Contribution to the consultation on the strategy for long-term EU greenhouse gas emissions reductions

Executive Summary

The fight against climate change is a global challenge in which the European Union ("EU") must stand as a leader. Orano calls for a renewed ambition in the EU emissions reduction strategy backed by a thorough decarbonisation roadmap ahead of COP24 in Katowice.

Orano supports a strengthened EU 2030 emissions reduction target (at least -45% compared to 1990). The overarching objective of the long-term EU strategy should be the full decarbonisation of the EU economy (net zero emissions, carbon neutrality).

The long-term transition to a low-carbon economy will be compatible with sustainable growth, a high level of employment and a strong EU industrial base only if cost-efficient options are chosen. Regarding the energy sector, a system cost approach at the EU level is required. In this context, **Orano** insists on the importance of relying on transparent data and credible assumptions for all existing, improved and future technologies. Informed, fact-based analyses will facilitate coordination of the Member States energy and climate planning and will help achieve the Energy Union's long-term goals.

The decarbonisation of the EU power sector is a no regret option and will be one of the major enabler of the decarbonisation of the EU economy. The EU long-term decarbonisation roadmap should aim at ensuring that the EU economy is fueled with reliable, competitive, low-carbon and sustainable electricity.

With increasing demand for electricity in the EU and renewal of existing power plants, investments in low-carbon generation will be colossal. **The European Commission assesses that investment in low-carbon electricity generation towards 2050 will total €270 billion[1] (or on average 1.5% of its GDP annually). Scalable and reliable low-carbon generation technologies such as nuclear power will be needed to keep up with rising power demand and to integrate higher penetration of intermittent renewables.** It is very unlikely that the reformed power market design applicable for the 2020-2030 period will offer appropriate solutions for long-term investment in low-carbon power generation.

Orano calls on the European Commission to come forward with concrete proposals to facilitate investments in all types of low-carbon generation, including nuclear power. An adapted legal framework could have a strong role in

[1] European Commission website, Climate Action, 2050 low carbon economy
See: https://ec.europa.eu/clima/policies/strategies/2050_en

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lowering the cost of capital (low carbon technologies are capital-intensive). The EU should implement adequate market solutions for long-term investments, strengthen long-term carbon pricing mechanisms and set an appropriate market design to reflect the value of the electricity generated (externalities on network, flexibility services, capacity services…).

The situation in the Member States as well as consistent international economic and academic analyses have shown that decarbonizing power mixes is achieved better, faster and cheaper with nuclear power.

Nuclear power ensures long term security of energy supply and the reliability of the EU power system.

According to the recent MIT study[2], a nuclear build-up (at historically feasible rate) can completely decarbonize the world's power sector within 30 years. Moreover, excluding nuclear power in a low carbon transition drives up the average cost of electricity. Globally, IPCC scenarios show that, for keeping the global temperature rise within 1.5 degrees of preindustrial levels, nuclear power has to play a large role in mitigation of Greenhouse Gases ("GHG"). In the EU, maintaining a high share of nuclear in France, the main nuclear installed based in the EU, will reduce the European GHG emissions and power system costs[3].

A full long-term energy system cost approach is required for informed policy making. Nuclear is contributing to reduce GHG emissions and customer costs (producing costs, grid costs, balancing cost, taxes). It supports the European security of supply with strategic technologies throughout the value chain and the fuel cycle. It offers skilled and sustainable secure jobs within the EU, and has a strong export potential.

Nuclear power improves the sustainability of the EU low-carbon power system in both short and long term. In the short to medium term, it mitigates risk of additional GHG emissions and the need for new investment in fossil fuel generation (lock-in). In the longer term, a mix with nuclear power brings baseload carbon-free electricity and reduces the overall power system cost.

Orano is committed to provide secure and competitive uranium, conversion and enrichment to the EU nuclear power utilities, to ensure the sustainable management of radioactive materials and wastes and to reduce its carbon and environmental footprint.

Orano will contribute to the long-term EU greenhouse gas emission reductions. Two years ahead of schedule, Orano (formerly Areva fuel cycle activities) has almost achieved its initial ambitions to reduce its energy consumption by 80% and by 50% its CO2 emissions in 2020 compared to 2004. Its activities, from mining to dismantling, as well as in conversion, enrichment, recycling, logistics and engineering, contribute to strengthening the supply chain of the EU nuclear industry.

