SMR Global Status Report April 2020

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Introduction

This report examines the global status of Small Modular Reactors (SMRs) and reviews their readiness for deployment.
Small reactors have been in wide use for more than 50 years to reliably power submarines and ice-breakers. A widely accepted definition of "small" is less than 300 MWe. Early CANDU (Pressurised Heavy Water Reactors) were "small" and sixteen are still operating in India.
Reports from Parliamentary inquiries at Federal and State levels in Australia in 2019 identified SMRs as suitable for Australian conditions.
Opponents of nuclear argued that SMRs existed only on paper but they are far more advanced than "paper reactors" and we expect to see them widely deployed globally for electricity generation during this decade in response to increasing energy security and emissions reduction concerns.
Reviewing the latest generation of SMRs for electricity generation, this report identifies that two are already operating, three are under construction and many more are at an advanced stage of licensing.
This report separately categorises SMRs according to their design features as Light Water Reactors (Gen III/Gen III+) or Gen IV Reactors.

Light Water Reactors (Gen III/Gen III+)

Country	Reactor and Company	Module size	licences	Construction	Operation
Russia	**KLT-40S** PWR Floating Power Plant Rosatom	35 MWe	June 2019 Operating licence	2007 vessel construction commenced June 2010 vessel launched 2013 reactors installed, 2 x 35 MWe 2019 deployed at Pevek, Chukotka region	**19/12/ 2019 in operation, connected to grid**
Argentina	**CAREM** IPWR CNEA/INVAP	27 MWe	Sept 2013 Construction Licence for Atucha site	Feb 2014 first concrete. **Construction in progress**	*Target 2023*

China	**ACPR50S** PWR Floating Power Plant CGN	60 MWe		Nov 2016 contract with Donfang Electric Corp for the pressure vessel. *Construction in progress*	*Target 2020*
USA	**NuScale** IPWR NuScale Power	60 MWe	**DCA Jan 2017 (NRC)** *Final Safety Evaluation Report scheduled Sept 2020, Design Certification Jan 2021*	*COLA (UAMPS) for INL site* *Target Construction start 2023*	*Target 2026*
USA	**SMR-160** IPWR SMR LLC (Holtec)	160 MWe	NRC pre-application activities. Phase 1 vendor design review by Canadian Nuclear Safety Commission (CNCS) started July 2018		*Target 2026*
South Korea	**SMART** IPWR KAERI	100 MWe	Design approval 2012 (now updating for passive safety)	March 2015 MOU with Saudi Arabia	
China	**AP-100** IPWR CNNC/NPIC	100 MWe	April 2015 IAEA Generic Reactor Safety Review Agreement. PSAR approved	March 2019 EIA for site at Changjiang, Hainan. July 2019 Preliminary site work commenced	*Target 2025*
USA	**BWRX-300** BWR GE-Hitachi	300 MWe	*Phase 1/2 vendor design review by CNSC pending.* December 2019 started regulatory licensing process with NRC	MOU's with Estonia, Poland and Czech Republic	
UK	**PWR** Rolls-Royce Consortium	440 MWe	*Will be licensed first in UK*	MOU with Turkey's state-owned EUAS International ICC	*Target 2029*

Gen IV Reactors

Country	Reactor	Module size	Licence	Construction	Operation
China	**HTR-PM** High Temperature Gas-cooled Reactor China Nuclear Engineering Corporation (CNEC) + Tsinghua University Institute of Nuclear and New Energy Technology (INET)	105 MWe		2014 construction commenced at Shidaowan, Shandong Province 2x105 MWe drive one 210 MWe turbine	*2020*
Canada	**MMR** Micro Modular Reactor High Temperature Gas-cooled Reactor Ultra Safe Nuclear Corporation with Global First Power	15 MWTh (5MWe)	Feb 2019 CNSC phase 1 vendor design review completed. *Phase 2 pending.*	March 2019 site preparation licence application for Chalk River site.	
Canada	**IMSR 400** Integrated Molten Salt Reactor Terrestrial Energy	195 MW	Feb 2016 CNSC Phase 1 vendor design review completed. Phase 2 review commenced Dec 2018	*Preferred site at Idaho National Labs* 2019 qualified to enter 2nd stage for deployment at Chalk River	*2020's*
USA	**Aurora Powerhouse** Micro reactor Sodium cooled Fast Reactor (SFR) Oklo Inc	1.5 MW	2016 started pre-application activities with NRC. March 2020 submitted COLA to NRC	Oklo has a permit for a site at Idaho National Labs.	
Canada	**ARC 100** Sodium cooled Fast Reactor (SFR) ARC Nuclear Canada Inc	100 MWe	Oct 2019 CNSC Phase 1 vendor design review completed		
UK/Canada	**Moltex Energy Stable Salt Reactor** Molten salt reactor Moltex Energy	300 MWe	Dec 2017 CNSC Phase 1 vendor design review started.	Nov 2019 proceeding into final negotiations for project at Chalk River site	

Description of Some Advanced Projects

KLT-40S Floating Nuclear Power Plant (Russia)

Russia has used small nuclear reactors to power icebreakers for many years. In 2007 they started a project to install two KLT-40S reactors producing 35 MWe each on a non-propelled vessel to supply electricity to remote regions. The 144m long, 30m wide vessel was launched in 2010 at the Baltic shipyard in Saint Petersburg and the two 35 MWe KLT-40S reactors were installed in 2013. In 2018 the vessel named *Akademik Lomonosov* was towed to Murmansk for fuelling. The operating licence was issued in June 2019 before deployment at Russia's northernmost city of Pevek, Chukotka region where it is replacing old power plants. On 19 December 2019 the plant was connected to the grid and started supplying electricity.

Status: In Operation

CAREM (Argentina)

CNEA/INVAP in Argentina are well known for their design and construction of research reactors, including ANSTO's OPAL 20 MW (thermal power) reactor at Lucas Heights, Sydney. OPAL does not produce electricity. CAREM (Central Argentina de Elementos Modulares) was designed with an output of 27 MWe as a prototype integral PWR. Construction commenced in February 2014 at a site adjacent to the existing Atucha NPPs. Construction is now well advanced with a target operating date in 2023.

Status: Under Construction

HTR-PM (China)

High Temperature Gas Cooled Reactor in advanced state of construction. Helium cooled, operates at a much higher temperature (750^{o}C) than PWR (340^{o}C) giving higher efficiency and possibility of supply of high temperature process heat.

Status: construction nearly completed

DEFINITIONS:

PWR - Pressurised Water Reactor (the most common type of reactor, used in submarines and nuclear power plants for more than 50 years).

IPWR - Integral Pressurised Water Reactor. Steam generators inside reactor pressure vessel.

DCA – US Nuclear Regulatory Commission (NRC) Design Certification Application. Allows a design to be licensed without a site being identified.

COLA – US NRC combined construction and operating licence application. Brings more certainty to the licencing process by combining the construction and operating licences so that once construction starts the project can continue to completion. The design certification can be referenced in the COLA.