



Decarbonizing with nuclear?

The time to act was yesterday

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Energy transition

The energy transition will involve a significant expansion of renewable energy sources (RES). However, **the role of nuclear power is undeniable**, it will play a vital role in achieving the energy transition to net-zero emissions.

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According to the net-zero emission scenario (NZE) by the IEA, the global electricity generation will more than double between 2021 and 2050

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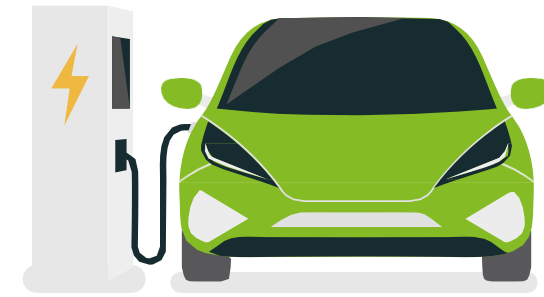
The share of electricity in the consumption is projected to increase from 20% in 2021 to almost 30% in 2030 and reach more than 50% in 2050

3

The share of renewables in electricity generation is expected to increase to more than 60% in 2030 and reaching nearly 90% in 2050

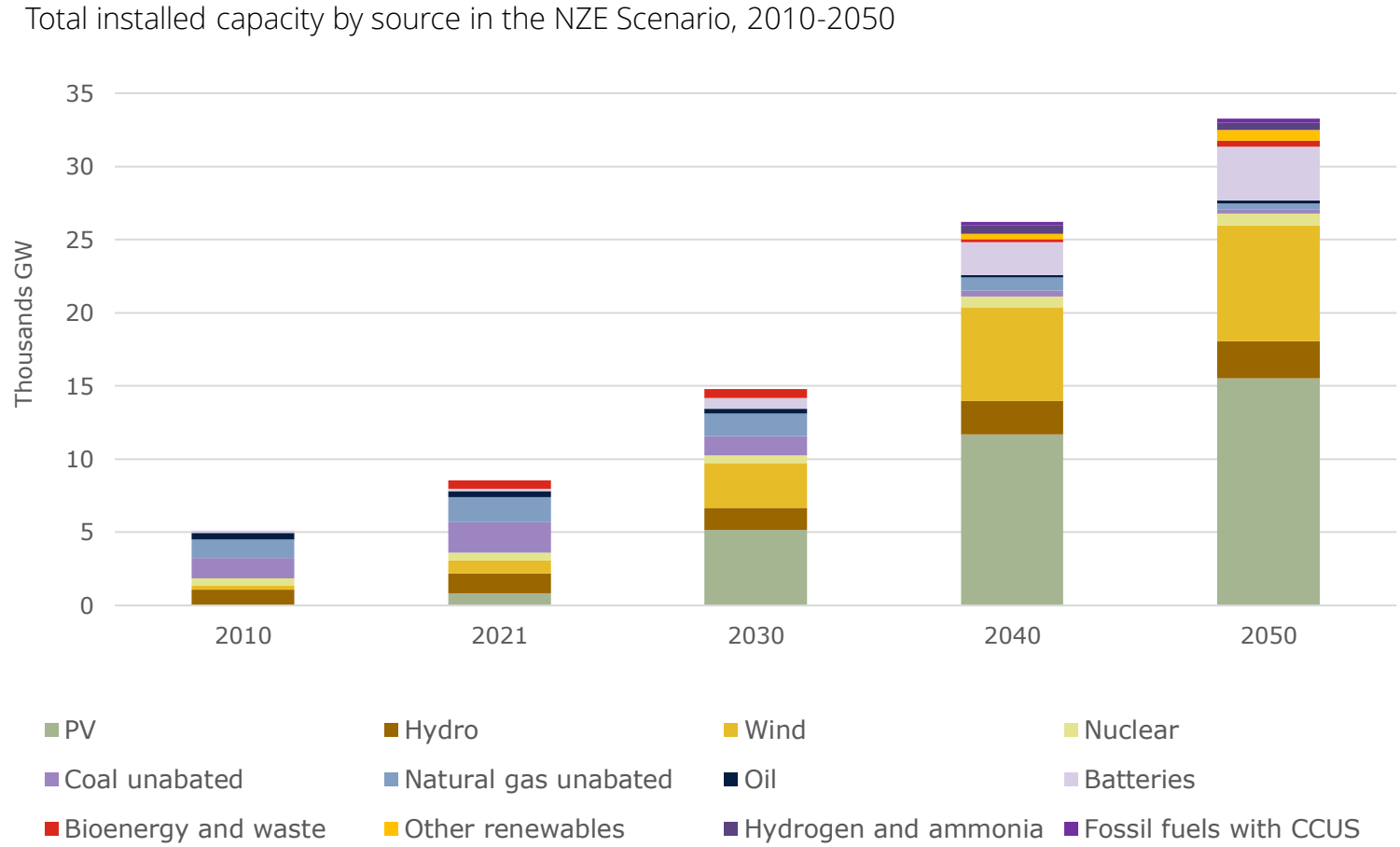
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The remaining share of 10% in the electricity generation will be covered by nuclear energy in the 2050 NZE scenario.