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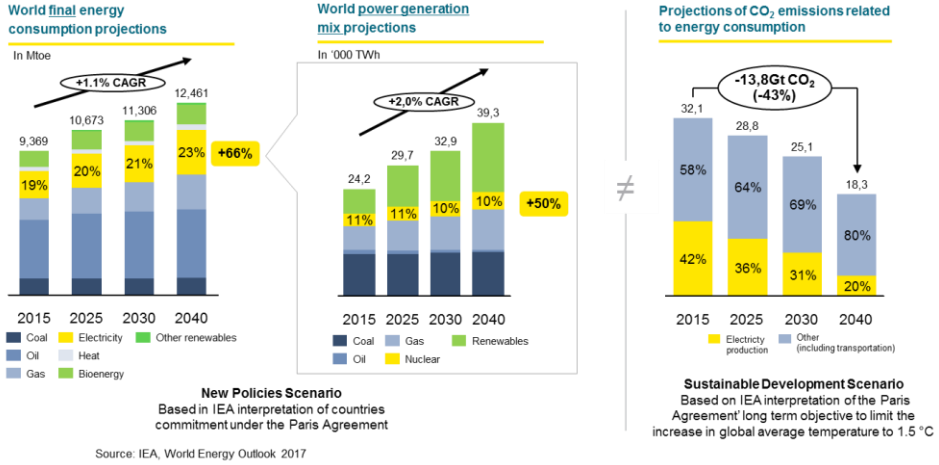
[2] MIT study "The Future of Nuclear power in a Carbon-Constrained World" (September 2018)
See: https://energy.mit.edu/wp-content/uploads/2017/02/MIT_Future_of_Nuclear_Study-Intro-for-Cross-cutting-Techs-workshop-Jan-30-31-2017-min.pdf

[3] Société Française de l'Energie Nucléaire, E3 – Modelling : L'importance du nucléaire français dans la transition bas-carbone de l'Europe (April 2018)
See:http://www.sfen.org/sites/default/files/public/atoms/files/le_nucleaire_francais_dans_le_systeme_energetique_europeen_-_sfen_-_ppe.pdf

1. The fight against climate change is a global challenge in which the EU must stand as a leader. Orano calls for a renewed ambition in the EU emissions reduction strategy backed by a thorough decarbonisation roadmap ahead of COP24 in Katowice.

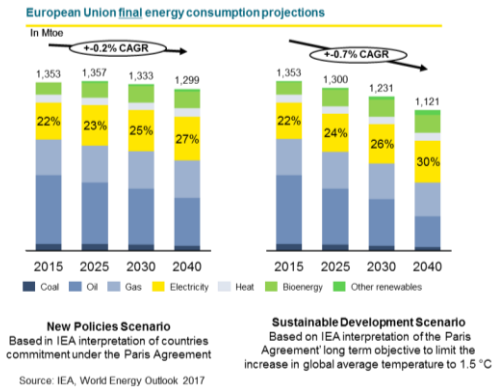
1.1. "Climate change is indeed running faster than we are (…). We need to do more and we need to do it quicker: we need more ambition and accelerated action by 2020. If we do not reverse the current trend of emissions by 2020, it may be impossible to meet the 1.5 degree goal"[4].

Global energy and climate challenges are colossal. Energy demand is expected to grow by 66% by 2040, while emissions will need to be reduced by almost a factor 2 to meet the objectives set at the COP21 and limit global warming. Current policies are not ambitious enough to meet Paris Agreement long-term objectives.



Source: IEA, World Energy Outlook 2017

Electricity demand is expected to increase sharply because of consistent drivers demography (+2 billion humans in 2050), urbanization (2/3 of the global population living in cities compared with 50% currently), economic development and improvements in people's living standards (domestic appliances), growth in the communication and information technology sectors), changes in use (electric transport, heating, etc.) and new applications overcompensating energy saving measures.



Source: IEA, World Energy Outlook 2017

In IEA WEO 2017, both central and SDS scenarios, the EU energy consumption is expected to be lower in 2040 but with higher share of electricity. Among energy efficiency, electrification will be key to meet Paris agreement objectives.

