



# NUCLEAR POWER INDUSTRY

- There are currently 31 countries with nuclear power plants in operation.
- Overall, 402 nuclear reactors are being operated worldwide.
- The total installed capacity of nuclear power worldwide has increased by 3.3 per cent in the last year and is currently totalling 348GW. The total installed capacity in 2014 was 333GW.<sup>1</sup> The projected growth by 2030 ranges from 435GW as a low projection to 722Gw as a high projection.<sup>2</sup>
- The investment in nuclear reactors in China amounted to 18 billion USD in 2015.
- The US is the largest nuclear energy producer worldwide.<sup>3</sup>

## Introduction:

Since the 1950's, the 440 nuclear power reactors worldwide have amassed in excess of 15,000 'reactor-years of operational experience'.<sup>4</sup> However, after the Fukushima disaster five years ago where a Japanese earthquake triggered a tsunami that destroyed four nuclear reactors, the nuclear industry's safety was brought into question.<sup>5</sup> Each country began ensuring that safety checks were taking place on all nuclear reactors and a minority of countries even began decommissioning theirs. However, others have begun scaling up their nuclear outputs again and countries such as Thailand, Indonesia and Bangladesh have made their first move into the nuclear power industry.

There are currently 31 countries with nuclear power plants in operation – one more than a year ago<sup>6</sup>- with some generating up to three quarters of their electricity with nuclear energy, and a large number relying on nuclear energy to provide between one quarter and one third of their electricity supply.<sup>7</sup> The number of reactors has also increased from mid-2015 when the number was 398. Since the beginning of 2015 the total installed capacity of nuclear power worldwide increased by 3.3 per cent, and is currently totalling 348GW. Globally, nuclear energy supplies around 11 per cent of electricity.<sup>8</sup>

Generally, uranium-fuelled nuclear power is efficient and clean. With the exception of the actual reactor, a nuclear power plant works in a very similar way to gas or coal fired power stations, but generates millions of times more power and far less CO2 emissions. This provides opportunities for consultants who are interested in transferring their skills to a more efficient method of producing energy. When comparing its efficiency to other power sources, nuclear is one of the most efficient in terms of land needed, waste produced and fuel required.<sup>9</sup>

<sup>1</sup> <http://www.worldnuclearreport.org/WNISR2014.html>

<sup>2</sup> <https://www.iaea.org/newscenter/news/iaea-issues-projections-nuclear-power-2020-2050>

<sup>3</sup> <http://www.powermag.com/global-nuclear-power-industry-faces-localized-outlooks/>

<sup>4</sup> <http://www.world-nuclear.org/nuclear-basics/how-does-a-nuclear-reactor-make-electricity.aspx>

<sup>5</sup> <http://www.cbc.ca/news/world/nuclear-outlook-5-years-later-1.3483238>

<sup>6</sup> <http://www.worldnuclearreport.org/The-World-Nuclear-Industry-Status-Report-2016-HTML.html>

<sup>7</sup> <http://www.world-nuclear.org/nuclear-basics/how-does-a-nuclear-reactor-make-electricity.aspx>

<sup>8</sup> <http://www.world-nuclear.org/nuclear-basics/how-does-a-nuclear-reactor-make-electricity.aspx>

<sup>9</sup> <http://www.greenworldinvestor.com/2011/07/07/nuclear-energy-efficiency-vs-fossil-fuels-oilgas-in-power-load-factorsenergy-density-and-waste/>

When delving into the nuclear sector there is one part of the industry that is potentially on the edge of a breakthrough – nuclear fusion. The front runners in the race to a discovery here on earth are the UK, China and Germany. On the precipice of discovery, this is the perfect time for companies to enter the race to nuclear fusion. While nuclear fission is currently the power behind nuclear plants, unlike fission, fusion as a natural process does not have the negative by-products that can be a consequence of nuclear fission.

## China:<sup>10</sup>

- The nuclear policy in China is a closed nuclear cycle, meaning that the useful fuel that remains is recycled.<sup>11</sup>
- In terms of reactor design, construction and the fuel cycle, it is predominantly self-sufficient, however western technology is utilised when it comes to improving and adapting.
- 'China's policy is to 'go global' with exporting nuclear technology including heavy components in the supply chain'.

In total, mainland China has 34 nuclear reactors in operation as well as 20 in the construction phase. Nuclear tends to have the most important role in coastal areas of China, away from the coalfields and it is in this area that the economy is rapidly evolving.

As well as the reactors currently under construction, there are more reactors planned that will be some of the most advanced in the world. As a result of the planned reactors, the country's nuclear capacity will be doubled to 58GW by 2020/21 and eventually up to 150GW by 2030.

