Nuclear Power Plants: 2015 atw Compact Statistics

Editorial

At the end of the last year 2015 (key date: 31 December 2015), nuclear power plants were operating in 31 countries worldwide (cf. **Table 1**). In total, **442 nuclear power plants** were operating on the key date. This means that the number did not change compared to the previous year's number on 31 December 2014. The **gross power output** of these nuclear power plant units[1)] amounted to around 409 GWe, the **net power output** was approximately 388 GWe This means that the available gross and net capacities were about 3 GW, i.e. 0.75 % above the previous year's values of about 406 GWe gross and 385 GWe net. (These numbers include the Beloyarsky 4 unit in Russia, which in is nuclear test operation since 2014).

Seven nuclear power plants **started (nuclear) operation**[1)] in two countries in 2015. Six units reached initial criticality, were synchronized with the grid and started commercial operation for the first time in 2015 (cf. **Tab. 1**): China: *Changjiang 1* (650 MW), *Fuqing 2* (1 087 MW,), *Ningde 3* (1 080 MW), *Yangjiang 2* (1 080 MW), *Yangjiang 3* (1 080 MW); Korea (Rep.): *Shin-Wolsong* (1 000 MW). Additionally in China the unit *Fangchenggang 1* (1 080 MW) reached first criticality in 2015 and was connected to the grid. The unit will start commercial operation in 2016.

For the first time since the accidents in Fukushima (Japan) nuclear power units **resumed** operation in 2015 after a longer shut-down. The units *Sendai 1* (PWR, 890 MW) and *Sendai 2* (PWR, 890 MW). *Sendai 1* was connected to the grid in August 2015, *Sendai 2* in October 2015. Further restarts are planned, prepared and applied for at the authorities.

Seven nuclear power plant units were definitively permanently shut-down worldwide in 2015. According to the revised Atomic Energy Act 2011 in Germany the pressurised water reactor *Grafenrheinfeld* (1 345 MW) in Bavaria ceased electricity production on 27 June 2015. Since commissioning in 1981 the plant has produced 333,280,185 MWh gross.

The last Magnox power station in the world, *Wylfa* (540 MW), stopped generating electricity on 30 December 2015, in the United Kindgom. As part of a well-established and long-planned decommissioning programme, reactor one was finally switched off after 44 years of electricity generation; five years after the plant's original planned closure date. Reactor two was shutdown in 2012. *Wylfa*, on Anglesey, was the last and largest in a fleet of 11 UK plants based on the ground-breaking Magnox design that led to the world's first-ever industrial-scale nuclear power station, supplying the nation with electricity. At the time of construction, *Wylfa* was the most technically advanced nuclear power station in the UK and the world's most powerful, generating 1,000 MW output at its peak. In Japan a total of 5 units were declared to be shut-down in 2015. The identified high costs for retrofitting identified exceeded the foreseeable economical benefits. The units are: *Genkai 1* (559 MW), *Mihama 1* (340 MW), *Mihama 2* (500 MW), *Shimane 1* (460 MW) and *Tsuruga 1* (357 MW).

At the end of last year 2015, 65 plants in 15 countries were **under construction**, in other words the number was unchanged compared to the previous year number due to commissioning and new-build of units (Note: correction of earlier information presented in the atw quick statistics due to initial construction work and dating of units to the turn of the year). The capacity of these projects amounts to about 69 GWe gross and 65 GWe net power output, in other words both about 1 GW more than a year earlier due to a higher capacity of the new-build projects. Seven new nuclear power plant projects were started in 2015: New construction projects are reported from China; six units, and the United Arab Republic; one project. Compared with the millennium change 1999/2000 this means that the number of projects under construction has risen, when 30 nuclear power plants were under construction worldwide.

In China the "standard nuclear power plant project" proceeded with the units *Fangchenggang 3* (1 080 MW), *Fuqing 5* (1 087 MW), *Fuqing 6* (1 087 MW), *Hongyanhe 5* (1 080 MW), *Hongyanhe 6* (1 080 MW) and *Tianwan 5* 1 118 MW). In the United Arab Republic the *Barakah 4* (1 400 MW) project started. The expansion plans of the country comprise at least 4 to 8 units in the mid-term. The construction of the first unit started in 2012. First criticality is expected in 2017.

Active construction projects (numbers in brackets) listed are: Argentina (1), Belarus (2), Brazil (1), China (24), Finland (1), France (1), India (6), Japan (2), Republic of Korea (4), Pakistan (2), Russia (8), Slovak Republic (2), Taiwan (2), the USA (5) and the United Arab Emirates (4).

In addition, there are about 125 nuclear power plant units in 25 countries worldwide that are in an advanced planning stage, others are in the pre-planning phase (status: 31 December 2015).

[1)] **Note:**
In the following information provided by atw, a reactor plant is said to be "operating" as of the point in time that initial criticality was reached. Other sources sometimes refer to the initial grid synchronization or the starting up of commercial operations.

Nuclear power plants are said to be "under construction" after the "first concrete has been cast". English sources also differentiate between the "unit", e.g. the nuclear power plant unit *Gundremmingen B* and nuclear power plants, e.g. nuclear plant *Gundremmingen*.