The projected installed capacity in 2050 should be based mainly on RES

It is expected that in 2050 RES will be the dominant source in terms of installed capacity, mainly photovoltaics and wind power. The installed capacity of these sources is projected to multiply several times. Nuclear energy will also play a role in decarbonization efforts, nuclear generated electricity is anticipated to more than double by 2050.

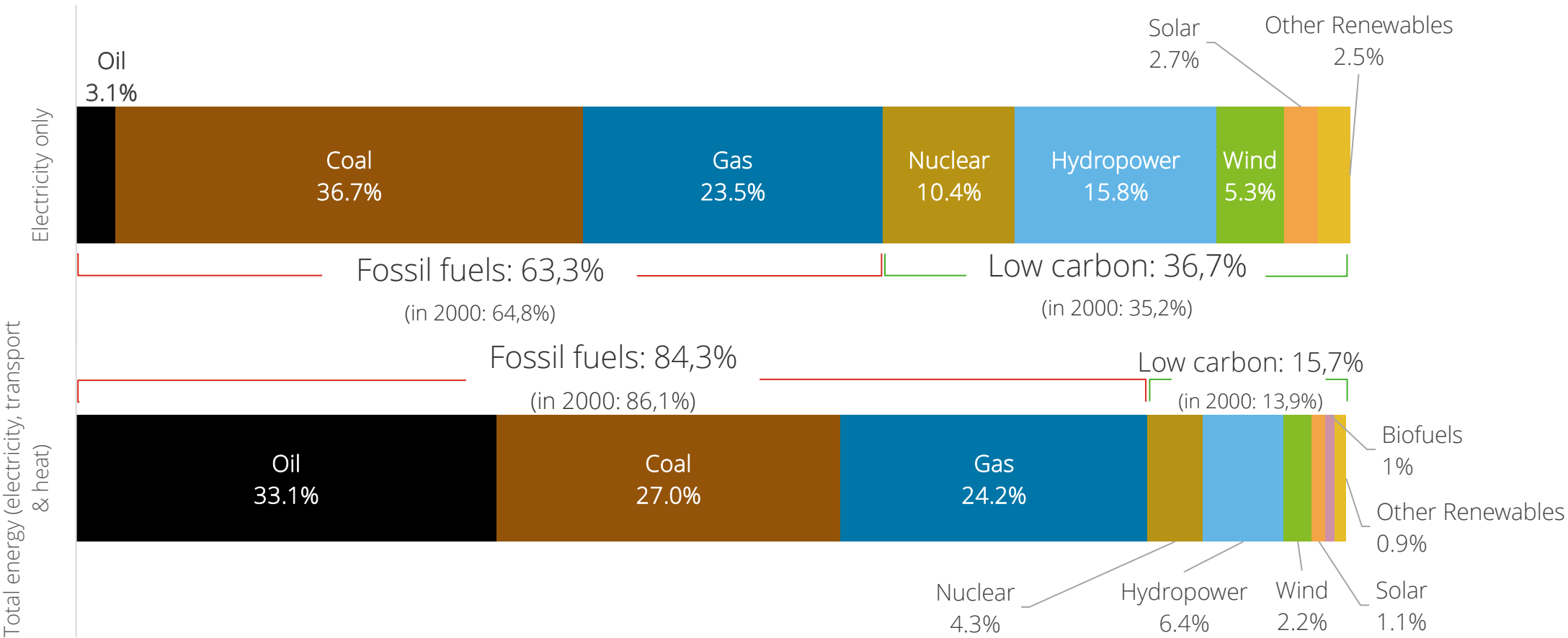


- The total capacity of RES is predicted to triple by 2030 and rise sevenfold to 2050.
- A major development of RES is needed to fulfil this scenario.
- The share of nuclear power in 2050 is projected to decrease to only 8%, the electricity generation will however double.
- Annually an average of 30 GW of new nuclear power plants (NPPs) capacity should be commissioned on the 2030s.

Fossil fuels accounted for more the 63% in electricity generation in 2020