[4] Remarks by António Guterres at the High-Level Event on Climate Change, September 2018
See: https://www.un.org/sg/en/content/sg/speeches/2018-09-26/remarks-high-level-event-climate-change

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1.2. The EU long-term strategy must show ambition and global leadership

The current negotiations on the 2030 energy and climate framework show that a higher ambition for emissions reduction is possible. **Orano welcomes and supports the suggestion by the European Commission to raise the emissions reduction objective from at least -40 to -45 percent in 2030, compared to 1990. Such a reinforced commitment towards 2030 would maintain the EU on track for the transition to a decarbonized EU economy in the long-term.**

In 2014 and ahead of COP21, the EU strongly committed to a 2050 decarbonisation objective. It allowed the EU to push for a stronger Paris Agreement. **Ahead of COP24 in Katowice, it is important that the EU maintains this global leadership. Orano calls for a long-term EU strategy which overarching objective should be carbon neutrality of the EU economy (full decarbonisation of the EU economy, net zero emissions).**

1.3. The EU long-term decarbonisation strategy must be backed by a thorough roadmap, based on transparent and credible assumptions.

Orano emphasizes that credible technology cost assumptions have to be taken into account in the energy modelling.

Regarding nuclear power, in particular, and based on a previous public consultation:

Overnight costs should not be overestimated: according to the IEA report, the Overnight Investments Costs for new nuclear reactors in Europe range between 3825 €/kW and 4855 €/kW in 2020.

Nuclear Gen III is still a young technology and is still at the beginning of its learning curve. It should benefit from a large worldwide deployment (1 000 reactors until 2050). Cost reductions are achievable through a combination of technical (e.g. twin projects) and organizational factors (e.g. restructuring of the European nuclear supply chain). In addition, beyond 2030, learning by doing and innovation should allow for future cost reductions.

Fixed O&M costs should not be overestimated and be consistent with external studies such as OECD data[5] that report an O&M costs for nuclear new build in France of 10€/MWh. Therefore, without changing the variable O&M costs assumptions (6.4€/MWh) and assuming a 91% availability factor, the fixed O&M costs are estimated to be 28.7€/kWe[6].

In Europe, there are a number of examples whereby reactors also deliver heat or steam to other processes like industry or district heating. These energy generations should be taken into account when calculating nuclear thermal efficiency factors. Then, the thermal efficiency factor of the complete unit is much higher than the factor used only in condensing applications – see the 2017 IAEA technical report on Opportunities for Cogeneration with Nuclear power. In any case, electrical efficiency for nuclear should be set at 1 as nuclear fuel is only used for electricity and heating generation.

[5] Projected Costs of Generating Electricity 2015 (IEA & NEA) - Median LCOE values with a WACC of 7% - see: https://www.oecd-nea.org/ndd/pubs/2015/7057-proj-costs-electricity-2015.pdf

[6] 3,6€/MWh (10€MWh-6,4€/MWh) lead to 28,7€/kWe : 3,6€/MWh x 12 763 296 MWh of annual production / 1 600 000 kWe

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Cost of fuel should be taken into account, based on last UxC[7] projections prices, front end fuel cost for GEN III should be between 2,5€$_{2018}$/MWh and 4€$_{2018}$/MWh over the projection period (2035).

The lifetime assumption retained for Nuclear Gen III should be 60 years rather than 50 years. 60 years is the lifetime for most Gen-III NPP by design especially when considering potential technology retained for future construction within the EU (see appendix 1).

The anticipated capacity factor should not be set at 85%. Modern reactors are normally designed to allow for an availability of at least 90%. For example, the availability factor for EPR is set at 91% by design.

2. The decarbonisation of the energy sector is a priority to meet the broader objective of decarbonizing the economy. A looking-forward EU strategy should aim at ensuring that the EU economy is fueled with competitive, reliable, low-carbon electricity.

All low-carbon power technologies will be needed to take up and solve the investment challenge to replace coal and gas.

According to the IPCC report[8], in order to limit global warming to 1.5°C, the annual investment needs in the energy system should reach around 2.4 trillion USD$_{2016}$ between 2016 and 2035 representing 2.5% of the world GDP.

The European Commission's 2050 scenarios (the latter was published in 2016) are based on ambitious forecasts in terms of energy efficiency, yet they predict a significant increase in the long-term electricity demand (+20 to 30%) due to transfers of use (electrification).The European Commission assesses that investment in low-carbon electricity generation towards 2050 will total €270 billion[9] (or on average 1.5% of its GDP annually).

Wholesale electricity prices continue to decrease as a result of stagnating electricity consumption, an increasing share of RES (low variable costs), and low coal, gas & CO2 prices. These lead to decrease in power plants' profitability (without support scheme) and underinvestment in firm capacity due to missing money. It is very unlikely that the reformed power market design applicable for the 2020-2030 period will offer appropriate solutions for long-term investment in low-carbon power generation.