Country Location/ Station name	Status	Reactor type	Capacity gross [MW]	Capacity net [MW]	1st Criticality [Year]
Argentina					
Atucha 1	■	D2O-PWR	357	341	1974
Embalse	■	Candu	648	600	1983
Atucha 2	■	D2O-PWR	745	692	2014
CAREM25	□	PWR	29	25	(2018)
Armenia					
Metsamor 2	■	VVER-PWR	408	376	1980
Belarus					
Belarusian 1	□	VVER-PWR	1 194	1 109	(2019)
Belarusian 2	□	VVER-PWR	1 194	1 109	(2021)
Belgium					
Doel 1	■	PWR	454	433	1975
Doel 2	■	PWR	454	433	1975
Doel 3	■	PWR	1 056	1 006	1982
Doel 4	■	PWR	1 090	1 039	1985
Tihange 1	■	PWR	1 009	962	1975
Tihange 2	■	PWR	1 055	1 008	1983
Tihange 3	■	PWR	1 094	1 046	1985
Brazil					
Angra 1	■	PWR	640	609	1984
Angra 2	■	PWR	1 350	1 275	1999
Angra 3	□	PWR	1 300	1 245	(2017)
Bulgarien					
Kozloduj 5	■	VVER-PWR	1 000	953	1987

Country Location/ Station name		Status	Reactor type	Capacity gross [MW]	Capacity net [MW]	1st Criticality [Year]
Kozloduj 6		■	VVER-PWR	1000	953	1989
Canada						
Bruce 1		■	Candu	824	772	1977
Bruce 2		■	Candu	786	734	1977
Bruce 3		■	Candu	805	730	1977
Bruce 4		■	Candu	805	750	1979
Bruce 5		■	Candu	872	817	1985
Bruce 6		■	Candu	891	822	1984
Bruce 7		■	Candu	872	817	1986
Bruce 8		■	Candu	845	817	1987
Darlington 1		■	Candu	934	878	1993
Darlington 2		■	Candu	934	878	1990
Darlington 3		■	Candu	934	878	1993
Darlington 4		■	Candu	934	878	1993
Pickering 1		■	Candu	542	515	1971
Pickering 4		■	Candu	542	515	1973
Pickering 5		■	Candu	540	516	1983
Pickering 6		■	Candu	540	516	1984
Pickering 7		■	Candu	540	516	1985
Pickering 8		■	Candu	540	516	1986
Point Lepreau		■	Candu	705	660	1983
China						
CEFR		■	SNR	25	20	2011
Changjiang 1	[1]	■	PWR	650	610	2015
Fangchenggang 1	[1]	■	PWR	1080	1000	2015
Fangjiashan 1		■	PWR	1080	1000	2014
Fangjiashan 2	[1]	■	PWR	1080	1000	2014
Fuqing 1		■	PWR	1087	1000	2014
Fuqing 2	[1]	■	PWR	1087	1000	2015
Guandong 1		■	PWR	984	944	1993
Guandong 2		■	PWR	984	944	1994
Hongyanhe 1		■	PWR	1080	1000	2013
Hongyanhe 2		■	PWR	1080	1000	2013
Hongyanhe 3	[1]	■	PWR	1080	1000	2014
Lingao 1		■	PWR	990	938	2002
Lingao 2		■	PWR	990	938	2002
Lingao II-1		■	PWR	1087	1000	2010
Lingao II-2		■	PWR	1087	1000	2011
Ningde 1		■	PWR	1087	1000	2012
Ningde 2		■	PWR	1080	1000	2014
Ningde 3	[1]	■	PWR	1080	1000	2015
Qinshan 1		■	PWR	310	288	1992
Qinshan II-1		■	PWR	650	610	2002
Qinshan II-2		■	PWR	650	610	2004
Qinshan II-3		■	PWR	642	610	2010
Qinshan II-4		■	PWR	642	610	2011
Qinshan III-1		■	Candu	728	665	2002
Qinshan III-2		■	Candu	728	665	2003
Tianwan 1		■	VVER-PWR	1060	1000	2005
Tianwan 2		■	VVER-PWR	1060	1000	2007
Yangjiang 1		■	PWR	1080	1000	2013
Yangjiang 2	[1]	■	PWR	1080	1000	2015
Yangjiang 3	[1]	■	PWR	1080	1000	2015
Changjiang 2		□	PWR	650	610	(2016)
Fangchenggang 2		□	PWR	1080	1000	(2016)
Fangchenggang 3	[2]	□	PWR	1080	1000	(2020)
Fuqing 3		□	PWR	1087	1000	(2016)
Fuqing 4		□	PWR	1087	1000	(2016)
Fuqing 5	[2]	□	PWR	1087	1000	(2020)
Fuqing 6	[2]	□	PWR	1087	1000	(2020)
Haiyang 1		□	PWR	1180	1100	(2016)
Haiyang 2		□	PWR	1180	1100	(2016)
Hongyanhe 4		□	PWR	1080	1000	(2016)
Hongyanhe 5	[2]	□	PWR	1080	1000	(2020)
Hongyanhe 6	[2]	□	PWR	1080	1000	(2021)
Ningde 4		□	PWR	1080	1000	(2016)
Sanmen 1		□	PWR	1180	1100	(2016)
Sanmen 2		□	PWR	1180	1100	(2016)
Shidaowan 1		□	HTGR	211	200	(2016)
Taishan 1		□	PWR	1750	1660	(2016)
Taishan 2		□	PWR	1750	1660	(2017)
Tianwan 3		□	VVER-PWR	1060	990	(2017)
Tianwan 4		□	VVER-PWR	1060	990	(2018)
Tianwan 5	[2]	□	VVER-PWR	1118	1000	(2020)
Yangjiang 4		□	PWR	1080	1000	(2016)
Yangjiang 5		□	PWR	1080	1000	(2018)
Yangjiang 6		□	PWR	1080	1000	(2018)
Czech Republic						
Dukovany 1		■	VVER-PWR	500	473	1985
Dukovany 2		■	VVER-PWR	500	473	1986
Dukovany 3		■	VVER-PWR	500	473	1987
Dukovany 4		■	VVER-PWR	500	473	1987
Temelín 1		■	VVER-PWR	1077	1027	1999
Temelín 2		■	VVER-PWR	1056	1006	2002

