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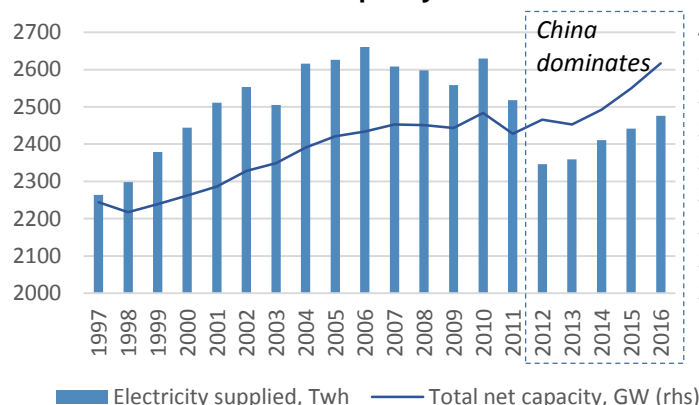
Commodity Update
***Nuclear reactor growth to
support long-term uranium prices***

March 2018

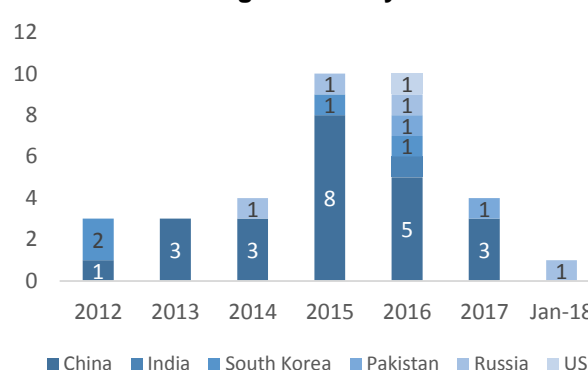
Key highlights

- Nuclear reactors generated 2,476 TWh of electricity in 2016, which was 1.4% YoY higher and 5.5% higher than in 2012, according to International Atomic Energy Agency (IAEA). Total net capacity amounted to 391 GW, which was 8 GW YoY higher than YoY and 17 GW higher than in 2012. During the last 5 years, most of additions to nuclear capacity was from China, but it decreased the pace since 2015 from eight new reactors to three in 2017. South Korea was in at the second place in terms of the number of new build reactors (4 new reactors) during 2012-2017, followed by Russia (3 new reactors). In 2017, one nuclear power plant in Pakistan (Kundian) and three in China (Yangjiang, Fuqing, and Lianyungang) started to supply electricity with gross electrical capacity of 3.6 GW.

Electricity generation by nuclear power plants and total net capacity



China dominates nuclear new build activity during the last 5 years



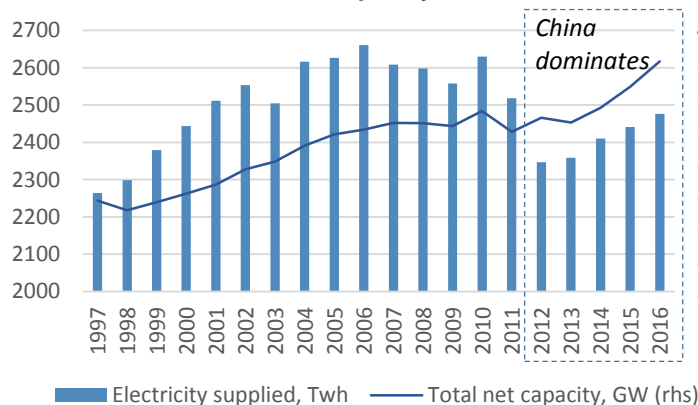
Source: IAEA, Samruk-Kazyna

- The share of nuclear electricity generation amounted to 10.7% of total annual electricity generation in 2015, according to the EIA. France, Slovakia, Ukraine and Hungary have the highest share of nuclear electricity generation in energy mix, however, in terms of the number of operating reactors the US, France, and Japan are the leading countries. Among top oil export countries, only Russia has relatively high share of nuclear in electricity generation at 17.1%. China generates only 3.6% of its total electricity from nuclear, which increased from 2% since 2012. France and Germany reduced their share of nuclear electricity generation from 74.8% and 16.1% in 2012 to 72.3% and 13.1% in 2016 respectively.
- Nuclear power is the world's second fastest-growing source of energy with the expected annual growth of consumption at 1.5% over period of 2015-2040. Strong nuclear reactor growth will support uranium market in the long-term, as 56 reactors are under construction. This market, however, is seen to be potentially volatile owing to both politics and economics.
- The share of nuclear electricity generation is forecasted to slightly decline to 10.2% by 2040 from 10.7% in 2015 due to nuclear generation's share decline in OECD Europe from around 25% in 2015 to less than 15% by 2040, which will be partially offset by increase in China's energy demand from 3% in 2015 to 11% by 2040, based on EIA data.