Orano therefore calls for a new EU action plan for long-term investments in sustainable and low-carbon generation, in particular: stop funding for coal, streamline EU funds from the next EU 2021-2027 budget, innovative products from the European Investment Bank, strengthen long-term and predictable carbon pricing mechanism, reform market rules allowing long-term price signals, ensure a level playing field among low-carbon technologies and reward low-carbon flexibility services.

[7] Uranium Market Outlook Q1 2018 - Composite Midpoint / Conversion Market Outlook S2 2017 – Composite EU Midpoint / Enrichment Market Outlook Q1 2018 – Composite Midpoint

[8] Global Warming of 1.5°C, IPCC (October 2018)
See: http://www.ipcc.ch/report/sr15/

[9] European Commission website, Climate Action, 2050 low carbon economy
https://ec.europa.eu/clima/policies/strategies/2050_en

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New revenue streams may appear for electricity producers beyond the energy price with appropriate market design that reflect the value of the electricity generated (externalities on network, flexibility services, capacity services, security of supply…).

3. Improve the sustainability of the EU low-carbon power system in the longer term

3.1. For the EU, the optimal path towards the decarbonisation of the power sector includes nuclear power

Today, nuclear power is by far the largest single source of low-carbon electricity in the EU as it contributes by 28.1%[10] in the EU electricity production (compared with 17.2% for solid fuels and 27.4% for all types of renewables). The installed nuclear base ensures the stability and the reliability of the European electricity system and offers solutions in terms of flexibility (a reactor can vary 80 percent of the electricity load in 30 minutes). Nuclear power helped Member States to quickly decarbonize their electricity systems, for instance in Sweden. On the contrary, countries that recently decided to phase out nuclear power will not meet their emission reduction commitments. There are no credible scenarios of nuclear phase out for a Member State without an increase in the energy dependency (for instance in Belgium) or a revision in the emissions targets (Germany).

According to a recent MIT study[11], only a nuclear build-up (at historically feasible rate) can completely decarbonize the world's power sector within 30 years, while excluding nuclear power drives up the average cost of electricity. Another consideration of the study is that rapid deployment of low carbon plants is critical to achieve current international climate mitigation goals. MIT indicates that historically, large scale increases in low carbon generation have occurred most rapidly with additions of nuclear power (see appendix 2).

Globally, IPCC scenarios show that, to maintain the global temperature rise within 1.5 degrees of preindustrial levels, nuclear power has to play a large role in mitigation of GHGs.

Beyond its contribution to reduce CO2 emissions of the power sector, nuclear generation mitigates the environmental footprint of the European power system (land use) and is the only alternative in countries with low renewables resources. It will also bring more resilience to the power system allowing development of other low carbon technologies.

3.2. Nuclear power ensures long-term security of energy supply and the reliability of the EU power system

The transition to a low-carbon energy system will reduce external dependency on fossil fuels but is likely to increase other types of dependency: on RES technologies and equipment, on raw materials. Nuclear scores high on the EU security of supply: mines, front-end, strategic technologies held by the EU industry, industrial mature sector.

[10] European Commission, EU energy statistical pocketbook (October 2018)
See : eu-energy-statistics-latest-data-now-available-2018-oct-04
[11] MIT study "The Future of Nuclear power in a Carbon-Constrained World" (September 2018)
See: https://energy.mit.edu/wp-content/uploads/2017/02/MIT_Future_of_Nuclear_Study-Intro-for-Cross-cutting-Techs-workshop-Jan-30-31-2017-min.pdf

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Nuclear power is an asset for the stability and reliability of the EU power system as there will still be a need for baseload electricity. Nuclear power is a proven large-scale form of low carbon electricity production which is not weather dependent. Nuclear power can also provide large scale solutions to answer the need for flexibility and network stability in some Member States. In the EU, maintaining a high share of nuclear in France, the main nuclear installed based in the EU, will reduce European GHG emissions and power system costs[12].

A full long-term energy system cost approach is required for informed policy making: the OECD report named 'Full costs of electricity provision' suggests to include beyond electricity production costs, all externalities including GHG emission, customer costs (balancing cost, taxes, transmission and distribution), employment and land use. High share of nuclear would mitigate the impact of the low-carbon transition on customer costs via lower total generation costs:

- With a plant level approach, nuclear is among the cheapest low carbon technologies (see appendix 3) especially when considering costs of installed base (for instance, cash costs are at 33€/MWh in France);
- Maintaining a high share of nuclear power will help to reduce system costs (balancing and grid costs) induced by variable renewable production and localization of renewable assets that are often far from demand centers (due to availability of resources).