Country Location/ Station name		Status	Reactor type	Capacity gross [MW]	Capacity net [MW]	1st Criticality [Year]
Finland						
Loviisa 1		■	VVER-PWR	520	496	1977
Loviisa 2		■	VVER-PWR	520	496	1981
Olkiluoto 1		■	BWR	890	860	1979
Olkiluoto 2		■	BWR	890	860	1982
Olkiluoto 3		□	PWR	1600	1510	(2018)
France						
Belleville 1		■	PWR	1363	1310	1987
Belleville 2		■	PWR	1363	1310	1988
Blayais 1		■	PWR	951	910	1981
Blayais 2		■	PWR	951	910	1982
Blayais 3		■	PWR	951	910	1983
Blayais 4		■	PWR	951	910	1983
Bugey 2		■	PWR	945	910	1978
Bugey 3		■	PWR	945	910	1978
Bugey 4		■	PWR	917	880	1979
Bugey 5		■	PWR	917	880	1979
Cattenom 1		■	PWR	1362	1300	1986
Cattenom 2		■	PWR	1362	1300	1987
Cattenom 3		■	PWR	1362	1300	1990
Cattenom 4		■	PWR	1362	1300	1991
Chinon B-1		■	PWR	954	905	1982
Chinon B-2		■	PWR	954	905	1983
Chinon B-3		■	PWR	954	905	1986
Chinon B-4		■	PWR	954	905	1987
Chooz B-1		■	PWR	1560	1500	1996
Chooz B-2		■	PWR	1560	1500	1997
Civaux 1		■	PWR	1561	1495	1997
Civaux 2		■	PWR	1561	1495	1999
Cruas Meysse 1		■	PWR	956	915	1983
Cruas Meysse 2		■	PWR	956	915	1984
Cruas Meysse 3		■	PWR	956	915	1984
Cruas Meysse 4		■	PWR	956	915	1984
Dampierre 1		■	PWR	937	890	1980
Dampierre 2		■	PWR	937	890	1980
Dampierre 3		■	PWR	937	890	1981
Dampierre 4		■	PWR	937	890	1981
Fessenheim 1		■	PWR	920	880	1977
Fessenheim 2		■	PWR	920	880	1977
Flamanville 1		■	PWR	1382	1330	1985
Flamanville 2		■	PWR	1382	1330	1986
Golfech 1		■	PWR	1363	1310	1990
Golfech 2		■	PWR	1363	1310	1993
Gravelines B-1		■	PWR	951	910	1980
Gravelines B-2		■	PWR	951	910	1980
Gravelines B-3		■	PWR	951	910	1980
Gravelines B-4		■	PWR	951	910	1981
Gravelines C-5		■	PWR	951	910	1984
Gravelines C-6		■	PWR	951	910	1985
Nogent 1		■	PWR	1363	1310	1987
Nogent 2		■	PWR	1363	1310	1988
Paluel 1		■	PWR	1382	1330	1984
Paluel 2		■	PWR	1382	1330	1984
Paluel 3		■	PWR	1382	1330	1985
Paluel 4		■	PWR	1382	1330	1986
Penly 1		■	PWR	1382	1330	1990
Penly 2		■	PWR	1382	1330	1992
St. Alban 1		■	PWR	1381	1335	1986
St. Alban 2		■	PWR	1381	1335	1987
St. Laurent B-1		■	PWR	956	915	1981
St. Laurent B-2		■	PWR	956	915	1981
Tricastin 1		■	PWR	955	915	1980
Tricastin 2		■	PWR	955	915	1980
Tricastin 3		■	PWR	955	915	1980
Tricastin 4		■	PWR	955	915	1981
Flamanville 3		□	PWR	1600	1510	(2018)
Germany						
Brokdorf		■	PWR	1480	1410	1986
Emsland		■	PWR	1406	1335	1988
Grohnde		■	PWR	1430	1360	1985
Gundremmingen B		■	BWR	1344	1284	1984
Gundremmingen C		■	BWR	1344	1288	1985
Isar 2		■	PWR	1485	1410	1988
Neckarwestheim II		■	PWR	1400	1310	1989
Philippsburg 2		■	PWR	1468	1402	1985
Grafenrheinfeld	[6]	✧	PWR	1345	1275	1982
Hungary						
Paks 1		■	VVER-PWR	500	470	1983
Paks 2		■	VVER-PWR	500	473	1984
Paks 3		■	VVER-PWR	500	473	1986
Paks 4		■	VVER-PWR	500	473	1987
India						
Kaiga 1		■	Candu (IND)	220	202	2001
Kaiga 2		■	Candu (IND)	220	202	1999

