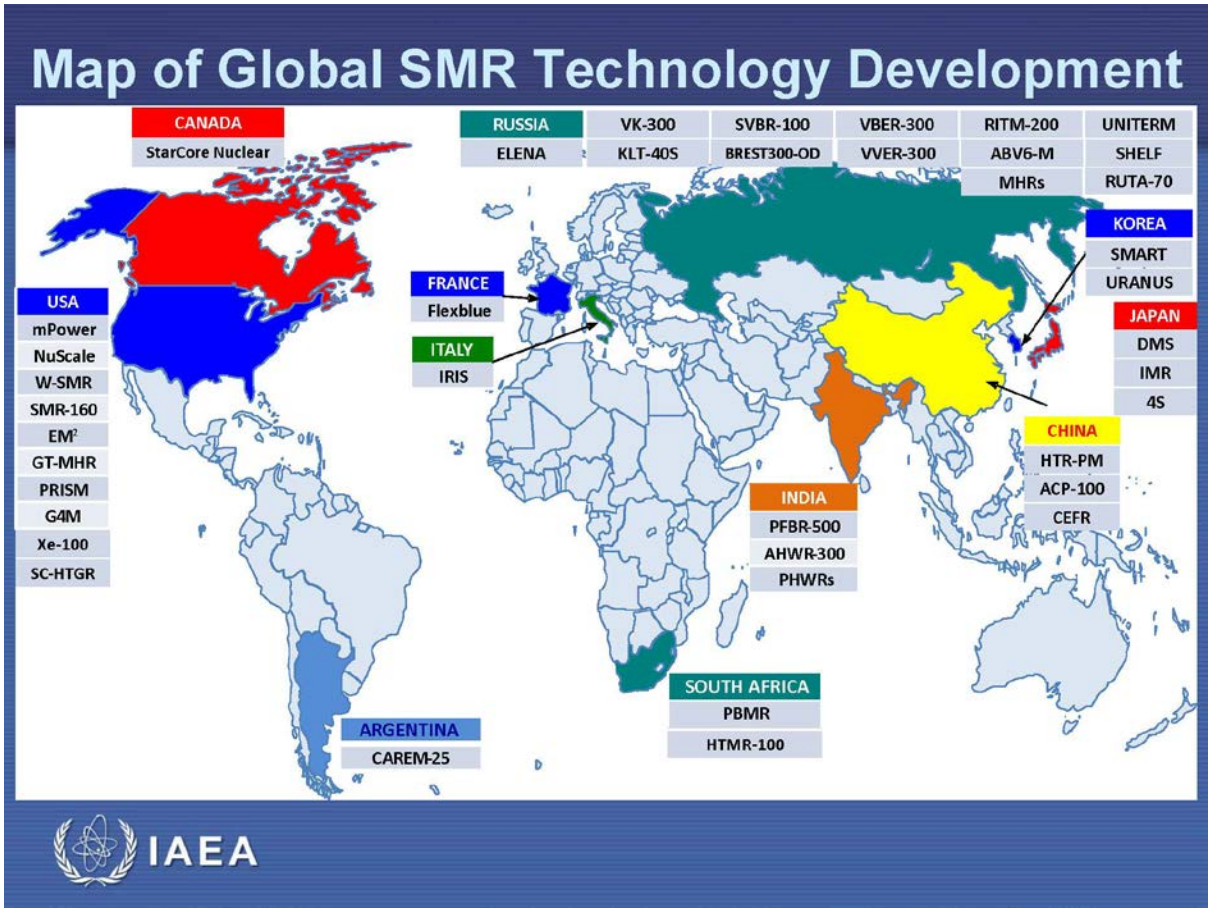
2016-IP38: Small Nuclear Reactors

There seems to be a growing interest and discussion with regard to the deployment of small nuclear reactors or small modular reactors as they are called by the IAEA[1] (SMRs) in countries like the UK and USA, but is deployment of SMRs a real prospect in the next 10-20 years?