Low carbon sources accounted for more than a third of global generated electricity in 2020. In the total energy production, the situation is worse, only about 15% is generated by low carbon sources.

The energy production in 2020



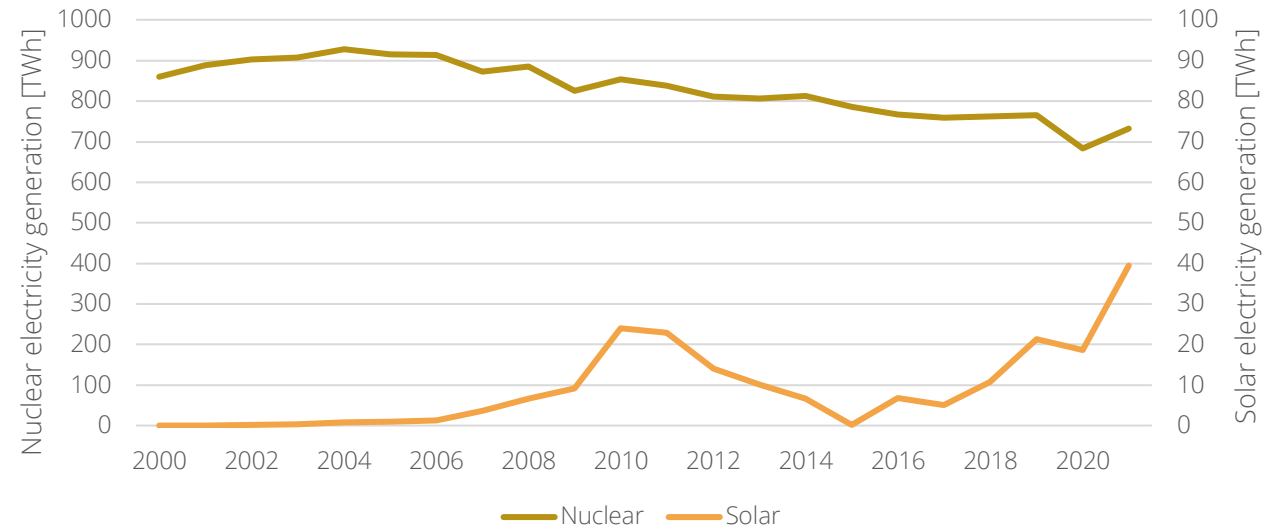
Source: Our World in Data

The EU's decarbonization plan relies on the cooperation of renewable sources and nuclear energy

The EU has made a firm commitment to achieve carbon neutrality by 2050. The primary emphasis will be on RES, supported by a complementary role for nuclear power, same path as presented by the EIA.

- The EU envisions that by 2050, renewable energy sources will account for 80% of the electricity generation.
- Nuclear power should provide about 15-16% of electricity generation, which in the terms of the future electricity mix corresponds to approximately 100 GW.
- Nuclear Alliance during their meeting proposed to increase the target to 150 GW in 2050.