Country Location/ Station name		Status	Reactor type	Capacity gross [MW]	Capacity net [MW]	1st Criticality [Year]
Kaiga 3		■	Candu (IND)	220	202	2007
Kaiga 4		■	Candu (IND)	220	202	2010
Kakrapar 1		■	Candu (IND)	220	202	1993
Kakrapar 2		■	Candu (IND)	220	202	1995
Kudankulam 1		■	VVER-PWR	1 000	917	2013
Madras Kalpakkam 1		■	Candu (IND)	220	205	1984
Madras Kalpakkam 2		■	Candu (IND)	220	205	1986
Narora 1		■	Candu (IND)	220	202	1992
Narora 2		■	Candu (IND)	220	202	1991
Rajasthan 1		■	Candu	100	90	1973
Rajasthan 2		■	Candu	200	187	1981
Rajasthan 3		■	Candu (IND)	220	202	1999
Rajasthan 4		■	Candu (IND)	220	202	2000
Rajasthan 5		■	Candu (IND)	220	202	2009
Rajasthan 6		■	Candu (IND)	220	202	2010
Tarapur 1		■	BWR	160	150	1969
Tarapur 2		■	BWR	160	150	1969
Tarapur 3		■	Candu (IND)	540	490	2006
Tarapur 4		■	Candu (IND)	540	490	2005
Kakrapar 3		□	Candu (IND)	700	640	(2016)
Kakrapar 4		□	Candu (IND)	700	640	(2016)
Kudankulam 2		□	VVER-PWR	1 000	917	(2016)
PFBR (Kalpakkam)		□	SNR	500	470	(2016)
Rajasthan 7		□	Candu (IND)	700	630	(2017)
Rajasthan 8		□	Candu (IND)	700	630	(2017)
Iran						
Bushehr 1		■	VVER-PWR	1 000	953	2011
Japan						
Fukushima Daini 1		■	BWR	1 100	1 067	1982
Fukushima Daini 2		■	BWR	1 100	1 067	1984
Fukushima Daini 3		■	BWR	1 100	1 067	1985
Fukushima Daini 4		■	BWR	1 100	1 067	1987
Genkai 2		■	PWR	559	529	1981
Genkai 3		■	PWR	1 180	1 127	1994
Genkai 4		■	PWR	1 180	1 127	1997
Hamaoka 3		■	BWR	1 100	1 056	1987
Hamaoka 4		■	BWR	1 137	1 092	1993
Hamaoka 5		■	BWR	1 267	1 216	2004
Higashidori 1		■	BWR	1 100	1 067	2005
Ikata 1		■	PWR	566	538	1977
Ikata 2		■	PWR	566	538	1982
Ikata 3		■	PWR	890	846	1994
Kashiwazaki Kariwa 1		■	BWR	1 100	1 067	1985
Kashiwazaki Kariwa 2		■	BWR	1 100	1 067	1990
Kashiwazaki Kariwa 3		■	BWR	1 100	1 067	1993
Kashiwazaki Kariwa 4		■	BWR	1 100	1 067	1994
Kashiwazaki Kariwa 5		■	BWR	1 100	1 067	1990
Kashiwazaki Kariwa 6		■	BWR	1 356	1 315	1996
Kashiwazaki Kariwa 7		■	BWR	1 356	1 315	1997
Mihama 3		■	PWR	826	781	1976
Monju		■	FBR	280	246	1994
Ohi 1		■	PWR	1 175	1 120	1979
Ohi 2		■	PWR	1 175	1 120	1979
Ohi 3		■	PWR	1 180	1 127	1991
Ohi 4		■	PWR	1 180	1 127	1993
Onagawa 1		■	BWR	524	496	1984
Onagawa 2		■	BWR	825	796	1995
Onagawa 3		■	BWR	825	798	2002
Sendai 1	[4]	■	PWR	890	846	1984
Sendai 2	[4]	■	PWR	890	846	1985
Shika 1		■	BWR	540	505	1993
Shika 2		■	BWR	1 358	1 304	2005
Shimane 2		■	BWR	820	791	1989
Takahama 1		■	PWR	826	780	1974
Takahama 2		■	PWR	826	780	1975
Takahama 3		■	PWR	870	830	1985
Takahama 4		■	PWR	870	830	1985
Tokai 2		■	BWR	1 100	1 067	1978
Tomari 1		■	PWR	579	550	1989
Tomari 2		■	PWR	579	550	1991
Tomari 3		■	PWR	912	866	2009
Tsuruga 2		■	PWR	1 160	1 115	1986
Shimane 3		□	BWR	1 375	1 325	(2018)
Ohma		□	BWR	1 385	1 325	(2020)
Genkai 1	[6]	✧	PWR	559	529	1975
Mihama 1	[6]	✧	PWR	340	320	1970
Mihama 2	[6]	✧	PWR	500	470	1972
Shimane 1	[6]	✧	BWR	460	439	1974
Tsuruga 1	[6]	✧	BWR	357	341	1970
Korea (Republic)						
Kori 1		■	PWR	603	576	1978
Kori 2		■	PWR	676	639	1983
Kori 3		■	PWR	1 042	1 003	1985
Kori 4		■	PWR	1 041	1 001	1986
Shin Kori 1		■	PWR	1 048	996	2010
Shin Kori 2		■	PWR	1 045	993	2011
Hanul 1		■	PWR	1 003	960	1988
Hanul 2		■	PWR	1 008	962	1989
Hanul 3		■	PWR	1 050	994	1998
Hanul 4		■	PWR	1 053	998	1998
Hanul 5		■	PWR	1 051	996	2003
Hanul 6		■	PWR	1 051	996	2004
Wolsong 1		■	Candu	687	645	1983
Wolsong 2		■	Candu	678	653	1997
Wolsong 3		■	Candu	698	675	1999
Wolsong 4		■	Candu	703	679	1999
Shin Wolsong 1		■	PWR	1 043	991	2012
Shin Wolsong 2	[1]	■	PWR	1 000	960	2015
Hanbit 1		■	PWR	996	953	1986
Hanbit 2		■	PWR	993	945	1987
Hanbit 3		■	PWR	1 050	997	1995
Hanbit 4		■	PWR	1 049	997	1996
Hanbit 5		■	PWR	1 053	997	2001
Hanbit 6		■	PWR	1 052	995	2002
Shin Kori 3		□	PWR	1 400	1 340	(2016)
Shin Kori 4		□	PWR	1 400	1 340	(2016)
Shin Hanul 1		□	PWR	1 400	1 340	(2016)
Shin Hanul 2		□	PWR	1 400	1 340	(2017)
Mexico						
Laguna Verde 1		■	BWR	820	765	1990
Laguna Verde 2		■	BWR	820	765	1995
Netherlands						
Borssele		■	PWR	515	482	1973
Pakistan						
Kanupp		■	Candu	137	909	1972
Chasnupp 1		■	PWR	325	300	2000
Chasnupp 2		■	PWR	325	300	2011
Chasnupp 3		□	PWR	340	315	(2016)
Chasnupp 4		□	PWR	340	315	(2016)
Romania						
Cernavoda 1		■	Candu	706	650	1996
Cernavoda 2		■	Candu	706	655	2007
Russia						
Balakovo 1		■	VVER-PWR	1 000	953	1986
Balakovo 2		■	VVER-PWR	1 000	953	1988
Balakovo 3		■	VVER-PWR	1 000	953	1990
Balakovo 4		■	VVER-PWR	1 000	953	1993
Beloyarsky 3		■	FBR	600	560	1981
Beloyarsky 4		■	FBR	800	750	2014
Bilibino 1		■	LWGR	12	11	1974
Bilibino 2		■	LWGR	12	11	1975
Bilibino 3		■	LWGR	12	11	1976
Bilibino 4		■	LWGR	12	11	1977
Kalinin 1		■	VVER-PWR	1 000	953	1985
Kalinin 2		■	VVER-PWR	1 000	953	1987
Kalinin 3		■	VVER-PWR	1 000	953	2004
Kalinin 4		■	VVER-PWR	1 000	953	2011
Kola 1		■	VVER-PWR	440	411	1973
Kola 2		■	VVER-PWR	440	411	1975
Kola 3		■	VVER-PWR	440	411	1982
Kola 4		■	VVER-PWR	440	411	1984
Kursk 1		■	LWGR	1 000	925	1977
Kursk 2		■	LWGR	1 000	925	1979
Kursk 3		■	LWGR	1 000	925	1984
Kursk 4		■	LWGR	1 000	925	1986
Leningrad 1		■	LWGR	1 000	925	1974
Leningrad 2		■	LWGR	1 000	925	1976
Leningrad 3		■	LWGR	1 000	925	1980
Leningrad 4		■	LWGR	1 000	925	1981
Novovoronezh 3		■	VVER-PWR	417	385	1972
Novovoronezh 4		■	VVER-PWR	417	385	1973
Novovoronezh 5		■	VVER-PWR	1 000	953	1981
Rostov 1		■	VVER-PWR	1 000	953	2001
Rostov 2		■	VVER-PWR	1 000	953	2010
Rostov 3	[1]	■	VVER-PWR	1 085	1 011	2014
Smolensk 1		■	LWGR	1 000	925	1983
Smolensk 2		■	LWGR	1 000	925	1985
Smolensk 3		■	LWGR	1 000	925	1990
Akademik Lomonosov I		□	PWR	40	35	(2019)
Akademik Lomonosov I		□	PWR	40	35	(2019)
Baltic 1 (Kaliningrad)		□	VVER-PWR	1 170	1 080	(2017)
Leningrad II-1		□	VVER-PWR	1 170	1 085	(2016)
Leningrad II-2		□	VVER-PWR	1 170	1 085	(2017)
Novovoronezh II-1		□	VVER-PWR	1 000	955	(2016)
Novovoronezh II-2		□	VVER-PWR	1 000	955	(2017)
Rostov 4		□	VVER-PWR	1 085	1 011	(2016)
Slovakia						
Bohunice 3		■	VVER-PWR	505	472	1985

