Nuclear for CLIMATE

Nuclear is part of the solution for fighting climate change


NUCLEAR IS A LOW CARBON ENERGY AVAILABLE NOW
#Nuclear4Climate
WE NEED ATOMS FOR THE FUTURE
#Nuclear4Climate
TO FIGHT CLIMATE CHANGE WE NEED TO ACT NOW
#Nuclear4Climate
WE NEED ALL LOW CARBON SOURCES OF ENERGY NOW
#Nuclear4Climate

Nuclear for Climate recognize the conclusions of Working Group I of the IPCC (Intergovernmental Panel on Climate Change), which states that human activity and greenhouse gas emissions are—with 95 percent certainty—the dominant cause of current climate change.

We welcome the Paris Agreement which was adopted at the 21st Conference of the Parties to the United Nations Framework Convention on Climate Change - widely known as COP 21 - in December 2015 and has entered into force 4th November, just before the COP22. We support its main aim to keep global temperature increases this century well below 2 degrees Celsius, and drive efforts to limit temperature increases to below 1.5 degrees Celsius, which the UNFCCC says is a "*significantly safer*" defense against the worst impacts of climate change.

We believe that **nuclear energy is a key part of the solution for limiting climate change,** and that:

1. **The world must increase the deployment of all low-carbon energy sources, including nuclear energy, if it is to limit climate change while still meeting development goals.**

The global challenge is immense: by 2050, according to the IPCC, 80 percent of global electricity will need to be produced with low-carbon technology (compared with 30 percent today) in order to contain climate change below 2°C[1]. During the same period, global demand for electricity should double to meet the basic needs of humanity in terms of population growth and development goals. Low-carbon electricity is expected to play a major role in decarbonizing other sectors[2]. This challenge requires the use of all low-carbon energy technologies: renewables, nuclear, and fossil fuels with carbon capture and sequestration, and underscores the need for large-scale low- or no-carbon electric generation options. The IPCC recognizes that "*The life cycle greenhouse gas emissions per kilowatt-hour from nuclear power plants are two orders of magnitude lower than those of fossil-fueled electricity generation and comparable to most renewables*"[3].

2. **The world needs to take urgent steps towards reducing greenhouse gas emissions. It cannot afford to wait for 'advanced technologies' or to prematurely close existing low carbon energy sources. Nuclear energy is a proven low-carbon option, available today.**

A significant part of the CO_2 released remains in the atmosphere for a long time and accumulates. To slow down the increase in concentration, we need to start reducing CO_2 emissions now. Energy transitions take decades to implement. To contain climate change, we need to make the most efficient use of the full range of low-carbon energy options available today while continuing to develop advanced technologies that can be implemented by 2050. Nuclear energy is one of the few currently available energy options that has already proven to be effective and can be implemented quickly and on a large scale. Today's nuclear power plants are the second largest source of low-carbon electricity globally. Countries which close nuclear plants prematurely instead of fossil plants (especially coal and lignite) are eating into the world's available carbon budget[4].

3. **All countries have the right to choose nuclear energy in order to reduce greenhouse gases while meeting their other energy objectives.**

Energy and climate experts agree, and multiple studies confirm, that pathways with the greatest probability for successfully decarbonizing the energy mix require the use of nuclear energy. Countries must meet climate goals and at the same time meet other energy policy objectives. Nuclear energy enables countries to reduce CO_2 emissions while helping to improve energy security, providing affordable electricity, and facilitating economic and industrial development.

We therefore call on decision-makers to ensure that the inalienable right of countries to choose nuclear energy in order to reduce greenhouse gas emissions while meeting their energy and development objectives is not prejudiced against in any way by the new UNFCCC protocols, specifically with regards to access to climate funding mechanisms such as Green Climate Funds.

[1] Fifth Assessment Report, IPCC (2013-2015) http://www.ipcc.ch/pdf/assessment-report/ar5/wg1/WG1AR5_ALL_FINAL.pdf

[2] Energy Technology Perspectives 2014, IEA
http://www.iea.org/publications/freepublications/publication/EnergyTechnologyPerspectives_ES.pdf

[3] Fifth Assessment Report, IPCC (2013-2015) https://www.ipcc.ch/pdf/assessment-report/ar5/wg3/ipcc_wg3_ar5_full.pdf

[4] The IPCC quantified the global "carbon budget," the amount of carbon dioxide emissions we can emit while still having a likely chance of limiting global temperature rise to 2 degrees Celsius above pre-industrial levels.

1. The world must increase the deployment of all low-carbon energy sources, including nuclear energy, if it is to limit climate change while still meeting development goals.