Electricity production from nuclear and solar



Source: Ember



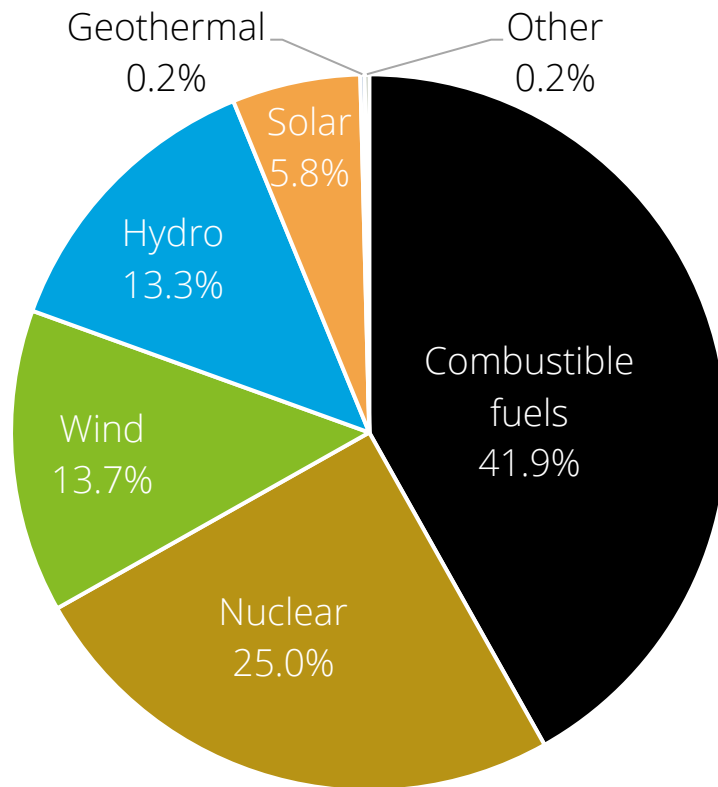
"By 2050, more than 80% of electricity will be coming from renewable energy sources (increasingly located offshore). Together with a nuclear power share of circa 15%, this will be the backbone of a carbon-free European power system."

European Commissioner for Energy, Ms. Kadri Simson, ENEF 2022

Nuclear power in 2021 accounted for more than 25% of electricity generated in the EU

In 2021, the EU's electricity production remained heavily reliant on combustible fuels, as nearly half of the generated electricity originated from these sources. Nuclear energy contributed to a quarter of the electricity generation, while the remainder was produced by renewable energy sources.