Country Location/ Station name		Status	Reactor type	Capacity gross [MW]	Capacity net [MW]	1st Criticality [Year]
Bohunice 4		■	VVER-PWR	505	472	1985
Mochovce 1		■	VVER-PWR	470	436	1998
Mochovce 2		■	VVER-PWR	470	436	1999
Mochovce 3		□	VVER-PWR	440	408	(2017)
Mochovce 4		□	VVER-PWR	440	408	(2017)
Slovenia						
Krsko		■	PWR	727	696	1983
South Africa						
Koeberg 1		■	PWR	970	930	1984
Koeberg 2		■	PWR	970	930	1985
Spain						
Almaraz 1		■	PWR	1049	1011	1981
Almaraz 2		■	PWR	1044	1006	1983
Ascó 1		■	PWR	1033	995	1984
Ascó 2		■	PWR	1027	997	1985
Cofrentes		■	BWR	1092	1064	1985
Trillo 1		■	PWR	1066	1002	1988
Vandellos 2		■	PWR	1087	1045	1987
Santa Maria de Garoña	[5]	•	BWR	466	446	1971
Sweden						
Forsmark 1		■	BWR	1022	984	1980
Forsmark 2		■	BWR	1158	1120	1981
Forsmark 3		■	BWR	1212	1170	1985
Oskarshamn 1		■	BWR	492	473	1972
Oskarshamn 2		■	BWR	661	638	1975
Oskarshamn 3		■	BWR	1450	1400	1985
Ringhals 1		■	BWR	910	878	1976
Ringhals 2		■	PWR	847	807	1975
Ringhals 3		■	PWR	1117	1064	1981
Ringhals 4		■	PWR	990	940	1983
Switzerland						
Beznau 1		■	PWR	380	365	1969
Beznau 2		■	PWR	380	365	1972
Gösgen		■	PWR	1060	1010	1979
Leibstadt		■	BWR	1275	1220	1984
Mühleberg		■	BWR	390	373	1973
Taiwan						
Chin Shan 1		■	BWR	636	604	1978
Chin Shan 2		■	BWR	636	604	1979
Kuosheng 1		■	BWR	985	948	1981
Kuosheng 2		■	BWR	985	948	1983
Maanshan 1		■	PWR	951	890	1984
Maanshan 2		■	PWR	951	890	1985
Lungmen 1		□	BWR	1356	1315	(2016)
Lungmen 2		□	BWR	1356	1315	(2017)
United Arab Emirates						
Barakah 1		□	PWR	1400	1340	(2017)
Barakah 2		□	PWR	1400	1340	(2018)
Barakah 3		□	PWR	1400	1340	(2019)
Barakah 4	[2]	□	PWR	1400	1340	(2019)
United Kingdom						
Dungeness B-1		■	AGR	615	520	1985
Dungeness B-2		■	AGR	615	520	1986
Hartlepool-1		■	AGR	655	595	1984
Hartlepool-2		■	AGR	655	585	1985
Heysham I-1		■	AGR	625	585	1984
Heysham I-2		■	AGR	625	575	1985
Heysham II-1		■	AGR	682	595	1988
Heysham II-2		■	AGR	682	595	1989
Hinkley Point B-1		■	AGR	655	610	1976
Hinkley Point B-2		■	AGR	655	610	1977
Hunterston B-1		■	AGR	644	460	1976
Hunterston B-2		■	AGR	644	430	1977
Sizewell B		■	PWR	1250	1191	1995
Torness Point 1		■	AGR	682	595	1988
Torness Point 2		■	AGR	682	595	1989
Wylfa 1	[6]	✧	GGR	540	490	1971
Ukraine						
Khmelnitski 1		■	VVER-PWR	1000	950	1985
Khmelnitski 2		■	VVER-PWR	1000	950	2004
Rovno 1		■	VVER-PWR	402	363	1981
Rovno 2		■	VVER-PWR	416	377	1982
Rovno 3		■	VVER-PWR	1000	950	1987
Rovno 4		■	VVER-PWR	1000	950	2004
Zaporozhe 1		■	VVER-PWR	1000	950	1985
Zaporozhe 2		■	VVER-PWR	1000	950	1985
Zaporozhe 3		■	VVER-PWR	1000	950	1987
Zaporozhe 4		■	VVER-PWR	1000	950	1988
Zaporozhe 5		■	VVER-PWR	1000	950	1988
Zaporozhe 6		■	VVER-PWR	1000	950	1989
South Ukraine 1		■	VVER-PWR	1000	950	1983
South Ukraine 2		■	VVER-PWR	1000	950	1985
South Ukraine 3		■	VVER-PWR	1000	950	1989

