a significant steady increase in installed capacity and an impressive reduction in manufacturing and installation costs, owing to strong gouvernment support. Average production costs per MWh of wind and solar PV are still higher than of nuclear energy, but this gap no longer seems insurmountable.

8. **The required ambitious reduction targets in the carbon footprint of electricity production cannot be achieved in the required timeframe by the further deployment of these non-hydro renewable technologies alone**. We believe that **the only way to achieve these targets is through combining non-hydro renewables with nuclear technologies**, with the latter providing low-carbon dispatchable power to accommodate the variability of solar and wind power and security of energy supply.

The power generated by solar PV arrays and wind turbines is intermittent. Power output depends upon the availability of the sun's rays and the intensity of the wind and the availability of these natural resources does not always coincide with electricity demands. Matching generation and demand with a system with a high proportion of intermittent renewable energy generation requires complementary dispatchable power sources to provide reliable supplies during the hours or days when wind does not

blow or the sun does not shine. Hydro and nuclear power are the only existing low-carbon options available to perform these functions.

9. The challenge for electricity production is therefore **to deliver a cost-effective solution** that is capable of achieving the required carbon emission reduction in the required timeframe. To achieve a cost effective and reliable solution for electricity generation, there needs to be an appropriate balance between low-carbon dispatchable and intermittent installed generating capacity. **We believe that to achieve this balance, the penetration of intermittent renewable energy should not exceed 40-50% of a country's required installed generating capacity**. For those countries that do not have hydro-electric capacity, this means that nuclear power will be required to provide a substantial share of the electricity generation capacity.

A recent study by the Massachusetts Institute of Technology has shown that the cost of decarbonising electricity is much lower when the generation mix includes substantial amounts of nuclear power [3]. A new OECD/NEA study [4] shows with its ''cost minimization with low-cost renewables'' scenario, which takes quite ambitious assumptions as to the future decline in the costs of solar PV and wind power, that an optimum mixture of electricity generation technologies, realistic for a broad range of OECD countries, would be composed of a share of 30-40% solar PV and wind power generation technologies, and a larger share of 40%-60% provided by dispatchable low-carbon generation technologies such as nuclear and hydroelectric, or perhaps one day fossil-fuelled plants with carbon capture, utilization and storage (CCUS).

The main reason for limiting the share of intermittent renewable energy generation is that as the share of intermittent generation increases, there is an excessive increase in electric system costs. This is because intermittent generation necessitates the installation of additional dispatchable generation capacity to back-up when the intermittent generating installations are not generating. Large scale energy storage technologies are not available, and hence dispatchable generating technologies- whether nuclear or fossil fueled- will have lower load factors. Low load factors result in less efficient generation. As deeper reductions in electricity sector carbon emissions are sought, the cost of incremental power from renewables increases dramatically. It must be understood that, in addition to increased electricity system costs, the average value of solar PV (and wind to a lesser extent) declines significantly as their penetration level increases. Thus, the value of solar PV is almost halved when a penetration level of 12.5% is reached, and its deployment up to a penetration level of 17.5% will further half its market value.

As stated in the MIT study, at the levels of 'deep decarbonization' that have been widely discussed in international policy deliberations (for example a 2050 emissions target for the electric sector that is well below 50 gCO2/kWh compared to the current ~500 gCO2/kWh world average), including nuclear power in the mix of generating capacity options helps to minimize or constrain rising system costs and makes attaining stringent emissions goals more realistic.

The four model pathways limiting global warming to 1.5°C provided by the IPCC SR15 all rely on a significant increase of global nuclear power generation, by a factor between two to six.

We believe that it is important for policy makers and the wider public to be aware of the significant, intrinsic technical and economic difficulties of achieving ambitious carbon emission reduction objectives with variable renewable generation technologies alone.

10. Given the massive investments that will be required to realise this radical transformation, we believe that **it is of paramount importance to implement long-term frameworks that provide stability and confidence for investors in all low-carbon power technologies.**

For countries relying on deregulated wholesale markets, this calls in particular:

a) for decarbonisation policies to create a level playing field that allows all low-carbon generation technologies, including nuclear to compete on their merits. It should also be

recognised that nuclear power plays a significant role in ensuring role in contributing security of energy supply;

b) for avoiding the imposition of targets for the progressive increasing share of specific technologies (which would go against cost-efficiency); and
c) for implementing financial mechanisms to reduce the risk premium of large-scale low-carbon investments which are all capital-intensive.

11. **We are concerned** to observe that while the EU claims to be a world champion in the fight for climate change, some Member States are **giving priority to reducing the share of nuclear or phasing it out, rather than reducing GHG emissions, leading to stagnation of carbon emissions in these Member States**.

We are concerned to observe that in the US, the drive is for the early closure of nuclear plants and their planned replacement with gas fired plants.

We are also concerned to observe that investments are still being made in coal fired power plants in Africa, China and other parts of the world. It is disheartening to see countries abandoning high CO2 emission technologies at home only to see them promoting or selling coal fired plants abroad.

We recognize that nothing in life is risk-free and decarbonisation will require countries to make difficult choices. We believe that the risk to people and society associated with the use of nuclear power is low and manageable. However unrestricted climate change will present a considerable risk to mankind. As shown in the IPCC SR15 report, those who decide to phase out nuclear should be aware (and should be informed!) that they will have to accept, among other risks, the risks to biodiversity.

12. All credible and affordable scenarios for decarbonisation require a considerable increase in the global deployment of nuclear power. This will require not only considerable reduction in the cost of new nuclear power projects but also public acceptance. For society to accept the widespread use of nuclear power, **we believe that more needs to be done to raise public awareness of the potential risks and benefits of the technology.**

13. **We believe that technology alone will not solve the problem of climate change**. The decarbonisation that is necessary to prevent catastrophic climate change will require both political and societal change. All countries will need to recognize that the long-term preservation of our planet and hence mankind, will require urgent decisions and changes to our way of life. We believe that the increased deployment of nuclear power is the best way to minimize the impact on society. Achieving this will not be easy but it is a noble goal for all of us, especially politicians and international organizations.

References

[1] IPCC. (2018). Special Report on Global Warming of 1.5°C (SR15).

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[3] MIT. (2018) The Future of Nuclear Energy in a Carbon-Constrained World. An interdisciplinary MIT study. MIT *Future of* Series.

[4] NEA. (2019). The Costs of Decarbonisation: System Costs with High Shares of Nuclear and Renewables. NEA No. 7299