Net electricity generation in the EU, 2021



Source: Eurostat

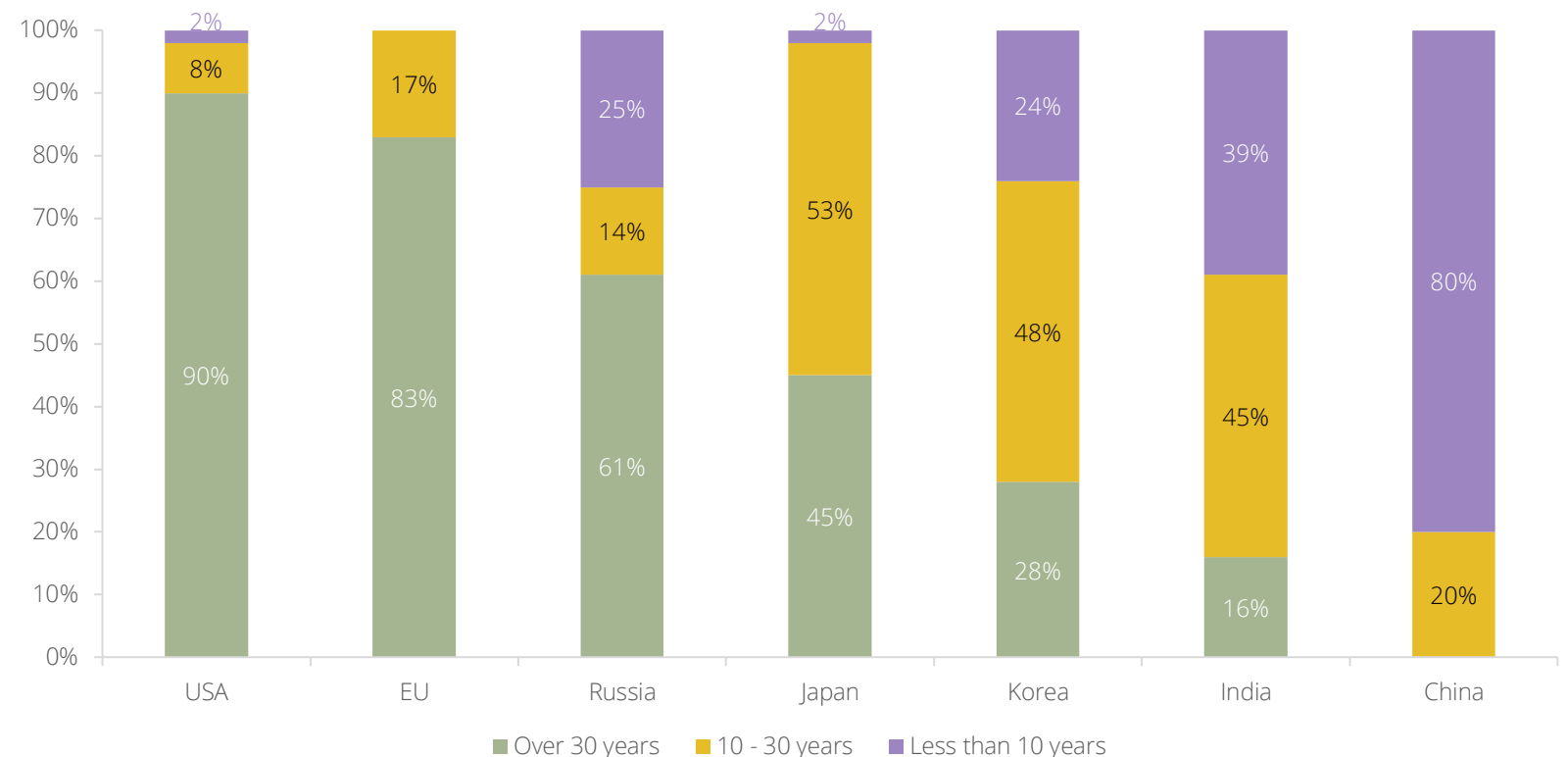
- In 2021, almost a half of the electricity generated in the EU was generated by combustible fuels (coal, natural gas, oil).
- Quarter of the electricity was generated by nuclear power, and the rest by RES.
- As of April 2023, there were 100 nuclear reactors operated in 13 Member States of the EU with the total capacity of about 100 GW.
- In the whole Europe there is 168 nuclear reactors operating with a total capacity of almost 150 GW.
- Nuclear power in total generated about 730 TWh of electricity in 2021.
- There are currently two reactors under construction in the EU (France and Slovakia), another four in Europe (the UK, Ukraine) plus four in Russia.

The average age of nuclear reactors in the world is increasing

Except for China and India, in the past 20 years, the nuclear power in the world was not developing, which resulted in ageing fleet. Four out of five reactors in the USA and the EU are more than 30 years old.

- The average age of nuclear power plants in the EU is 35 years, 83% of NPPs are more than 30 years old
- Long-term operation (LTO) programmes can ensure the operation beyond the original lifetime.
- Even if 60 years operation is assumed, the majority of the EU's NPPs will be shut down by 2050.
- Between the years 2040 and 2050, 76 reactors will be shut down.
- This results in the necessity to construct new NPPs as soon as possible.