The European nuclear sector has strong industrial and technological assets: it supports the European security of supply with strategic technologies through the value chain and the fuel cycle. It offers skilled and sustainable secure jobs in the EU, and has a strong export potential. It is also today a technology industrially able to be deployed on a large scale. Nuclear also avoids a significant increase in the energy dependency to imported fuel of the European economy and uranium resources are abundant and mainly located in OECD and some other countries (see appendix 4).

In order to keep this advantage, European research must be upgraded to support innovation and the development of new technologies in the nuclear sector. This could only be achieved through an increased Euratom budget for nuclear research. There are needs for innovation for nuclear to stay competitive in the future (as it is today), while staying safe. A more significant budget would help industrials to develop new types of nuclear reactors (such as Small Modular Reactors).

All major decarbonisation scenarios[13] combine nuclear, renewables and Carbon Capture Storage to achieve the climate objectives. But it is important to look beyond CO2 emissions: nuclear power has strong advantages that should be considered. In the report named 'The Growing Role of Minerals and Metals for A Low-Carbon Future', the World Bank underlines that renewables need 'significantly more' ores and metals than traditional energy supply systems.

Globally, low-carbon power generation technologies will need to reduce their overall environmental impact. Circular economy is the way forward, in particular in regards to the management of wastes. In this regard, treatment and reprocessing techniques have been developed by the nuclear industry to reduce the volume and the

[12] Société Française de l'Energie Nucléaire, E3 – Modelling : L'importance du nucléaire français dans la transition bas-carbone de l'Europe (April 2018)
See:http://www.sfen.org/sites/default/files/public/atoms/files/le_nucleaire_francais_dans_le_systeme_energetique_europeen_-_sfen_-_ppe.pdf

[13] 2DS/B2DS from OEDE-IAE (June 2017) and PRIMES from the European Commission (July 2016) *Global Warming of 1.5°C*, IPCC (October 2018)

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radioactivity of nuclear waste. It is now crucial that all other types of low-carbon energy sources work on recycling solutions.

4. Orano is committed to provide secure and competitive uranium, conversion and enrichment to the EU nuclear power utilities, to ensure the sustainable management of radioactive materials and wastes and to reduce our own carbon and environmental footprint.

Orano will contribute to the long-term EU greenhouse gas emission reductions. Two years ahead of schedule, Orano (formerly Areva fuel cycle activities) has almost achieved its initial ambition to reduce its energy consumption by 80% and by 50% its CO2 emissions in 2020 compared to 2004.

Orano is a €4 billion company with 16,000 people, with two third of them in Europe. The company delivers products and services with high added value throughout the entire nuclear fuel cycle, from raw material to waste treatment. Its activities, from mining to dismantling, as well as in conversion, enrichment, recycling, logistics and engineering, contribute to strengthening the supply chain of the EU nuclear industry, not mentioning its future other area of applications, like in medicine for instance.

Orano is contributing to increase the EU's security of supply of nuclear fuel with its diversified mining resources in three continents with a significant volume of reserves. Its modernized facilities bring flexible supplies of conversion and enrichment services allowing the EU to have high-value and strategic technologies and industrial capabilities within its borders. Orano's P. Coste and Georges Besse 2 facilities at the Tricastin site produce enough fuel to generate low-carbon electricity for 90 million houses.

In addition, Orano's technology and industrial experience in processing, recycling and managing nuclear fuel solutions are assets for the EU, enabling Member States to fulfill their commitments for the safe and sustainable management of spent fuel and waste, as required by the EU law.

Since 1967, reprocessing-recycling participates in the responsible approach for waste management: this process separates recoverable and valuable materials for re-use in a new Mox fuel. In comparison with direct disposal which considers used fuels as waste, this technology allows to cut volume by five and toxicity of the high and intermediate level waste by ten. La Hague and Melox recycling facilities are the cornerstones of the French approach and benefit to other European countries such as Germany, Switzerland, Italy, Spain, Belgium and the Netherlands. La Hague is the world's largest nuclear fuel reprocessing plant (with 2.500 employees) with an authorized maximum treatment capacity of 1,700 mt per year. Thus, Orano is the only company able to recycle 96% of the fuel, which considerably reduce the volume of its natural resources requirement. Thanks to this innovative process, 10% of French nuclear electricity is produced by recycled fuels.