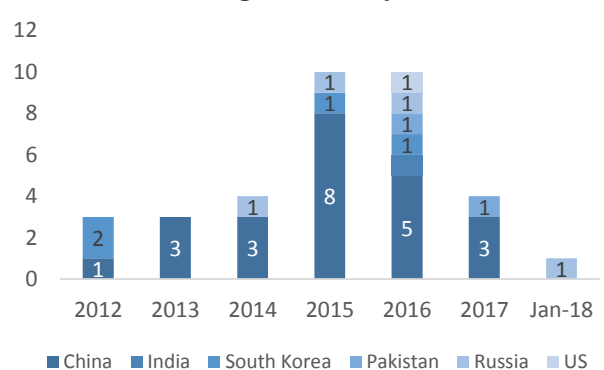
Nuclear reactors current capacity

Nuclear reactors generated 2,476 TWh of electricity in 2016, which was 1.4% YoY higher and 5.5% higher than in 2012, according to International Atomic Energy Agency (IAEA). Total net capacity amounted to 391 GW, which was 8 GW YoY higher than YoY and 17 GW higher than in 2012. During the last 5 years, most of additions to nuclear capacity were from China, but it decreased the pace decelerated since 2015 from eight new reactors to three in 2017. South Korea was in at the second place in terms of the number of new build reactors (4 new reactors) during 2012-2017, followed by Russia (3 new reactors). In 2017, one nuclear power plant in Pakistan (Kundian) and three in China (Yangjiang, Fuqing, and Lianyungang) started to supply electricity in 2017 with gross electrical capacity of 3.6 GW.

Electricity generation by nuclear power plants and total net capacity



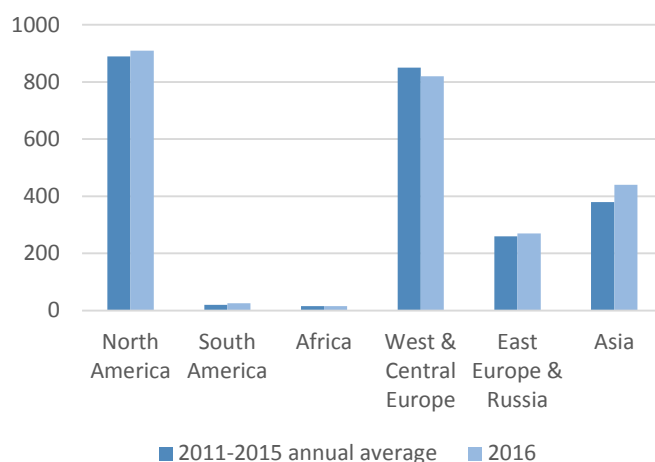
China dominates nuclear new build activity during the last 5 years



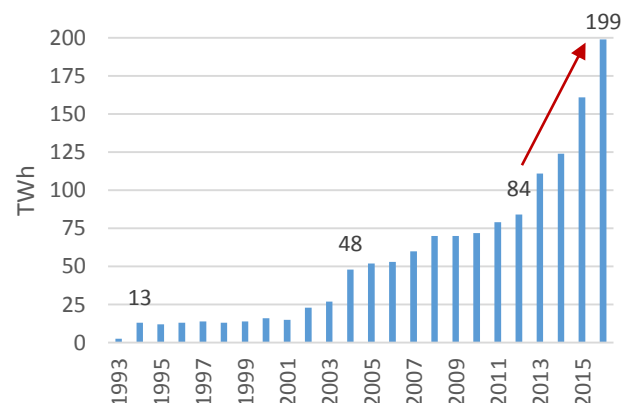
Source: IAEA, Samruk-Kazyna

In 2016, nuclear generation was higher in all regions except West & Central Europe, compared to the average annual generation in the preceding five years. Nuclear output rose most markedly in Asia, with generation 72 TWh higher than the 2011-2015 average. Nuclear electricity generation in China more than doubled in five years to 199TWh in 2016.