Worldwide power generation increased by 1.3 per cent in the past year largely due to China's advances in the industry, which saw it increase its energy production by 31 per cent.<sup>12</sup> In 2015, 10 nuclear power reactors began operating and the construction of another six reactors started (only eight were started worldwide).<sup>13</sup> China generates roughly two per cent of its electricity from nuclear power – this is targeted to be six per cent by 2020.<sup>14</sup>

Much of this increase is a result of reactor's generating capacity being increased. For example in Switzerland, five of its reactor's capacity has been increased by 13.4 per cent. In Spain, they have upgraded nine reactors by up to 13 per cent and in Sweden, all three of their plants have been upgraded, resulting in an increased output.<sup>15</sup>

Unlike other countries, China has increasing motivation to convert from its use of coal fired plants to nuclear power due to the air pollution it causes. In 2004, China's national policy moved from 'moderate development' of nuclear to 'positive development'. This then changed again in 2011/12 to 'steady development with safety'.

China is also one of the leading countries in nuclear fusion research and development, recently achieving temperatures three times hotter than the sun in a quest to recreate fusion in a controlled environment. Through this experiment, the reactor was able to create plasma, however not sustain it – another obstacle faced by an experiment undertaken in Germany. Both experiments 'created plasma through nuclear fusion,' however, it is the time that the plasma remains stable that is integral to the development of nuclear fusion, and is one of the experiment's main obstacles.

<sup>10</sup> <http://www.world-nuclear.org/information-library/country-profiles/countries-a-f/china-nuclear-power.aspx>

<sup>11</sup> [http://www.nuclearconnect.org/wp-content/uploads/2013/06/NuclearFuelCycle\\_web.pdf](http://www.nuclearconnect.org/wp-content/uploads/2013/06/NuclearFuelCycle_web.pdf)

<sup>12</sup> <http://www.worldnuclearreport.org/The-World-Nuclear-Industry-Status-Report-2016-HTML.html>

<sup>13</sup> <http://www.worldnuclearreport.org/The-World-Nuclear-Industry-Status-Report-2016-HTML.html>

<sup>14</sup> <http://www.scmp.com/news/china/policies-politics/article/1932939/after-brief-pause-china-rushes-build-more-nuclear-power>

<sup>15</sup> <http://www.world-nuclear.org/information-library/current-and-future-generation/plans-for-new-reactors-worldwide.aspx>

China is also one of the leading countries in nuclear fusion research and development, recently achieving temperatures three times hotter than the sun in a quest to recreate fusion in a controlled environment.<sup>16</sup> Through this experiment, the reactor was able to create plasma, however not sustain it – another obstacle faced by an experiment undertaken in Germany. Both experiments ‘created plasma through nuclear fusion,’ however, it is the time that the plasma remains stable that is integral to the development of nuclear fusion, and is one of the experiment’s main obstacles.

### **Jordan:<sup>17</sup>**

- One of the up and coming countries in the nuclear power industry.
- Currently imports over 95 per cent of its energy.
- Jordan currently has plans in place for two nuclear power plants that will hopefully generate nearly half of its electricity.

In 2007, the Committee for Nuclear Strategy in Jordan was established, setting out plans to generate 30 per cent of its electricity from nuclear by 2030. The nuclear law in Jordan was then amended in order to set up the Jordan Atomic Energy Commission and the Jordan Nuclear Regulatory Commission.

This year, construction began on Jordan’s first nuclear reactor, Qasr Amra 1 with hopes of being in operation by 2023. There is also a second nuclear reactor planned, Qasr Amra 2, that is expected to be in operation by 2024 – 2025, though construction on the second reactor hasn’t yet begun. Both Qasr Amra 1 and 2 will have a capacity of 1060 MW and there are plans to build a third and fourth reactor in the long term. These new plants are expected to create a wealth of jobs to help build, operate, maintain and eventually, decommission the reactors.

### **Vietnam:<sup>18</sup>**

- Initially, Vietnam undertook nuclear power studies in the 1980s and followed these up with a report in 1995 – which stated that: ‘Around the year 2015, when electricity demand reaches more than 100 billion kWh, nuclear power should be introduced’.
- Russia is financing the construction of 2400MWe of nuclear capacity in Vietnam from 2020.
- Japan is financing construction of 2200MW of capacity in Vietnam.
- Vietnam’s electricity usage is anticipated to triple from 2015 – 2030.

In the last few years, the majority of Vietnam’s energy supply has come from hydropower. However, due to a rapid growth in demand for electricity, the country is currently facing electricity rationing. Subsequently, plans have been put in place to develop the nuclear offering in the country, and by 2030 it is expected that 5.7 per cent of the country’s electricity will come from nuclear power.

There are numerous nuclear power plants planned, with many beginning construction in the next decade. As well as eventual opportunities for consultants in the construction of the plants and the operating and upkeep, there is currently a dearth of research opportunities for consultants as planning and development gets underway. Vietnam is currently establishing the Centre for Nuclear Energy Science and Technology and plans to build a research reactor to run at 15MW which is set to begin construction in October 2018.