The challenge is immense: by 2050, 80 percent of electricity will need to be low-carbon[5].

That is in stark contrast to today's global electricity portfolio, 70 percent of which is comprised of technology that burns fossil fuels. Electricity production is the primary source of CO_2 emissions. Today's low-carbon energy accounts for only 30 percent of the electricity mix – primarily from hydro (approximately one-half) and nuclear energy (approximately one-third).

To reduce the dominant use of fossil fuels, significant efforts will be needed, especially given that the use of fossil fuels for electricity production is not currently declining. Since 2010, the growth of coal was actually higher than that of all non-fossil energy sources combined.[6]

Since 1990 (the reference year for the Kyoto Protocol), CO_2 emissions, far from decreasing, have actually continued to increase (+ 60 percent)[7]. If the electricity mix continues to be dominated by fossil fuels, the average global rise in temperature will be 6°C[8], well beyond the objective of 2°C.

Global electricity demand should double to meet the basic needs of humanity in terms of population growth and development goals.

By 2050, the world's population will be around 9.6 billion[9]. Progress in the field of energy efficiency, no matter how significant, will not be sufficient to meet rising electricity demand (which is growing faster than energy demand). International Energy Agency (IEA)[10] scenarios, although ambitious in terms of energy efficiency, predict between 80 to 130 percent increase in electricity demand by 2050, mainly driven by emerging economies.

The fight against climate change should not jeopardize the development of countries: Today, approximately 1.2 billion people - the equivalent of the population of India or Africa - do not have access to electricity nor to the development benefits that it brings. In addition, 1 billion more have access only to unreliable electricity networks. About 2.8 billion use wood or other biomass products for cooking and heating, which creates pollution that is harmful for human health. Increasing electrification will help lift these people out of poverty and improve their quality of life.

Low-carbon electricity is expected to play a major role in decarbonizing other sectors[11].

Electricity can replace fossil fuels in many sectors (e.g., domestic heating and transport), thereby reducing CO_2 emissions if it is low-carbon. For instance, in the transportation sector, deployment of rail transport and development of electric vehicles using low-carbon electricity significantly reduces the consumption of oil and

[5] Fifth Assessment Report, IPCC (2013-2015) http://ipcc.ch/pdf/assessment-report/ar5/wg3/ipcc_wg3_ar5_full.pdf
[6] Energy Technology Perspectives 2014, IEA
http://www.iea.org/publications/freepublications/publication/EnergyTechnologyPerspectives_ES.pdf
[7] Global Carbon Project http://www.globalcarbonproject.org/carbonbudget/14/hl-compact.htm
[8] Energy Technology Perspectives 2014, IEA
http://www.iea.org/publications/freepublications/publication/EnergyTechnologyPerspectives_ES.pdf
[9] United Nations (2015) http://esa.un.org/wpp/documentation/pdf/wpp2012_press_release.pdf
[10] Technology Roadmap 2014, IEA http://www.iea.org/publications/freepublications/publication/technology-roadmap-nuclear-energy-
[11] Energy Technology Perspectives 2014, IEA
http://www.iea.org/publications/freepublications/publication/EnergyTechnologyPerspectives_ES.pdf

coal[12]. To achieve global climate targets, the IEA recommends that low-carbon electricity account for 25 percent of total energy usage by 2050, up from 17 percent today[12].

Achieving such a challenging goal will require the use of all low-carbon technologies, including nuclear energy.

The IPCC identifies three types of carbon-free electricity: renewables, nuclear energy and CCS.

Nuclear power is a low-carbon energy source. Throughout its life cycle (construction, operation, decommissioning) its emissions are comparable to those of renewable energy sources. Nuclear power emits an average of 15g CO_2/kwh. This is 30 times less than gas (491g/kwh), 65 times less than coal (1024g/kwh), three times less than photovoltaic (45g/kwh) and about the same level as wind power[13].

2. The world needs to take urgent steps towards reducing greenhouse gas emissions. It cannot afford to wait for 'advanced technologies' or to prematurely close existing low carbon energy sources. Nuclear energy is a proven low-carbon option, available today.

A significant part of the CO_2 released remains in the atmosphere for a long time. To slow down the resulting increase in CO_2 concentration, we need to start reducing emissions now.

Once released, CO_2 is exchanged between the atmosphere, the ocean and the land. Part of the CO_2 dissolves in the ocean (which makes the ocean become more acidic). However, it is estimated than nearly half of the CO_2 emitted remains in the atmosphere for a century, with some fraction (20 percent) remaining for as long as several millennia[14].