Orano is ready to capture opportunities with its proven technologies and innovation capabilities, its renewed assets and its unique skills with high level of expertise throughout the nuclear fuel cycle.

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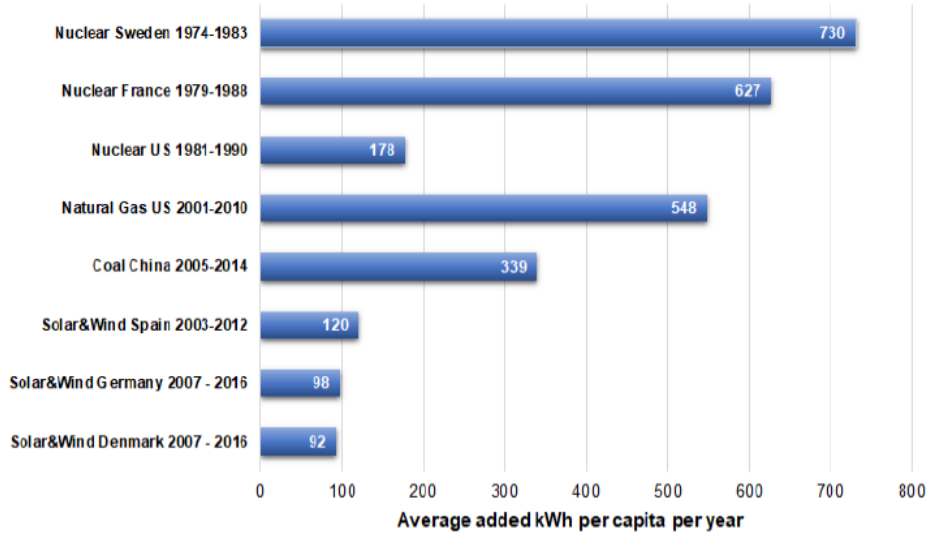
Appendices

Appendix 1- Example of advanced reactors lifetime

Manufacturer	**Type / Name**	**Lifetime** (in years)
EDF – Framatome	EPR	60
EDF - Framatome / MHI	ATMEA1	60
MHI	APWR	60
GE Hitachi / Westinghouse	ABWR	60
GE Hitachi	ESBWR	60
Westinghouse	AP1000	60
KHNP	APR-1400	60
Westinghouse China	CAP1400	60
CNNC & CGN	Hualong One	60
SNPTC	CAP1400	60
Rosatom	VVER New	60
Rosatom	BN-1200	60

Appendix 2- Electricity growth (kWh per year per capita) based on actual data for added power capacity in various countries – source: MIT



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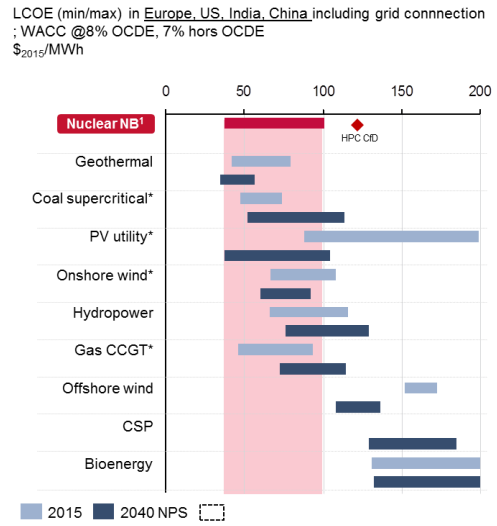
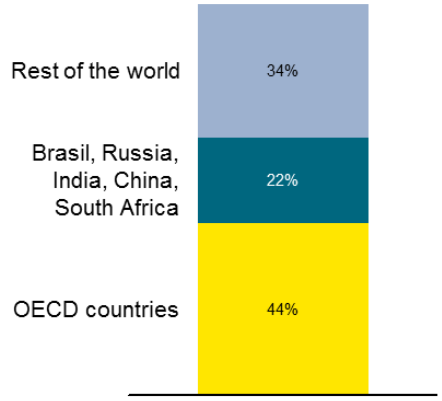
Appendix 3- LCOE of different technologies



Source : WEO 2016 NPS, WEO 2017 NPS IEA ETP 2015

Appendix 4 - Uranium reserves (RAR < US$100/lbU) – 2017



Source: Enerdata

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