TECHNOLOGY FACTSHEET

NUCLEAR ENERGY: SMALL MODULAR REACTOR (SMR)

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Sector	Electricity generation
ETS / Non-ETS	ETS
Type of Technology	Nuclear energy
Description	The primary differences in small modular reactors (SMRs) in comparison with larger nuclear power plants are their low power output (typically below 300 MWe per unit), their modularity and integrated design (NEA/OECD, 2016). An integrated design means that the reactor pressure vessel typically contains all primary components, such as the pressurizer, steam generators and reactor coolant pumps (European Commission, 2016). The main design falls under three categories: light-water reactors (LWR), high-temperature gas cooled reactors (HTGR) and liquid-metal fast reactors (LMFR). LWRs have the most advanced design (European Commission, 2016).
TRL level 2020	TRL 5
	SMR prototypes have not been deployed yet. The creation of a market for SMRs will first require the successful deployment of first-of-a-kind (FOAK) reactors in the vendor's country before other countries will consider deploying the technology (NEA, 2015). According to JRC (2014), SMRs can be in commercial operation by 2020 at the earliest.

TECHNICAL DIMENSIONS

	Functional Unit		Value and Range								
Capacity	MW		225								
			100			-			300		
Potential		MW	**Current**			**2030**			**2050**		
			-			Unlimited			Unlimited		
			-	–	-	-	–	-	-	–	-
Market share	EU	%	30			Unknown			Unknown		
			30	–	30	-	–	-	-	–	-
Capacity utlization factor	95.00										
Full-load running hours per year	8,322										
Unit of Activity	PJ/year										
Technical lifetime (years)	60										
Progress ratio	0.90										
Hourly profile	No										
Explanation	A feasibility study from the UK National Nuclear Laboratory (2014) concluded that there is a significant market for SMRs that cannot, in all circumstances, be met by large nuclear plants. Nuclear power currently generates 30% of the total electricity in Europe and the growth potential of SMRs in Europe is uncertain (JRC, 2014). The main reference is based on a one-unit 225 MW LWR plant (JRC, 2014). Taking into account the evidence from similar capital intensive manufacturing industries, the examples achieved in the nuclear defence programme and the parametric modelling of SMR manufacture, it could be assumed that cost reductions of 10% for every doubling of volume should be achievable (National Nuclear Laboratory, 2014).										

COSTS

Year of Euro	2015								
	Euro per Functional Unit	**Current**			**2030**			**2050**		
Investment costs	mln. € / MW	6.46			5.90			5.44		
		3.95	–	7.95	3.74	–	7.28	3.44	–	6.67
Other costs per year	mln. € / MW	N/A			N/A			N/A		
		-	–	-	-	–	-	-	–	-
Fixed operational costs per year (excl. fuel costs)	mln. € / MW	0.13			0.12			0.11		
		0.08	–	0.16	0.07	–	0.15	0.07	–	0.13
Variable costs per year	mln. € /	-			-			-		
		Min	–	*Max*	*Min*	–	*Max*	*Min*	–	*Max*
Costs explanation	The main reference is for a one-unit 225 MW LWR plant with a CAPEX of €6,300/kWe and FOM (fixed operation and maintenance) costs are considered to be 2% of the CAPEX (JRC, 2014). CAPEX estimates includes civil and structural costs, major equipment costs, balance of plant costs, electrical and I&C supply and installation, project indirect costs and development costs (JRC, 2014). The CAPEX ranges between €3,850/kWe €7,550/kWe (JRC, 2014). The NEA/OECD (2016) estimated that the Nth-of-a-kind (NOAK) total overnight cost for an SMR is about $525 million or $5,250/kWe.									

ENERGY IN- AND OUTPUTS

	Energy carrier	**Unit**	**Current**			**2030**			**2050**		
Energy carriers (per unit of main output)	*Main output:* Electricity	PJ	-1.00			-1.00			-1.00		
			-1.00	–	-1.00	-1.00	–	-1.00	-1.00	–	-1.00
	Uranium	PJ	1.39			1.39			1.39		
			1.39	–	1.39	1.39	–	1.39	1.39	–	1.39
		PJ	N/A			N/A			N/A		
			-	–	-	-	–	-	-	–	-
		PJ	N/A			N/A			N/A		
			-	–	-	-	–	-	-	–	-
Energy in- and Outputs explanation	For a light-water reactor (LWR) SMR, a net efficiency of 28% is used as reference (JRC, 2014).										

EMISSIONS (Non-fuel/energy-related emissions or emissions reductions (e.g. CCS)

	Substance	**Unit**	**Current**			**2030**			**2050**		
Emissions			N/A			N/A			N/A		
			-	–	-	-	–	-	-	–	-
			N/A			N/A			N/A		
			-	–	-	-	–	-	-	–	-
			N/A			N/A			N/A		
			-	–	-	-	–	-	-	–	-
			N/A			N/A			N/A		
			-	–	-	-	–	-	-	–	-
Emissions explanation	Small modular reactors emit no direct emissions (JRC, 2014).										

REFERENCES AND SOURCES

JRC (2014). Energy Technology Reference Indicator (ETRI) projections for 2010-2050. Joint Research Centre of the European Commission.

NEA (2015). Technology Roadmap - Nuclear Energy.

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