Annex 9: Nuclear Reactors in the World "Under Construction"

Table 21: Nuclear Reactors in the World "Under Construction" (as of 1 July 2016)

Country/Reactors	Units	MWe (net)	Construction Start	Planned Grid Connection	Delayed
Argentina	1	25			
Carem25			08/02/14	2018 (first power)[1]	?
Belarus	2	2 218			
Belarusian-1		*1109*	06/11/13	2018 (operation)[2]	?
Belarusian-2		*1109*	03/06/14	2020 (operation)[3]	?
Brazil	1	1 245			
Angra-3			01/06/10	5/2019 (commercial operation)[4]	Yes
China[5]	21	21 500			
Fangchenggang-2		*1000*	23/12/10	2016	Yes
Fangchenggang-3		*1000*	24/12/15	2019	?
Fuqing-3		*1000*	31/12/10	2016	Yes
Fuqing-4		*1000*	01/10/12	7/2017	?
Fuqing-5		*1000*	07/05/15	2020[6]	Yes
Fuqing-6		*1000*	22/12/15	2020[7]	Yes
Haiyang-1		*1000*	24/09/09	2017[8]	Yes
Haiyang-2		*1000*	21/06/10	2017[9]	Yes
Hongyanhe-5		*1000*	29/03/15	2021[10]	?
Hongyanhe-6		*1000*	24/07/15	2021[11]	?
Sanmen-1		*1000*	19/04/09	6/2017[12]	Yes
Sanmen-2		*1000*	17/12/09	End 2017[13]	Yes
Shandong Shidaowan		*200*	01/12/12	2/2017[14]	Yes
Taishan-1		*1660*	28/10/09	2017[15]	Yes
Taishan-2		*1660*	15/04/10	2017[16]	Yes
Tianwan-3		*990*	22/12/12	2/2018	?
Tianwan-4		*990*	27/09/13	11/2018	?

Country/Reactors	Units	MWe (net)	Construction Start	Planned Grid Connection	Delayed
Tianwan-5		*1000*	27/12/15	2021[17]	?
Yangjiang-4		*1000*	01/11/12	7/2017	?
Yangjiang-5		*1000*	18/09/13	11/2017	?
Yangjiang-6		*1000*	31/12/13	7/2019	?
Finland	1	1 600			
Olkiluoto-3			12/08/05	2018[18]	Yes
France	1	1 600			
Flamanville-3			03/12/07	2018[19]	Yes
India	6	3 907			
Kakrapar-3		*630*	22/11/10	2017 (completion)[20]	Yes
Kakrapar-4		*630*	22/11/10	2018 (completion)[21]	Yes
Kudankulam-2		*917*	04/07/02	6/2016 (first criticality)[22]	Yes
PFBR		*470*	23/10/04	3/2017 (criticality)[23]	Yes
Rajasthan-7		*630*	18/11/11	2018 (“completion date”)[24]	Yes
Rajasthan-8		*630*	30/09/11	2019 (“completion date”)[25]	Yes
Japan	2	2 650		Notes[26]	
Ohma		*1 325*	07/05/2010	?	Yes
Shimane		*1 325*	12/10/2007	?	Yes
Pakistan	3	1 644			
Chasnupp-3[27]		*315*	28/05/11	12/2016 (commercial operation)	?
Chasnupp-4[28]		*315*	18/12/11	10/2017 (commercial operation)	?
K-2 (Karachi 2)[29]		*1 014*	20/08/15	late 2021(commercial operation)	?
Russia[30]	7	5 473			
Leningrad-2-1		*1085*	25/10/08	2017 [31]	Yes
Leningrad-2-2		*1085*	15/04/10	2019[32]	Yes
Novovoronezh-2-1		*1114*	24/06/08	2016[33]	Yes
Novovoronezh-2-2		*1114*	12/07/09	2019[34]	Yes
Rostov-4		*1011*	01/01/83[35]	06/2017[36]	Yes