The IAEA in 2014 produced a report on the status of development of SMRs, see https://www.iaea.org/NuclearPower/Downloadable/SMR/files/IAEA_SMR_Booklet_2014.pdf

The status of development of SMR technology globally is illustrated in the figure below:



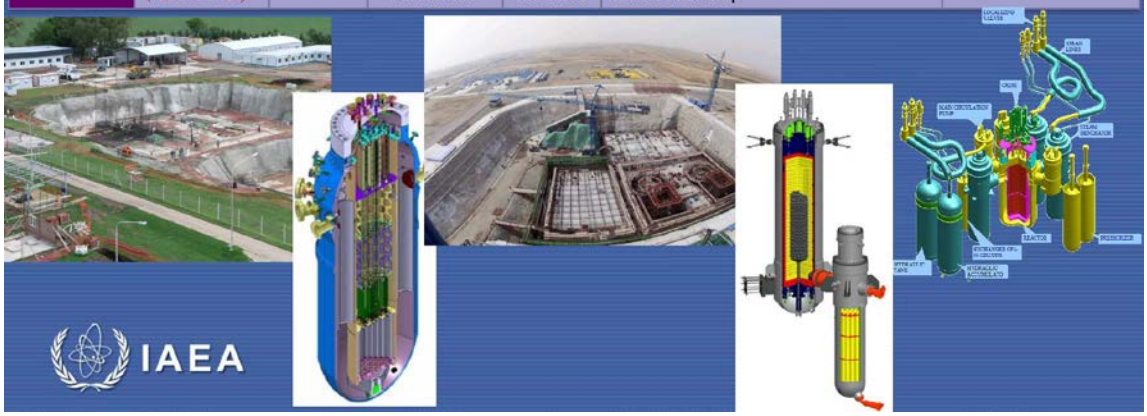
It seems that some 11 countries are working on the design of SMRs for use within their countries, designs include those based on water cooled, High Temperature Gas-cooled, Liquid-metal cooled and a metal salt cooled reactor.

Also SMRs could be deployed In 4 countries as early as 2018, see figure v below.

[1] International Atomic Energy Authority

SMRs Under Construction for Immediate Deployment – the front runners …

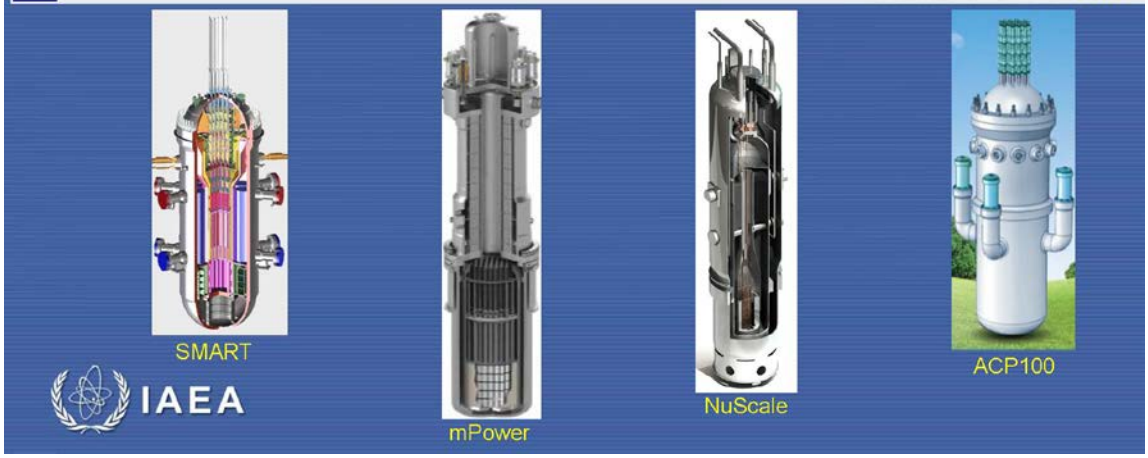
Country	Reactor Model	Output (MWe)	Designer	Number of units	Site, Plant ID, and unit #	Commercial Start
Argentina	CAREM-25	27	CNEA	1	Near the Atucha-2 site	2017 ~ 2018
China	HTR-PM	250	Tsinghua Univ./Harbin	2 mods, 1 turbine	Shidaowan unit-1	2017 ~ 2018
India	PFBR-500	500	IGCAR	1	Kalpakkam	2015 ~ 2016
Russian Federation	KLT-40S *(ship-borne)*	70	OKBM Afrikantov	2 modules	Akademik Lomonosov units 1 & 2	2016~2017
	RITM-200 *(Icebreaker)*	50	OKBM Afrikantov	2 modules	RITM-200 nuclear-propelled icebreaker ship	2017 ~ 2018