Regional nuclear generation, TWh



Nuclear electricity production in China

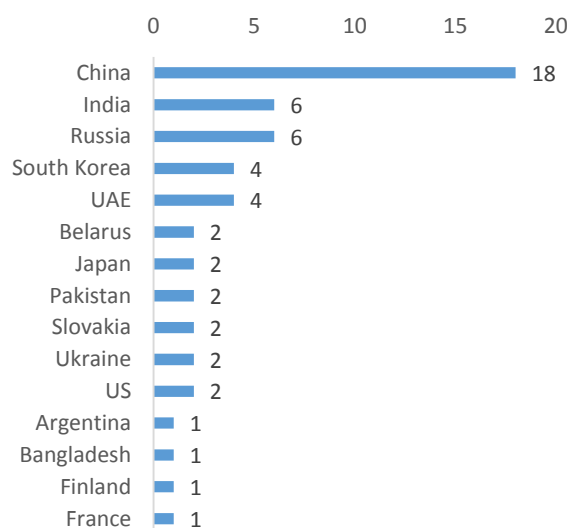


Source: World Nuclear Association, IAEA PRIS, Samruk-Kazyna

Nuclear reactors under construction

The total number of reactors under construction amounted to 56 lower than 61 in 2016, after five reactors have been started in 2017 and January 2018. The most active growth of nuclear reactors is expected in China (18), India (6), Russia (6), South Korea (4) and UAE (4). The construction of nuclear reactors in China is expected to be completed by 2024. Most of reactors under construction are pressurized light-water-moderated and cooled reactors (82% or 46) with an expected capacity of 48.7GW. The active growth of new reactor will be partially offset by decline in the US, Japan and Europe.

Total number of reactors under construction

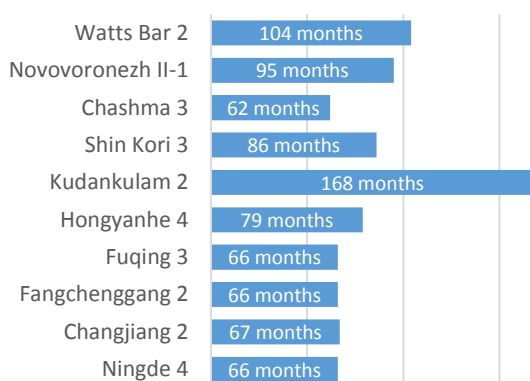
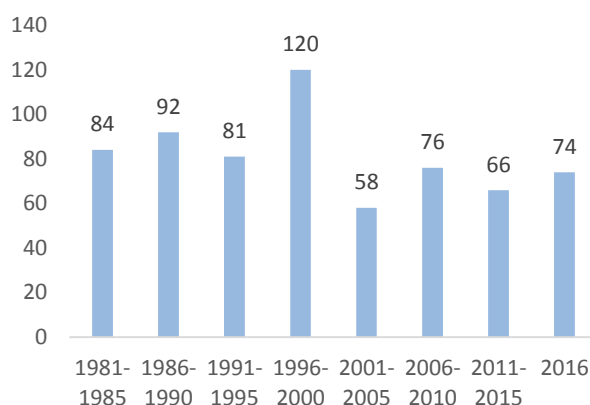


Source: IAEA, Samruk-Kazyna

The strong impetus for developing new nuclear power in China comes from the need to improve urban air quality and reduce greenhouse gas emissions. The government has stated long-term target, as outlined in its Energy Development Strategy Action Plan, 2014-2020, is for 58 GWe nuclear capacity by 2020, with 30 GWe more under construction. Moreover, Russia has announced a massive expansion of their nuclear power plants. Currently Russia operates 36 nuclear reactors with around 27 GW. 6 reactors are in the construction phase. Furthermore, Russia plans the construction of an additional 26 nuclear power plants which should increase the percentage of the nuclear energy in the Russian energy mix from currently 17% to 19%. In a second step, Russia wants to increase this quota to 25%. By the year 2030 Russia wants to build 26 reactors.