Country/Reactors	Units	MWe (net)	Construction Start	Planned Grid Connection	Delayed
Severodvinsk Lomonosov-1		*32*	15/04/07	31/12/19 (commercial operation)[37]	Yes
Severodvinsk Lomonosov-2		*32*	15/04/07	01/12/19 (commercial operation)[38]	Yes
Slovakia	2	880			
Mochovce-3		*440*	01/01/85	Early 2017 (first power)[39]	Yes
Mochovce-4		*440*	01/01/85	2018 (first power)[40]	Yes
South Korea[41]	3	4 020			
Shin-Hanul-1		*1340*	10/07/12	04/2018 (commercial operation)[42]	Yes
Shin-Hanul-2		*1340*	19/06/13	02/2019 (commercial operation)[43]	Yes
Shin-Kori-4		*1340*	15/09/09	03/2017 (commercial operation)[44]	Yes
United Arab Emirates[45]	4	5 380			
Barakah-1		*1345*	01/07/12	2017	?
Barakah-2		*1345*	30/05/13	2018	?
Barakah-3		*1345*	24/09/14	2019	?
Barakah-4		*1 345*	30/07/15	2020[46]	?
USA	4	4 468			
Virgil C. Summer-2		*1117*	09/03/13	mid 2019[47]	Yes
Virgil C. Summer-3		*1117*	02/11/13	mid 2020[48]	Yes
Vogtle-3		*1117*	12/03/13	mid 2019[49]	Yes
Vogtle-4		*1117*	19/11/13	mid 2020[50]	Yes
TOTAL	**58**	**56 610**	**1983-2015**	**2016-2021**	**38**

Sources: IAEA-PRIS, MSC, 2016, unless noted otherwise

[1] No startup date in IAEA/PRIS. CNEA indicates fuel loading in second half of 2017. Startup date from CNEA, "Proyecto CAREM – Cronograma"; Undated, see http://www.cnea.gov.ar/carem-cronograma, accessed 24 May 2016. First power from WNA, "Nuclear Power in Argentina", updated May 2016, see http://www.world-nuclear.org/info/Country-Profiles/Countries-A-F/Argentina/, accessed 24 May 2016.

[2] No startup date in IAEA/PRIS. Operation start "November 2018" from WNA, "Nuclear Power in Belarus", Updated September 2015, see http://www.world-nuclear.org/info/Country-Profiles/Countries-A-F/Belarus/, accessed 24 May 2016; and *WNN*, "Reactor vessel assembly completed for second Belarusian unit", 26 May 2016, see http://www.world-nuclear-news.org/NN-Reactor-vessel-assembly-completed-for-second-Belarusian-unit-26051601.html, accessed 26 May 2016. WNISR previously used commercial operation date (2019) from WNA.

[3] No startup date in IAEA/PRIS. Ibidem.

[4] Delayed numerous times. Start-up estimate was 2018 in WNISR 2015. Commercial operation date of May 2019 from Brunswick, "Global Aspects and Contract Model of the Angra 3 Project", Paper presented at the IAEA Technical Meeting, 10-12 February 2016, see https://www.iaea.org/NuclearPower/Downloadable/Meetings/2016/2016-02-10-02-12-NPES/5_Brazil_Brunswick_R1.pdf, accessed 24 May 2016.

[5] Unless noted otherwise, dates are from Shan Sun, "Challenges during construction of new NPPS", Huaneng Shandong Shidao Bay Nuclear Power Company, 4 February 2014, see http://www.iaea.org/NuclearPower/Downloadable/Meetings/2014/2014-02-04-02-07-TM-INIG/Presentations/37_S7_China_Sun.pdf, accessed 31 May 2014; table translated in *NIW*, "China—Sanmen—Two Year Delay Pushes Costs Higher", 14 March 2014.

[6] CNNC states that expected construction of first Hualong reactor to be completed by June 2020. *Reuters*, "China's debut Westinghouse reactor delayed until June 2017", 9 March 2016, see http://www.reuters.com/article/us-china-parliament-nuclear-idUSKCN0WB09F, accessed 24 June 2016.

[7] Additional delay follows from CNNC statement in March 2016, see previous note.

[8] Delayed again. Original startup date 2014, one-year delay compared to WNISR2015, see WNA, "Nuclear Power in China", updated June 2016, see http://www.world-nuclear.org/information-library/country-profiles/countries-a-f/china-nuclear-power.aspx, accessed 26 June 2016.

[9] Delayed again at least by several months, from planned startup date 9/2016 in WNISR2015. Ibidem.

[10] *WNN*, "Construction Starts on Hongyanhe 5", 30 March 2015, see http://www.world-nuclear-news.org/NN-Construction-starts-on-Hongyanhe-5-3003154.html, accessed 8 July 2016.

[11] Ibidem.