Age profile of nuclear power capacity in selected regions, 2019

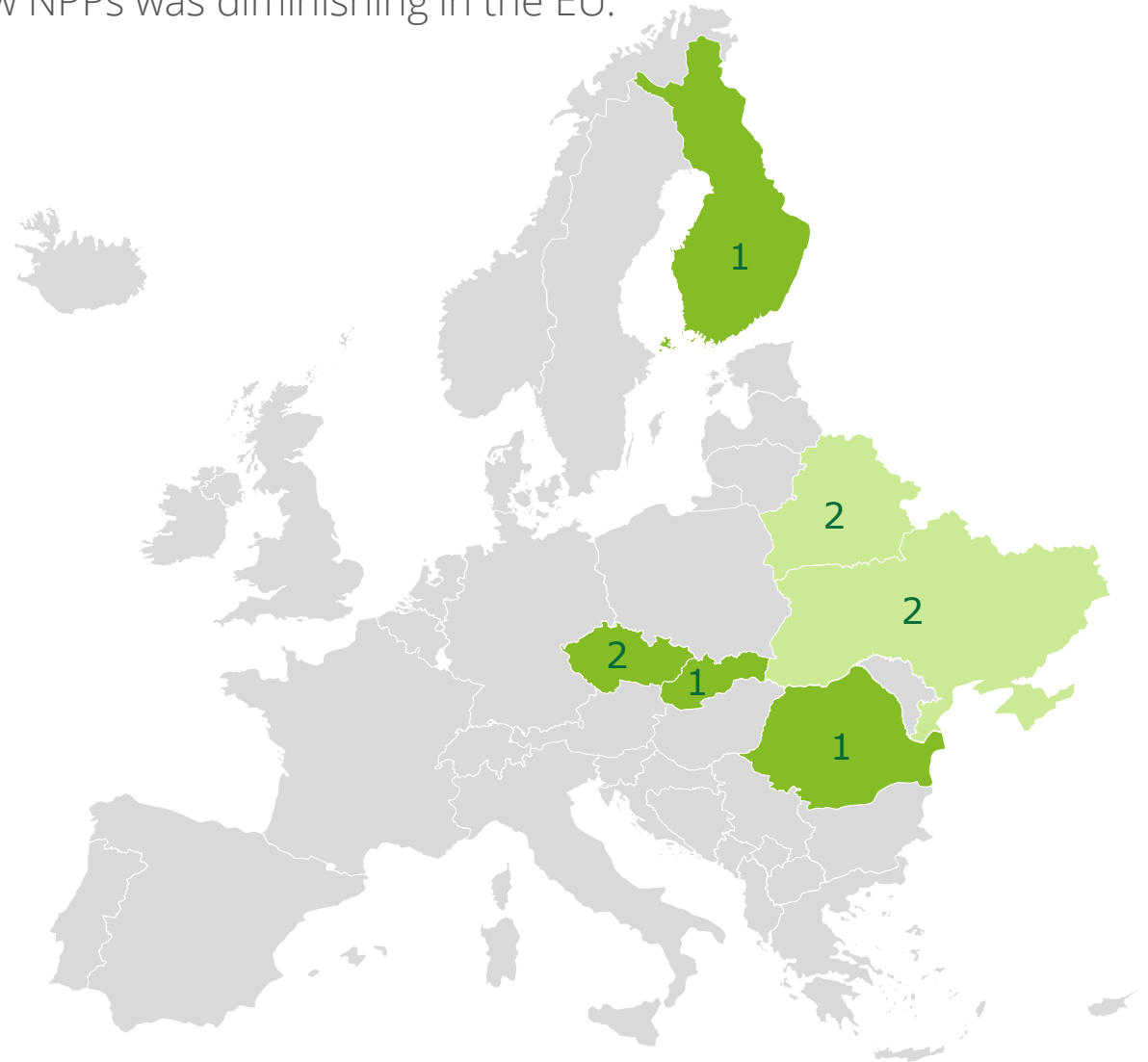


Source: Nuclear Power in a Clean Energy System, IEA, 2019

Nuclear power in Europe was in the state of conservation

Will the EU Member States be able to build the necessary nuclear capacity to substitute the shut down nuclear power plants by 2050? In the last 20 years the construction of new NPPs was diminishing in the EU.

- Since 2000 Europe has built only 9 reactors, within the EU only 5 reactors were built.
- Western Europe hasn't built a single reactor from the year 1999. French Flamanville will be the first commissioned NPP after 25 years (if commissioned in 2024).
- The current projects are battling with delays and cost overruns.
- The nuclear industry in Europe was struggling, several companies went bankrupt, changed field or were acquired by competitor or state.
- Substituting the shut down reactors in 27 years will certainly be challenging. **The action must be taken now.**



Technology readiness will be key for the successful substitution of ageing reactors

For a successful simultaneous and on time construction technology readiness, modularization and standardization of processes are needed. Currently the construction of NPPs is being done on a one-of-kind basis, resulting in cost overruns and delays.