Country Location/ Station name	Status	Reactor type	Capacity gross [MW]	Capacity net [MW]	1st Criticality [Year]
USA					
Arkansas Nuclear One 1	■	PWR	969	903	1974
Arkansas Nuclear One 2	■	PWR	1006	943	1980
Beaver Valley 1	■	PWR	955	923	1976
Beaver Valley 2	■	PWR	957	923	1987
Braidwood 1	■	PWR	1289	1225	1988
Braidwood 2	■	PWR	1289	1225	1988
Browns Ferry 1	■	BWR	1200	1152	1974
Browns Ferry 2	■	BWR	1193	1152	1975
Browns Ferry 3	■	BWR	1232	1190	1977
Brunswick 1	■	BWR	1074	1002	1977
Brunswick 2	■	BWR	1075	1002	1975
Byron 1	■	PWR	1307	1225	1985
Byron 2	■	PWR	1304	1225	1987
Callaway	■	PWR	1316	1236	1985
Calvert Cliffs 1	■	PWR	935	918	1975
Calvert Cliffs 2	■	PWR	939	911	1977
Catawba 1	■	PWR	1286	1205	1985
Catawba 2	■	PWR	1286	1205	1986
Clinton 1	■	BWR	1175	1138	1987
Comanche Peak 1	■	PWR	1283	1215	1990
Comanche Peak 2	■	PWR	1283	1215	1993
Donald Cook 1	■	PWR	1266	1152	1975
Donald Cook 2	■	PWR	1210	1133	1978
Columbia (WNP 2)	■	BWR	1244	1200	1984
Cooper	■	BWR	844	801	1974
Davis Besse 1	■	PWR	971	925	1978
Diablo Canyon 1	■	PWR	1236	1159	1985
Diablo Canyon 2	■	PWR	1246	1164	1985
Dresden 2	■	BWR	1057	1009	1970
Dresden 3	■	BWR	1057	1009	1971
Duane Arnold	■	BWR	737	680	1975
Farley 1	■	PWR	933	888	1977
Farley 2	■	PWR	934	888	1981
Fermi 2	■	BWR	1317	1217	1988
FitzPatrick	■	BWR	918	882	1975
Fort Calhoun 1	■	PWR	526	502	1973
Ginna	■	PWR	713	614	1970
Grand Gulf 1	■	BWR	1516	1440	1985
Hatch 1	■	BWR	891	857	1974
Hatch 2	■	BWR	905	865	1979
Hope Creek 1	■	BWR	1360	1291	1986
Indian Point 2	■	PWR	1348	1299	1974
Indian Point 3	■	PWR	1051	1012	1976
La Salle 1	■	BWR	1242	1170	1984
La Salle 2	■	BWR	1238	1170	1984
Limerick 1	■	BWR	1203	1139	1986
Limerick 2	■	BWR	1199	1139	1990
McGuire 1	■	PWR	1358	1220	1981
McGuire 2	■	PWR	1358	1220	1984
Millstone 2	■	PWR	946	910	1975
Millstone 3	■	PWR	1308	1253	1986
Monticello	■	BWR	734	685	1971
Nine Mile Point 1	■	BWR	671	642	1969
Nine Mile Point 2	■	BWR	1302	1259	1988
North Anna 1	■	PWR	1035	980	1978
North Anna 2	■	PWR	1033	980	1980
Oconee 1	■	PWR	955	887	1973
Oconee 2	■	PWR	955	887	1974
Oconee 3	■	PWR	961	893	1974
Oyster Creek	■	BWR	595	550	1969
Palisades	■	PWR	870	812	1971
Palo Verde 1	■	PWR	1528	1403	1986
Palo Verde 2	■	PWR	1524	1403	1988
Palo Verde 3	■	PWR	1524	1403	1986
Peach Bottom 2	■	BWR	1233	1160	1974
Peach Bottom 3	■	BWR	1233	1160	1974
Perry 1	■	BWR	1397	1312	1987
Pilgrim	■	BWR	712	670	1972
Point Beach 1	■	PWR	696	643	1970
Point Beach 2	■	PWR	696	643	1972
Prairie Island 1	■	PWR	642	593	1973
Prairie Island 2	■	PWR	641	593	1974
Quad Cities 1	■	BWR	1061	1009	1973
Quad Cities 2	■	BWR	1061	1009	1973
RiverBend 1	■	BWR	1073	1036	1986
Robinson 2	■	PWR	855	769	1971
Salem 1	■	PWR	1276	1170	1977
Salem 2	■	PWR	1303	1170	1981
Seabrook 1	■	PWR	1330	1242	1990
Sequoyah 1	■	PWR	1259	1221	1981
Sequoyah 2	■	PWR	1279	1221	1982
Shearon Harris 1	■	PWR	983	951	1987