[12] Delayed again by more than a year since WNISR 2015. According to Sun Qin, chairman of the China National Nuclear Corporation "*We are forecasting that if everything goes smoothly, the first unit will go into operation in June 2017, and the second unit at the end of 2017*", as quoted in *Reuters*, "China's debut Westinghouse reactor delayed until June 2017", 9 March 2016, see http://www.reuters.com/article/us-china-parliament-nuclear-idUSKCN0WB09F, accessed 8 July 2016. Chief Engineer of State Power Investment Corporation Wang Jun stressed in April 2016 that Sanmen-1 would be operational by the end of the year 2016, see *Nuclear Street News*, "Engineer Confirms Sanmen AP1000 Start Up In 2016", 7 April 2016, see https://nuclearstreet.com/nuclear_power_industry_news/b/nuclear_power_news/archive/2016/04/07/engineer-confirms-sanmen-ap1000-start-up-in-2016-040702, accessed 8 July 2016 ; but again, Westinghouse later said that fuel loading is expected by the end of 2016, see Westinghouse, "First Westinghouse AP1000® completes cold Hydro Test at Sanmen 1", 26 May 2016, see http://www.westinghousenuclear.com/About/News/View/first-westinghouse-ap1000%c2%ae-completes-cold-hydro-test-at-sanmen-1, accessed 8 July 2016.

[13] Delayed again, by a year and a half compared to WNISR 2015; see previous note.

[14] Delayed. Originally planned for startup in 2016. In March 2013, the date was pushed back by one year. This date from WNA, "Nuclear Power in China", Updated June 2016, see http://www.world-nuclear.org/information-library/country-profiles/countries-a-f/china-nuclear-power.aspx, accessed 7 July 2016.

[15] Delayed again. A further delay of about 2 years compared to WNISR 2015. Taishan reactors are at least three years behind schedule. Taishan-1 is now expected to be operating in the first half of 2017; *Bloomberg*, "China's Areva-Designed Nuclear Reactors to Start Up in 2017", 15 March 2016, see http://www.bloomberg.com/news/articles/2016-03-15/china-s-areva-designed-nuclear-reactors-to-start-up-in-2017, accessed 15 March 2016. See also *NW*, "2015 was a strong year for Chinese nuclear power development, industry says", 14 January 2016.

[16] Delayed again. A further delay of about 2 years compared to WNISR 2015. Taishan reactors are at least three years behind schedule. Taishan-2 is now expected to be operating in the second half of 2017. See previous note.

[17] WNA, "Nuclear Power in China", Updated June 2016, see http://www.world-nuclear.org/information-library/country-profiles/countries-a-f/china-nuclear-power.aspx, accessed 26 June 2016.

[18] Delayed. After numerous revisions of the original planned commissioning in 2009. the date refers to "commercial operation". In 2013, TVO was preparing for the possibility that the start of regular electricity production of Olkiluoto 3 may be postponed until year 2016, see TVO, "Information About the Start-up of Olkiluoto 3 Nuclear Power Plant Unit", 11 February 2013, see http://www.tvo.fi/news/32, accessed 11 February 2013. In 2014, TVO decided not to provide any new startup date; see TVO, "TVO Does Not Provide an Estimate of the Start-up Time of Olkiluoto 3 Nuclear Power Plant", see http://www.tvo.fi/news/190, accessed 12 February 2014. AREVA, "Updated Schedule for Olkiluoto 3", 1 September 2014, see http://www.areva.com/EN/news-10288/updated-schedule-for-olkiluoto-3.html; and TVO, "Olkiluoto 3 ready for electricity production in 2018, according to the plant supplier", 1 September 2014, accessed 1 September 2014. In 2016, TVO sticks to this position: "*According to the schedule submitted by the OL3 supplier, regular electricity generation at OL3 will start at the end of 2018*.", see TVO, "TVO Submits OL3 Operating License Application to the Ministry of Employment and the Economy", 14 April 2016, see http://www.tvo.fi/news/1711, accessed 5 May 2016.

[19] Delayed again by at least one year compared to WNISR2015. Delayed numerous times from the original planned startup date in 2012. EDF's "Reference Document 2014", April 2015, states: "*In November 2014, the project schedule was revised, with the first marketable production scheduled for 2017*". Now the project is expected to "load fuel and start up" in the fourth trimester 2018. EDF, "Rapport Annuel 2015", February 2016.

[20] In WNISR 2015, start-up was delayed two years from previous estimates. DAE (Department of Atomic Energy of India) indicated an anticipated completion date of 2017-2018 for Kakrapar 3 & 4. DAE, in Rajya Sabha, "Statement Referred to in Reply to Rajya Sabha Starred Question n°14 for Answer on 23.04.2015 by Shri K.C. Tyagi Regarding Generation of Power by Nuclear Plants", 23 April 2015, see http://www.dae.nic.in/writereaddata/parl/budget2015/rssq14.pdf, accessed 1 May 2015.