<sup>16</sup> <http://www.independent.co.uk/news/science/chinese-nuclear-fusion-scientists-achieve-temperatures-three-times-hotter-thathesun-a6872161.html>

<sup>17</sup> <http://www.world-nuclear.org/information-library/country-profiles/countries-g-n/jordan.aspx>

<sup>18</sup> <http://www.world-nuclear.org/information-library/country-profiles/countries-t-z/vietnam.aspx>

## France:<sup>19</sup>

- Around 75 per cent of France's energy comes from nuclear power. This may dip to 50 per cent by 2025 as a result of the Energy Transition for Green Growth Bill 2014 setting a nuclear power capacity cap.
- Worldwide, France is the largest net exporter of electricity. This is due to the low cost of electricity generation in the country. In terms of revenue, France makes over three billion euros yearly from exporting electricity.
- France is very active in nuclear development and imparts a lot of its knowledge on other countries, including China. The country's technology, reactors and fuel products are a substantial export.
- About 17 per cent of France's electricity is from recycled nuclear fuel, with the additional fuel coming from sources such as hydropower, fossil fuel, wind and solar PV.

### Nuclear Power Plants in France



Source: World Nuclear Association

France is a big player in the nuclear power industry due to the French government's decision in 1974 to expand its nuclear power capacity after the first oil shock. As a result of this decision, France now has a significant amount of independence in nuclear energy and is able to sell its power at one of the lowest prices in Europe. It also has very low levels of CO<sub>2</sub> emissions per capita from electricity generation making it an attractive work destination for consultants who are becoming more aware of the consequences of high emissions. France currently has 58 nuclear reactors, and at least an additional two nuclear reactors planned by 2030- each operated by Electricite de France (EDF) - with a combined capacity of 63.2GWe.<sup>20</sup>

<sup>19</sup> <http://www.world-nuclear.org/information-library/country-profiles/countries-a-f/france.aspx>

<sup>20</sup> <http://www.reuters.com/article/edf-nuclear-epr-idUSL8N1554S4>

## Belgium:<sup>21</sup>

- Half of Belgium's electricity is generated by seven nuclear reactors.
- The first commercial nuclear reactor in Belgium came online in 1974.

### Nuclear Power Plants in Belgium



In Belgium in 2014, 47 per cent of electricity produced was from nuclear power. Belgium's nuclear capacity is just under 6GW which is generated from seven reactors across the country. The 6GW capacity accounts for just over 40% of the country's installed electricity generation capacity.

The country had previously seen a dip in capacity (2014-2015) due to plants going offline as a result of nuclear plant legislation. However, with an amendment to the nuclear phase-out law these plants were able to serve for an additional 10 years with their lives extending to 2025. Consequently the nuclear capacity of the country rose again.<sup>22</sup>

<sup>21</sup> <http://www.world-nuclear.org/information-library/country-profiles/countries-a-f/belgium.aspx>

<sup>22</sup> <http://www.icis.com/resources/news/2016/08/10/10024473/improved-nuclear-availability-to-keep-lid-on-belgian-electricity-prices/>

## **CZECH REPUBLIC:<sup>23</sup>**

- One third of the Czech Republic's electricity is generated by six nuclear reactors.
- Its first commercial reactor came online in 1985.
- The Czech Government is committed to nuclear energy as part of the country's future energy landscape.
- Plans for new nuclear capacity are currently stalled, but policy calls for a substantial increase by 2040, therefore long term opportunities for contractors.

### **Nuclear Power Plants in Czech Republic**



*Source: World Nuclear Association*

This year, the Czech Government set up a committee, headed by the Prime Minister, to organise nuclear power development in the Czech Republic. The committee will be responsible for new construction, supply chain, wastes, and legislation to move the nuclear sector forward.

Currently, the country has six reactors up and running, although there are plans in place for two additional nuclear power reactors and two proposed reactors.

<sup>23</sup> <http://www.world-nuclear.org/information-library/country-profiles/countries-a-f/czech-republic.aspx>

**JOB ROLES:**

Roles in the nuclear power industry are typically broken down into the following areas:

- Commercial
- Engineering
- Environmental/Waste Management
- Project Control/Management
- Safety
- Scientific

Examples of jobs within these areas include:

- Chemistry Technician
- Experienced Engineer
- Instrumentation and Control Technician
- Senior Reactor Operator
- Operations Manager
- CAD Designer

**OUTLOOK:**

Even with the Fukushima disaster etched in memories, the use of nuclear energy continues to increase by two to three per cent annually. There are many major plans for new units in both Asia and Russia, as well as significant increases in plant upgrades and plans to extend the life of plants. All of this results in the need for workers across the world in different areas of the nuclear power industry.

**About Procorre**

Procorre is a global professional services consultancy, which successfully manages the whole life cycle of projects, across a range of industries.

Currently deploying over 1,500 highly skilled and experienced consultants on projects around the world, Procorre seeks to acquire the best talent

and provide them with a more rewarding way to work.

Procorre also offers a range of advisory and consultancy services to clients worldwide, as well as collaborating with preferred suppliers to ensure consultants have access to the best projects across the globe.

**Read more reports & white papers**

[www.procorre.com](http://www.procorre.com)

And on Twitter

For consultants @procorre

For partners @procorrepartner

Singapore +65 3158 7777

UK +44 20 3432 0480

Ireland +353 15 134 777