According to IPCC, there is a limited amount of cumulative CO_2 emissions[15] (referred to as the "carbon budget") that must not be exceeded in the future if we are to keep CO_2 concentration under a certain level and limit average global warming to 2°C. They estimate that we have already used nearly two-thirds of this amount.

We need to start reducing CO_2 emissions now.

This means, first, that we cannot afford to select pathways which will delay future emissions reductions. It has been demonstrated that when a nuclear power plant closes, it is often replaced by fossil-fueled electricity output. Following the closure of the San Onofre nuclear plant in California in 2012, demand for natural gas immediately increased, and carbon dioxide emissions increased by 9 million tons in the first twelve months (this is the equivalent of putting 2 million additional cars on the road)[16]. Following the closure of Vermont Yankee at the end of 2014, demand for gas increased in New England and carbon dioxide emissions increased by 3 million tons in 2015[17]. In Germany, it was demonstrated that replacing a low-carbon source of energy (nuclear) by other ones (wind and solar) do not decrease emissions: following the decision to accelerate the nuclear energy phase-out in 2011 greenhouse gas emissions are unchanged since 2009 at 27% below 1990 levels.

[12] 2DS Scenario, IEA

[13] Fifth Assessment Report, IPCC (2013-2015) http://ipcc.ch/pdf/assessment-report/ar5/wg3/ipcc_wg3_ar5_full.pdf

[14] Fifth Assessment Report - IPCC (2013-2015) https://www.ipcc.ch/publications_and_data/ar4/wg1/en/faq-10-3.html

[15] IPCC estimated that a total of 2,900 billion tons maximum can be emitted since the pre-industrial era till an increase of 2°C is reached, of which 70% (2000 billion tons) have already been released into the atmosphere. With a strong acceleration in the last 40 years.

[16] Market Impacts of a Nuclear Power Plant Closure - University of California, Berkeley and NBER (2015) https://ei.haas.berkeley.edu/research/papers/WP248.pdf

[17] Institute for Energy Research (2016) http://instituteforenergyresearch.org/analysis/new-england-using-more-natural-gas-following-vermont-yankee-closure/

In both cases, even if the proportion of renewable energy in the mix is subsequently increased, the premature closure of nuclear plants has unjustifiably reduced the available budget of greenhouse gas emissions that can be made before temperature targets are breached.

History tells us that energy transitions take decades to achieve. According to IEA, the share of fossil fuels within the world energy supply has been relatively stable over 40 years. We cannot wait for future technologies to be available. We need to leverage the full breadth of low-carbon options available today while continuing to develop advanced technologies that can be implemented by 2050. Nuclear, hydro, wind and solar, among the low-carbon sources of electricity listed by IPCC, are available for large-scale industrial deployment and have proven effective. By contrast, the IEA considers that CCS has developed *"slowly due to high costs and a lack of political and financial commitment".*

Nuclear energy is an available, low-carbon and efficient industrial solution.

With 438[18] nuclear reactors in operation, nuclear energy is available in 30 countries, accounting for greater than two-thirds of the world's population. Nuclear power has demonstrated its effectiveness: according to IEA[19], since 1971, nuclear power has avoided the equivalent of two years of total global CO_2 emissions at current rates. In Europe, nuclear power avoids annual CO_2 emissions equivalent to those produced every year by all the cars on the roads in Germany, Spain, France, the United Kingdom and Italy[20] .

Currently, only six countries meet or exceed the recommendations of the IPCC electricity mix (80 percent of low-carbon electricity). Four of them — Switzerland, Sweden, France and Brazil — have an electricity portfolio that includes a notable share of nuclear power. Nuclear energy accounts for 77 percent of electricity production in France and 40 percent of electricity in Switzerland and Sweden. For its part, Brazil has two nuclear reactors that generate three percent of its electricity.

Nuclear energy has also be proven effective in how fast it can achieve massive results. As of now, the countries that have managed to decarbonize their electricity supplies the fastest – such as Sweden and France – have done so primarily by increasing the proportion of nuclear energy.

In OECD[21] countries, nuclear power plants are the primary source of low-carbon electricity. We must invest in these assets to achieve our climate goals.

Operating nuclear power plants longer, where technically feasible, or restarting nuclear plants that have been temporarily shut down, provides immediate additional low-carbon capacity. It prevents progress from stalling or even, as former nuclear capacity may be replaced by fossil fuels, from retreating. It enables countries to further reduce CO_2 emissions by concentrating reduction efforts on the share of fossil fuels.