Country Location/ Station name	Status	Reactor type	Capacity gross [MW]	Capacity net [MW]	1st Criticality [Year]
South Texas 1	■	PWR	1410	1354	1988
South Texas 2	■	PWR	1410	1354	1989
St. Lucie 1	■	PWR	1122	1080	1976
St. Lucie 2	■	PWR	1135	1080	1983
Virgil C. Summer	■	PWR	1071	1030	1984
Surry 1	■	PWR	900	848	1972
Surry 2	■	PWR	900	848	1973
Susquehanna 1	■	BWR	1374	1298	1983
Susquehanna 2	■	BWR	1374	1298	1985
Three Mile Island 1	■	PWR	1021	976	1974
Turkey Point 3	■	PWR	906	877	1972
Turkey Point 4	■	PWR	800	760	1973
Vogtle 1	■	PWR	1223	1160	1987
Vogtle 2	■	PWR	1226	1160	1989
Waterford 3	■	PWR	1250	1200	1985
Watts Bar 1	■	PWR	1370	1270	1996
Wolf Creek	■	PWR	1351	1268	1984
Vogtle 3	□	PWR	1080	1000	(2019)
Vogtle 4	□	PWR	1080	1000	(2020)
Virgil C. Summer 2	□	PWR	1080	1000	(2018)
Virgil C. Summer 3	□	PWR	1080	1000	(2019)
Watts Bar 2	□	PWR	1240	1180	(2016)

[1] Start of nuclear operation (first criticality), 7 units in 2015 (first criticality: C, first grid connection: G, commercial operation: O): China: Changjiang 1 (650 MW, CGO), Fuqing 2 (1087 MW, CGO), Ningde 3 (1080 MW, CGO), Yangjiang 2 (1080 MW, CGO), Yangjiang 3 (1080 MW, CGO); Korea (Rep.): Shin-Wolsong (1000 MW, CGO). Start of operation: China: Fangchenggang 1 (1080 MW, CG), Fangjiashan 2 (1080 MW, GO), Hongyanhe 3 (1080 MW, GO). Russia: Rostov 3 (1085 MW, O). The number for nuclear power plants in operation also includes the Beloyarsky 4 (CG) unit (800 MW, FBR) which is in nuclear test operation since 2014.