Construction time of reactors

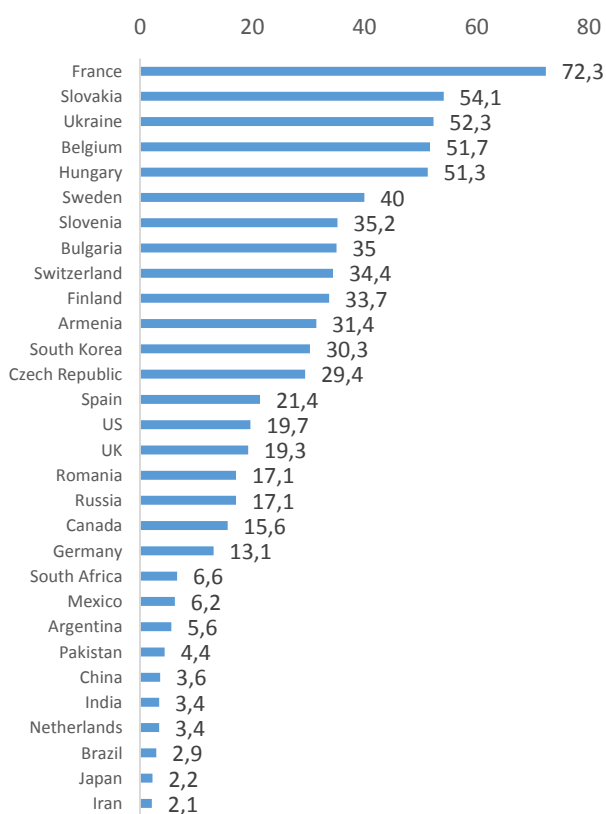
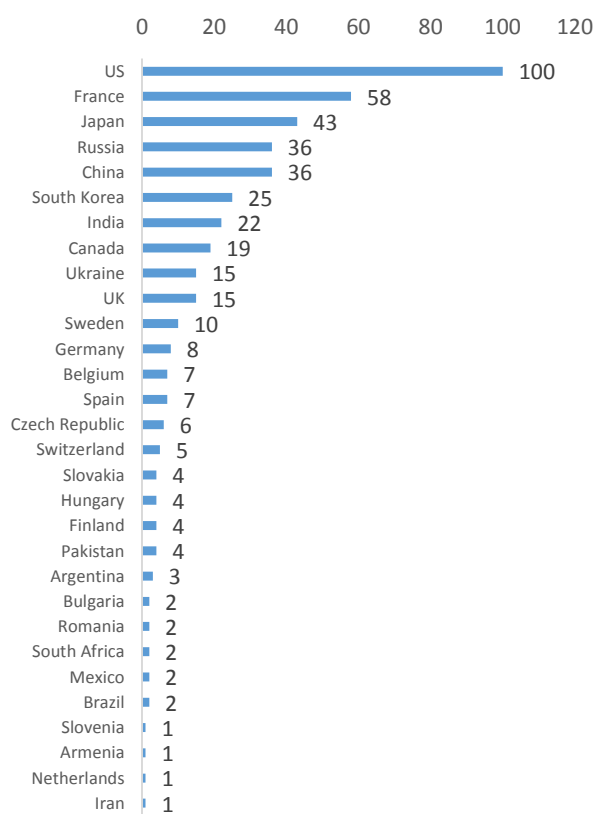
The best performance for construction times for those reactors grid-connected in 2016 are all associated with China. Five of the six reactors built in the shortest time were built in China, and the sixth, Chashma 3, is a Chinese-designed and built reactor, constructed in Pakistan. The construction time listed for Watts Bar 2 is based on the restart date for construction, in October 2007. The median construction time for reactors grid-connected in 2016 was 74 months, higher than for the average in the preceding five years. Construction times have remained below the levels seen prior to 2000.

Construction times of new units connected to the grid in 2016**Median construction times for reactors since 1981**

Source: World Nuclear Association, IAEA PRISE, Samruk-Kazyna

Nuclear electricity generation by countries

The share of nuclear electricity generation amounted to 10.7% of total annual electricity generation in 2015, according to the EIA. France, Slovakia, Ukraine and Hungary have the highest share of nuclear electricity generation in energy mix, however, in terms of the number of operating reactors the US, France, and Japan are the leading countries. Among top oil export countries, only Russia has relatively high share of nuclear in electricity generation at 17.1%. China generates only 3.6% of its total electricity from nuclear, which increased from 2% since 2012. France and Germany reduced their share of nuclear electricity generation from 74.8% and 16.1% in 2012 to 72.3% and 13.1% in 2016 respectively.