Nuclear energy accounts for 63 percent of the low-carbon electricity generated in the United States. Of the 99 reactors in operation, 78 reactors have already been licensed by the U.S. Nuclear Regulatory Commission to operate for 60 years.

In the European Union, nuclear energy accounts for more than half of all low-carbon electricity. Finland, the Netherlands, the United Kingdom and Switzerland have also launched programs to upgrade their fleets for long

[18] International Status and Prospects for Nuclear Power – IEA (2014)
http://www.iaea.org/About/Policy/GC/GC58/GC58InfDocuments/English/gc58inf-6_en.pdf

[19] World Energy Outlook – IEA (2014) http://www.iea.org/newsroomandevents/pressreleases/2014/november/signs-of-stress-must-not-beignored-iea-warns-in-its-new-world-energy-outlook.html

[20] Eurostat (2014)

[21] Organization for Economic Cooperation and Development (OECD)

term operations. In France, EDF intends to complete the renovation of its 58 reactors, and to have them operate safely beyond 40 years.

In Japan, where the share of fossil fuels in the electricity mix had risen up to 85 percent after the shutdown of nuclear reactors, the gradual restart of reactors beginning in the summer of 2015 is a key step to decarbonizing its electricity sector. In Paris, Japan proposed a plan for 2030 with nuclear energy accounting for at least 20 percent of the electricity mix.

Nuclear energy supports low-carbon growth in emerging countries.

In 2050, the six largest national economies will be the United States and the "BRICS" (Brazil, Russia, India, China and South Africa). In China, coal represents 70 percent of total electricity; in India, it is as high as 80 percent.

All six nations already operate commercial nuclear reactors and have ambitious nuclear programs. China has the most ambitious nuclear energy growth program with more than 20 reactors under construction[22]. According to IEA, China alone is expected to account for one-third of the world's installed nuclear energy capacity by 2050. In the draft of China's new five-year plan that covers 2016 to 2020, more will start up over the next decade, with a rhythm of seven new reactors annually between now and 2030.

3. All countries have the right to choose nuclear energy in order to reduce greenhouse gas emissions while meeting their energy objectives.

Energy and climate experts agree that pathways with the greatest probability for successfully decarbonizing the energy mix require the use of nuclear energy.

According to the 2DS scenario[23], which is considered to be its most effective blueprint for meeting the target of a 2°C rise, the IEA forecasted that gross nuclear capacity needed to more than double by 2050, up from its current level of around 400 GWe to 930 GWe. This corresponds to an increase in the share of the global electricity mix from 11 percent to 17 percent.

In an open letter[24] published in late 2013, four major climate scientists stated: "*There is no credible path to climate stabilization that does not include an important role for nuclear energy….We cannot afford to turn away from any technology".*

Countries must meet climate goals and at the same time meet other energy policy objectives.

Generally speaking, energy policies pursue several objectives at the same time, such as security of supply, affordability of electricity and economic and industrial development. Each country must also manage a variety of constraints in terms of natural resources, infrastructure, skills, public opinion, transport networks and distribution, and electricity demand. It is up to national policymakers to make the most appropriate decisions to meet the objectives while taking into account local constraints.

According to the Paris agreement, each country is submitting its national contribution to the overall global effort to reduce carbon emissions. The most realistic commitments — that is, the ones with the best chances of future successful implementation — will be the plans that achieve reduction in CO_2 emissions while meeting other energy policy objectives.

[22] IAEA (2014) http://www.iaea.org/About/Policy/GC/GC58/GC58InfDocuments/English/gc58inf-6_en.pdf

[23] World Energy Investment Outlook, IEA (2014) http://www.iea.org/newsroomandevents/pressreleases/2014/june/name,72035,en.html

[24] Washington Post (2013) http://www.columbia.edu/~jeh1/NuclearPowerInClimateBattle.WashingtonPost_2013.11.03.pdf

It is necessary that countries have access to the broadest possible portfolio of low-carbon energy options, which will allow them maximum flexibility to meet this challenge.

Nuclear energy enables to reduce CO_2 emissions, while helping to improve energy security.

Nuclear energy can contribute significantly to energy security in many countries.

First, it reduces the need to import coal and natural gas.

Also, production costs of nuclear energy are stable over time and support stable electricity bills. In the case of electricity generated from fossil fuels, the share of fuel costs in the total cost is significant, and these fuel prices are subject to fluctuations. For nuclear energy, the share of uranium cost is only a small fraction (about 5 percent) of the total cost of electricity.