[21] In WNISR 2015, startup was delayed 3 years from previous estimates. DAE indicated an anticipated completion date of 2017-2018 for Kakrapar 3 & 4. DAE, in Rajya Sabha, "Statement Referred to in Reply to Rajya Sabha Starred Question n°14 for Answer on 23.04.2015 by Shri K.C. Tyagi Regarding Generation of Power by Nuclear Plants", 23 April 2015, see http://www.dae.nic.in/writereaddata/parl/budget2015/rssq14.pdf, accessed 1 May 2015. Grid Connection (30 September 2015) and commercial operation dates deleted from IAEA/PRIS in August 2013. The expected commercial operation date of "December 2015" has been replaced by "under review" in NPCIL, "Plants Under Construction, Kakrapar", Undated, see http://www.npcil.nic.in/main/ConstructionDetail.aspx?ReactorID=91, accessed 27 June 2016.

[22] Delayed numerous times. Construction at least seven years behind schedule. No IAEA/PRIS startup date. This "First Criticality" date - a further delay of 9 months compared to WNISR 2015 - from NPCIL, "Plants Under Construction, Kudankulam", Updated May 2016, see http://www.npcil.nic.in/main/ConstructionDetail.aspx?ReactorID=77, accessed 12 June 2016.

[23] Delayed numerous times. No IAEA start-up date. Criticality is now "expected" by March 2017. A further delay of one year compared to WNISR 2015. Lok Sabha - "Unstarred Question No.1762 - To be answered On 04-05.2016 -Fast Breeder Reactors, The Minister Of State For Personnel, Public Grievances & Pensions And Prime Minister's Office (Dr.Jitendra Singh)" see http://dae.nic.in/writereaddata/parl/budget2016/lsus1762.pdf, accessed 29 May 2016.

[24] Delayed. Startup date (31 March 2016) was deleted from IAEA/PRIS. DAE indicates an anticipated completion date of 2018-2019 for Rajasthan 7 & 8. DAE, in Rajya Sabha, "Statement Referred to in Reply to Rajya Sabha Starred Question n°14 for Answer on 23.04.2015 by Shri K.C. Tyagi Regarding Generation of Power by Nuclear Plants", 23 April 2015, see http://www.dae.nic.in/writereaddata/parl/budget2015/rssq14.pdf, accessed 1 May 2015. Expected date of Commercial operation still June 2016 according to NPCIL, "Plants Under Construction, Rajasthan", see http://www.npcil.nic.in/main/ConstructionDetail.aspx?ReactorID=87, accessed 12 June 2016.

[25] Delayed. Startup date (30 September 2016) was deleted from IAEA/PRIS. DAE indicates an anticipated completion date of 2018-2019 for Rajasthan 7 & 8. DAE, in Rajya Sabha, "Statement Referred to in Reply to Rajya Sabha Starred Question n°14 for Answer on 23.04.2015 by Shri K.C. Tyagi Regarding Generation of Power by Nuclear Plants", 23 April 2015, see http://www.dae.nic.in/writereaddata/parl/budget2015/rssq14.pdf, accessed 1 May 2015. Expected date of Commercial Operation still "December 2016", according to NPCIL, "Plants Under Construction, Rajasthan", see http://www.npcil.nic.in/main/ConstructionDetail.aspx?ReactorID=87, accessed 12 June 2016.

[26] Although there remain major obstacles for both reactors, with little public information on the exact status and advancement of construction, even though no planned grid connection date has been communicated, considering that *some* construction work is reportedly ongoing, for the time being, WNISR reintegrates Shimane-3 and Ohma in its listing of reactors under construction.

[27] Dates were deleted from IAEA/PRIS. These dates from WNA, "Nuclear Power in Pakistan", Updated May 2016, see http://www.world-nuclear.org/info/Country-Profiles/Countries-O-S/Pakistan/, accessed 12 June 2016.

[28] Dates were deleted from IAEA/PRIS. These dates from WNA, "Nuclear Power in Pakistan", Updated May 2016, see http://www.world-nuclear.org/info/Country-Profiles/Countries-O-S/Pakistan/, accessed 12 June 2016.

[29] Construction start of "K-2" reactor on 20 August 2015 was retroactively introduced on the IAEA-PRIS website in 2016, IAEA-PRIS, see https://www.iaea.org/pris/ (2015), accessed 11 May 2016. In IAEA-PRIS database, grid connection is 7/2020. This commercial operation date from WNA, "Nuclear Power in Pakistan", Updated May 2016, see http://www.world-nuclear.org/info/Country-Profiles/Countries-O-S/Pakistan/, accessed 12 June 2016.