[2] Start of construction (first concrete), 7 units in 2015: China, Fangchenggang 3 (1080 MW), Fuqing 5 (1087 MW), Fuqing 6 (1087 MW), Hongyanhe 5 (1080 MW), Hongyanhe 6 (1080 MW), Tianwan 5 1118 MW); United Arab Republic: Barakah 4 (1400 MW).

[3] Project under construction finally cancelled: none.

[4] Resumed operation: Japan: Sendai 1 and Sendai 2

[5] Nuclear power plant in long-term shutdown: none.

[6] Nuclear power plants permanently shutdown in 2015 (7 units): Germany: Grafenrheinfeld (1345 MW); Japan: Genkai 1 (559 MW), Mihama 1 (340 MW), Mihama 2 (500 MW), Shimane 1 (460 MW), Tsuruga 1 (357 MW); United Kingdom: Wylfa 1 (540 MW).

(All capacity data in MWe gross)

AGR: Advanced Gas-cooled Reactor, Candu: CANada Deuterium Uranium reactor (IND: Indian type), D_2O-PWR: heavy water moderated, pressurised water reactor, PWR: pressurised water reactor, GGR: gas-graphite reactor, LWGR/GLWR: light water cooled graphite moderated reactor (Russian type RBMK), BWR: boiling water reactor, FBWR: advanced boiling water reactor, FBR: fast breeder reactor

Tab. 1.
Nuclear power plant units worldwide on 31.12.2015 in operation (■), under construction (□), in lay-up operation/long-term shutdown (●) or permanently shut-down in 2015 (✧) [Sources: Operators, IAEO]. All information and data refer to the year 2015. Data have been updated with reference to the sources

Top

Safety and licensing requirements for Small Modular Reactors: IAEA hosts first workshop for regulators

(iaea) A new generation of advanced, prefab nuclear power reactors called small modular reactors (SMRs) could be licensed and hit the market as early as 2020, and the IAEA is helping regulators prepare for their debut. In a series of workshops that began earlier this month, the IAEA is working closely with regulators on approaches to safety and licensing ahead of potential global SMR deployment.

Safety and licensing requirements for Small Modular Reactors: IAEA hosts first workshop for regulators. (Courtesy: IAEA)

Safety requirements, guidelines and licensing procedures for SMRs were among the topics participants from the Arab Atomic Energy Agency (AAEA) and the Arab Network of Nuclear Regulators (ANNuR) learnt during a recent IAEA workshop in Vienna.

"Small modular reactors are a very attractive proposition for the Arab world as more than half the countries in our region don't have the resources to build large, traditional nuclear power plants. SMRs are more feasible, manageable and require lower investment – it is a very realistic option for Arab countries to consider," said Abdelmajid Mahjoub, Director General of the Arab Atomic Energy Agency and the Chairman of the workshop.

Co-sponsored by the United States Nuclear Regulatory Commission (NRC), the workshop brought together regulatory authorities, operator companies, and other governmental organizations, working or expected to work towards the establishment of national safety and technical infrastructures for SMRs.

Workshop participants received detailed information about the role of regulatory authorities and licensing requirements, including the approval of SMR designs, siting and operations. The IAEA facilitated discussions among regulators on use of IAEA Safety Standards and on changes that may be needed in national regulations.

Small and safe

Designed to be modular using prefabricated modules, SMRs, with an output of less than 300 MW, will have shorter construction times and are expected to be competitive to build. Four SMRs in three countries are already under construction. "Though smaller, the safety and security measures for this next generation of nuclear power reactors are no different than the international obligations that present day reactors are subjected to," said Stewart Magruder, a senior nuclear safety officer at the IAEA.

The global safety and security standards that are applicable to existing nuclear power reactors as well as those under construction are mostly applicable to SMRs. "We need to establish a set of clear and pragmatic requirements for safety and licensing," said Greg Rzentkowski, Director of the Division of Nuclear Installation Safety at the IAEA. "Regulatory certainty is essential for successful deployment of SMRs."

The IAEA will coordinate additional work in this area in coming years. This is likely to include the development of an overarching safety objective and a guidance document on establishing relevant requirements in accordance with the facility type and size, Rzentkowski said.

Develop, assess and deploy

These pre-fabricated nuclear reactor modules can be shipped to specific destination points, much like transporting a manufactured component from one industrial park to another. The potential benefits to countries and end-users resulting from the commercial operation of SMRs are immense, for example, to provide much needed electricity to remote regions – altering the dynamics of world-wide energy supply.

SMR development began nearly two decades ago and several countries are independently engaged in deploying prototypes. The IAEA has observed a significant increase in Member State participation in SMR technology development that reflects the vast potential seen in its deployment to expand