Currently operating reactors
(undergoing LTO)



New reactors being built and
operated & SMRs



Advanced reactors



THE FOCUS AND SUPPORT MUST BE GIVEN TO ALL OF THEM

Ageing workforce is one of the major issue in nuclear sector.

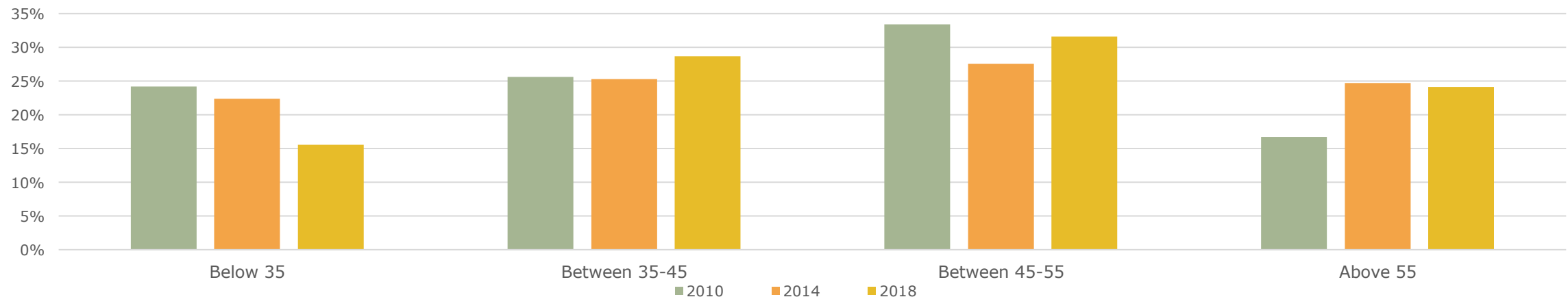
The nuclear sector is struggling with the outflow of nuclear experts. Plus, many of them are approaching the retirement age and young people are not choosing nuclear energy for their careers. Thus, the knowledge sharing is difficult, and the nuclear expertise is slowly vanishing.

Almost 25% of nuclear experts in 2018 were older than 55 years, nuclear experts younger than 35 years made up only approximately 15%. The number of nuclear experts younger than 35 years was decreasing from 2010 to 2018.

Educating a nuclear experts is a long and demanding process, if one assumes the secondary technical education, university and specific work training it can take up to 12 years. **This again underlines the necessity to act now.**

Nuclear sector lost its attractiveness, young people are choosing different sectors (EV, IT, space engineering). Combining retiring experts and lack of young professionals, is resulting in diminishing workforce.