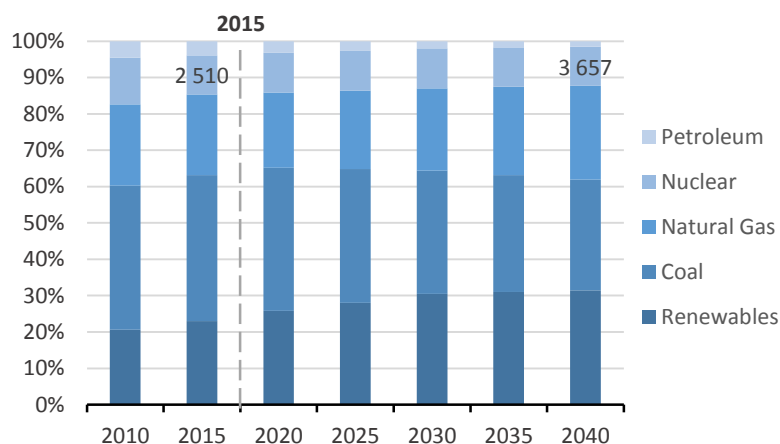
The share of nuclear in electricity generation, %**Number of operating reactors**

Source: US oil and gas reserves study, EY 2017, Samruk-Kazyna

Outlook on nuclear power

Nuclear power is the world's second fastest-growing source of energy with the expected annual growth of consumption at 1.5% over period of 2015-2040. The share of nuclear electricity generation is forecasted to slightly decline to 10.2% by 2040 from 10.7% in 2015. The generation mix in OECD Europe is expected to change significantly by 2040, with nuclear generation's share declining from around 25% in 2015 to less than 15% by 2040. The share of nuclear energy within China's energy demand increases from 3% in 2015 to 11% by 2040, based on EIA data.

Share of net electricity generation, % (2010-2040f)

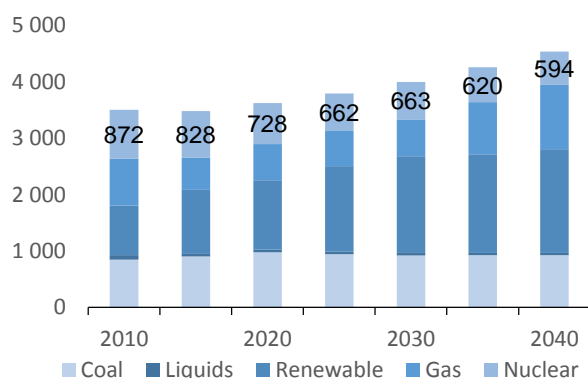


Source: International Energy Outlook 2017, EIA, Samruk-Kazyna

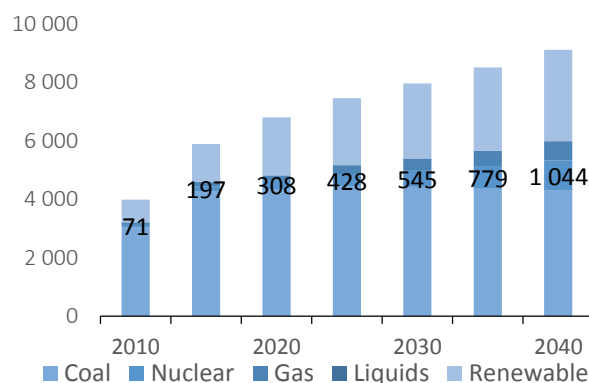
According to ExxonMobil Energy outlook 2018, nuclear demand is expected to increase by 70% between 2016 and 2040, mostly driven by China, which is estimated to account for 50% of this growth. BP expects that renewable energy, nuclear and hydro to contribute for over 80% of the increase in China's energy demand out to 2040. The increase in nuclear energy is expected to be offset by declines in both the EU and US as aging nuclear plants are retired and not replaced.

Strong nuclear reactor growth will support uranium market in the long-term, as 56 reactors are under construction. This market, however, is seen to be potentially volatile owing to both politics and economics, as the increased use of nuclear energy is considered by some governments having negative implications on safety and security.

Electricity generation in OECD Europe, bln kwh



Electricity generation in China, bln kwh



Source: International Energy Outlook 2017, EIA, Samruk-Kazyna

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