Four more reactors in Korea, USA and China are on a path for deplyment around 2020 onwards.

SMRs under development for Near-term Deployment - Some samples …

	Name	Design Organization	Country of Origin	Electrical Capacity, MWe	Design Status
1	System Integrated Modular Advanced Reactor (SMART)	Korea Atomic Energy Research Institute	Republic of Korea	100	Standard Design Approval Received **4 July 2012**
2	mPower	B&W Generation mPower	United States of America	180/module	Design Certification Application **2015**
3	NuScale	NuScale Power Inc.	United States of America	50/module (gross)	Design Certification Application mid **2016**
4	ACP100	CNNC/NPIC	China	100	Detailed Design, Construction Starts in **2016**



What is the interest in SMR technology? The IAEA lists their advantages as:

- Increasased energy security;
- A reduction in lengthy construction times while simultaneously increasing quality, thereby minimising the costs associated with the current time for construction that span 5 to 8 years.
- Ability to meet a need for flexible power generation for wider range of users and applications;
- Replacement of ageing fossil fuel-fired power plants;
- Enhanced safety performance through inherent and passive safety features; offering better upfront capital cost affordability;
- Suitability for cogeneration and non-electric applications;
- Options for remote regions with less developed infrastructures;
- They also offer possibilities for synergetic hybrid energy systems that combine nuclear and alternate energy sources, including renewables.

Simlarly the Climate and Energy Intelligence Unit in the UK in 2016[2] has listed the percieved benefits of the technology compared to large nuclear stations as:

- Lower absolute capital cost; potentially easing the path for investors
- Reduced construction risk via off-site factory production and standardisation of components and systems
- Shorter construction and installation times
- Lower coollng requirements , potentially allowing installation on inland sites
- Reduced investment in the transmission network (as they could be deployed in a more dispersed pattern)
- Easier to decommission
- Design of safety features made easier by smaller reactors, since less heat would need to be dissipated in the case of emergency
- Reduced refuelling needs, with some plants anticipated to operate for 30 years without replenishment of uranium
- In addition to generating electricity, the size of SMRs makes them attracrive to more bespoke applications like water desalination.

Interestingly the IAEA do not list potential disadvantages of the technology, the Climate and Energy Inteillgence however do and list them as:

- Only some SMR designs potentially offer significant safety advantages in that they are literally ‘fail-safe’; if all safety processes failed, the reactors would turn themselves off with no potential for release of radioactive substances.
- SMRs do not actually exist yet and there is no obvious market for them
- A fleet of smaller, dispersed nuclear installations would they consider provoke more problems with public acceptance and incur a greater cost for security.

In summary, SMRs are being talked about increasingly as a low carbon technology option with the potential for reduced cost and shorter construction times than their larger cousins. The technology is close to demonstration but not demonstrated fully yet. Issues I would have is:

- Are they flexible i.e. can they meet the new increasing demands for fliexible power generation placed on electricty grids world wide with the growing introduction of variable renewable energy technologies?

[2] http://eciu.net/assets/Briefing-SMR.pdf

- In terms of cost they may well be competitive cost with larger nuclear plants but how competive are they with other low carbon technology options that are already in the commercial market place and whose costs are decreasing through earlier deployment than SMR's.
- They do of course tick the energy secutiry box, but how will the public react to SMRs is an open question certainly in a post Fukushima world.
- Then there is the added issue of the "heightended terrorism" scenario and whether distrbuted small nuclear reactors can be secure from terroist attacks.

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