Normalized age span for nuclear experts in different years



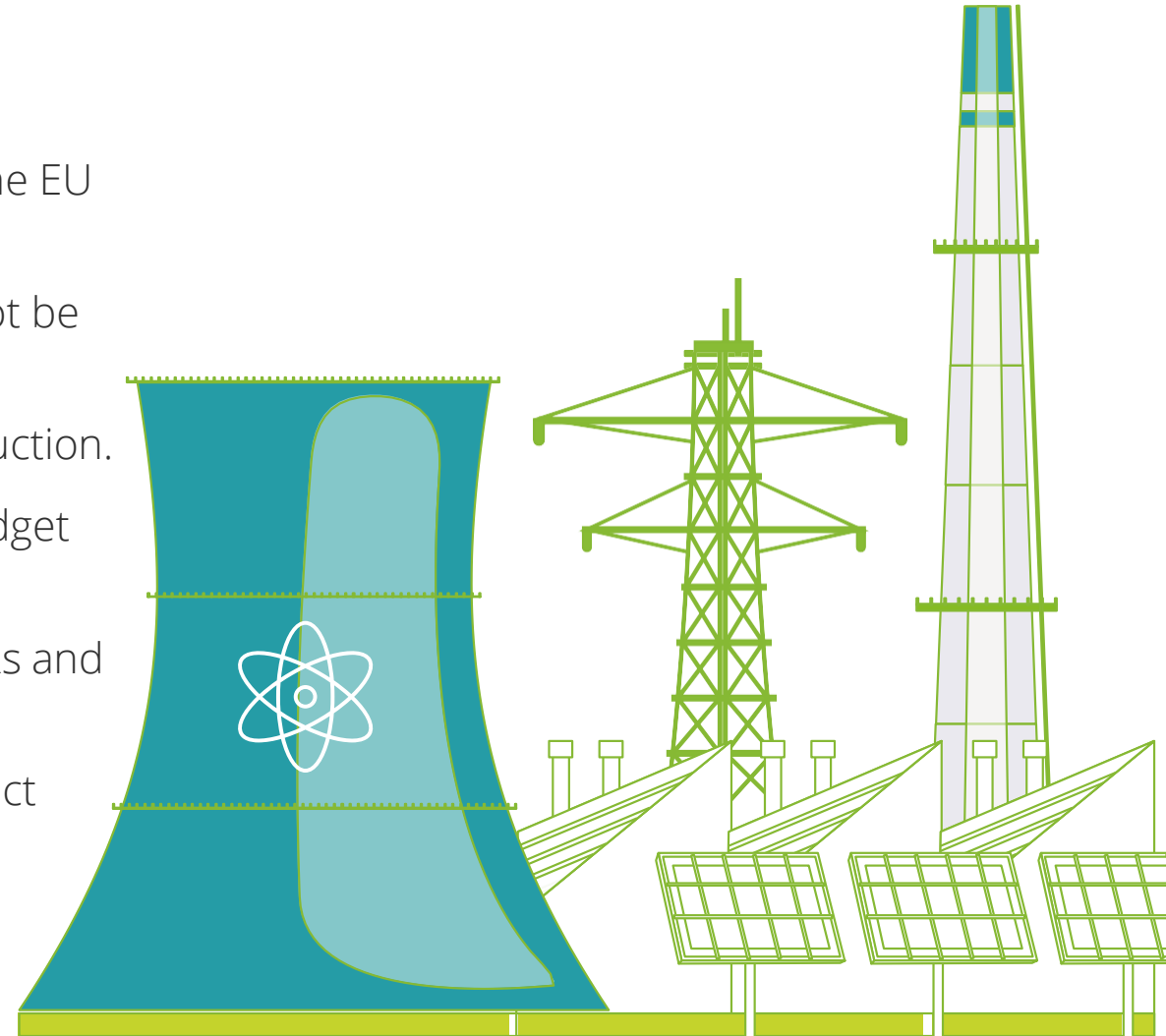
Source: Results of surveys of the Supply of and Demand for Nuclear Experts within the EU-28 Civil Nuclear Energy Sector, EHRO-N, 2019

How to address the issues that are accompanying the nuclear power these days?

Addressing the presented issues is not an easy task, it requires a strong collaboration of the main players in the nuclear sector: politicians, regulators, industry and academia.

What is needed:

- A clear political support and commitment to nuclear power on the EU and Member States level.
- A focused and well defined LTO program – without LTO it may not be possible to fulfil the climate objectives.
- Standardization is vital for achieving a simpler and faster construction.
- Better management of the project to ensure on-time and on-budget construction.
- The biggest focus must be put to the Gen III+ reactors, then SMRs and then advanced reactors.
- The cooperation between industry and academia is a key to attract new talents into nuclear sector.
- Research centers and research reactors should be supported.
- A knowledge management/sharing must become a top priority.



Deloitte is conducting a nuclear ecosystem study for the European Commission

The study is assessing the readiness of the nuclear ecosystem in the EU and whether it is fit for the EU's climate objectives.

- It's a year long study gathering stakeholders insights throughout the European nuclear ecosystem (in total 18 stakeholders).
- It is focusing on all aspects of nuclear ecosystem, from financing nuclear projects, through supply chain and human capacities, all the way to decommissioning and waste management.
- Part of the study is also economical analysis, assessing the benefits that nuclear power will bring to the EU market.
- The final study should be publicly available in 2024.



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