[30] No dates for Russian reactors in IAEA/PRIS. All dates ("Start") and other information from WNA, "Nuclear Power in Russia", Updated June 2016, see http://www.world-nuclear.org/info/Country-Profiles/Countries-O-S/Russia--Nuclear-Power/, accessed 14 June 2016, unless otherwise noted.

[31] Delayed many times from original startup date in October 2013 (see WNISR 2009). Previous date of 2016 startup from *NIW*, "Weekly roundup", 20 February 2015. WNA indicates grid connection June 2017 and commercial operation in 2018.

[32] Previous date of 2018 from *NIW*, "Weekly roundup", 20 February 2015. WNA now says grid connection 11/2019, and commercial operation 2020.

[33] Delayed from original start-up date on 31 December 2012 (see WNISR2009).

[34] Previously announced to start up in 2016.

[35] Rostov 4 - Construction date: IAEA-PRIS considers construction start date to be 16 June 2010, but the Rostov-4 reactor was already listed as under construction with a construction start of 1983 in the IAEA, "Nuclear Power Reactors in the World", April 1986 Edition.

[36] Delayed numerous times. WNA indicates June 2017 or 2019. No update from WNISR 2015

[37] Delayed several times. This estimate of 2019 from WNA Reactor Database, "Akademik Lomonosov 1", see http://world-nuclear.org/NuclearDatabase/reactordetails.aspx?id=27570&rid=E4152D64-0C6B-475E-86ED-BDADF73D9C19&country=Russian%20Federation, accessed 8 June 2015. As of June 2016, WNA indicates 2017-2018, without providing any reason.

[38] Delayed several times. This estimate of 2019 from WNA Reactor Database, "Akademik Lomonosov 2", see http://world-nuclear.org/NuclearDatabase/reactordetails.aspx?id=27570&rid=A0D78EB7-B62A-48FF-9D78-21A8E4534D90, accessed 8 June 2015. As of June 2016, WNA indicates 2017-2018, without providing any reason.

[39] Delayed numerous times. Latest IAEA/PRIS date was deleted. This estimate - a few month delay compared to WNISR 2015 - from WNA, "Nuclear Power in Slovakia", Updated April 2016, see http://world-nuclear.org/info/Country-Profiles/Countries-O-S/Slovakia/, accessed 29 May 2016.

[40] Delayed numerous times. Latest IAEA/PRIS date was deleted. This estimate - a few month delay compared to WNISR 2015 - from WNA, "Nuclear Power in Slovakia", Updated April 2016, see http://world-nuclear.org/info/Country-Profiles/Countries-O-S/Slovakia/, accessed 29 May 2016.

[41] No IAEA startup date for any Korean reactor. Dates from KHNP (Korean Hydro and Nuclear Power Co).

[42] Delayed a further year since WNISR 2015. KHNP, "Shin-Hanul #1,2", 30 April 2016, see http://cms.khnp.co.kr/eng/content/547/main.do?mnCd=EN03020303, accessed 29 May 2016.

[43] Delayed a further year since WNISR 2015. KHNP, "Shin-Hanul #1,2", 30 April 2016, see http://cms.khnp.co.kr/eng/content/547/main.do?mnCd=EN03020303, accessed 29 May 2016.

[44] Delayed an additional year since WNISR 2015, a three-year delay since WNISR 2014. KHNP, "Shin-Kori #3,4", 31 March 2016, see http://cms.khnp.co.kr/eng/content/546/main.do?mnCd=EN03020302, accessed 1 May 2016.

[45] No IAEA startup dates. Dates for three reactors from Emirates Nuclear Energy Corporation (ENEC), "ENEC Submits Operating License Application to FANR for Barakah Units 1 & 2", 26 March 2015, see http://www.enec.gov.ae/media-centre/news/content/enec-submits-operating-license-application-to-fanr-for-barakah-units-1, accessed 23 May 2015.

[46] This date from WNA, "Nuclear Power in the United Arab Emirates", Updated April 2016, see http://www.world-nuclear.org/information-library/country-profiles/countries-t-z/united-arab-emirates.aspx, accessed 7 July 2016.

[47] Delayed. This date is from USDOE, "Quarterly Nuclear Power Deployment Summary—April 2016", April 2016, see http://www.energy.gov/sites/prod/files/2016/04/f30/DEPLOYMENT_SCORECARD_APRIL_2016.pdf, accessed 7 July 2016.

[48] Ibidem.

[49] Ibidem.

[50] Ibidem.