Countries relying on nuclear energy have usually built several years of strategic inventories for fuel supply. The incredible energy density of nuclear fuel means that only small volumes of uranium need to be transported and it is easy to store several years' worth of inventory at plant locations. Uranium resources are available from a variety of countries all over the world, including OECD countries such as Canada and Australia. According to the IAEA, identified resources of uranium are sufficient to support the projected growth of nuclear energy for over 120 years[25]. Furthermore, additional exploitable resources should extend the availability of uranium to well over 300 years.

Finally, in electrical systems, nuclear energy and renewables appears as more and more complementary, contributing to reliable electricity supply.

Reliable supply of electricity to consumers requires a sophisticated system to balance supply and demand at all times, various means are used by utilities to guaranty this equilibrium: flexibility of the different generation's technologies, Pumped-storage hydroelectricity (PSH, or PHES), and management of the demand. Demand for electricity varies during the day as well as during different seasons of the year. The development of new renewable technologies contributes to decarbonizing the electricity mix, with production that also varies during the day and the season. Nuclear plants complement renewables as they provide dispatchable low-carbon electricity supply, 24 hours a day (with programmed maintenance shutdowns). Nuclear power plants allow electric systems to accommodate the variability of solar and wind energy.

Nuclear energy enables the reduction of CO_2 emissions while providing affordable electricity.

Retail electricity price includes the cost of production, but also balancing costs, electricity distribution and transport costs and taxes. All vary from one country to another.

The production cost structure of nuclear energy, like solar and wind, is dominated by fixed costs, corresponding to the upfront capital investment of building the capacity. In a September 2015 study, the OECD[26] confirmed that, nuclear energy is generally one of the lowest with respect to all the electricity production means, including fossil baseload technologies such as natural gas and coal in all countries surveyed. This is particularly true with low discount rates, which are regularly used in the framework of Climate Change. This confirms nuclear as a competitive low-carbon option available at scale.

Also, because nuclear energy is dispatchable, its "system costs" (resulting mainly from the investments required in peak production, transmission and distribution systems to ensure reliable electricity supply) remain low, contributing to an affordable retail electricity price. In total, its competiveness is recognized as one of the best

[25] Uranium 2014: Resources, Production and Demand – OECD-NEA http://www.oecd-nea.org/ndd/pubs/2014/7209-uranium-2014.pdf
[26] Projected Costs of Generating Electricity - OECD-NEA (2015) https://www.oecd-nea.org/ndd/egc/2015/

in the future decades, showing that its speed development in Asia will very probably show the way for other main parts of the world.

Nuclear energy enables the reduction of CO_2 emissions while providing economic and industrial development.

Nuclear energy investments are growth engines for the regions and countries in which they are built, from initial turnkey projects towards greater technological self-sufficiency.

Nuclear investments directly create highly skilled employment, far beyond reactor operation and maintenance. Careers include engineering, construction, manufacturing and design, regulation, legal, government, finance, insurance, research, mining, transport, radiation, environment and radiation protection, and communications. The introduction of nuclear power also boosts education levels in the wider population, as all jobs require a high level of basic science.

As documented by IAEA in the Korean experience[27], nuclear power plant construction requires the existence of a nationally capable construction industry; medium and heavy manufacturing including cement, steel, machinery and equipment and chemicals; as well as competency in other services such as civil engineering, quality assurance control and testing. Domestic industries gradually become the main suppliers for the nuclear energy program, as manufacturers extend their product lines to incorporate nuclear designs and standards.

Finally, beyond the effects of the creation of a local nuclear industry, nuclear energy has positive implication at the macroeconomic level, through providing reliable, affordable electricity to the whole economy.

According to IAEA[28], several studies have demonstrated the relationship between nuclear investments and economic growth.

[27] Nuclear Technology and Economic Development in the Republic of Korea – AIEA (2006) https://www.iaea.org/sites/default/files/rok0809.pdf
[28] Climate Change and Nuclear Power – AIEA (2015) https://www.iaea.org/newscenter/news/iaea-report-highlights-nuclearpower%E2%80%99s-role-combating-climate-change

"Nuclear for Climate" is an initiative launched by members of the French Nuclear Energy Society (SFEN), the American Nuclear Society (ANS) and the European Nuclear Society (ENS). It now brings together nuclear professionals and scientists from all parts of the globe, through the representation of 150 regional and national nuclear associations and technical societies.

More information: nuclearforclimate.com

Contact:

Boris LE NGOC (SFEN)	boris.lengoc@sfen.org
Eileen LANGEGGER (ENS)	eileen.langegger@euronuclear.org
Denis JANIN (IYNC)	denis.janin@iync.org