## **TECHNOLOGY FACTSHEET**



Date of factsheet Author	2-8-2018		HYDROGEN PRODUCTION			
	Silvana Gamboa Palacios					
ector	Hydrogen supply					
TS / Non-ETS	ETS					
ype of Technology	Nuclear energy					
escription	Generation-IV nuclear power plants represent a set of advanced reactor designs that are currently going through extensive research for commercial applications. Generation-IV					
	nuclear energy systems include the nuclear reactor, its energy conversion systems and necessary fuel-cycle technologies. The Generation IV International Forum (GIF) selected six systems as generation-IV technologies: gas-cooled fast reactor (GFR), lead-cooled fast reactor (LFR), molten salt reactor (MSR), sodium-cooled fast reactor (SFR), supercritical-water-cooled reactor (SCWR) and very high-temperature reactor (VHTR) (NEA, 2014). According to IAEA (2013), the VHTR					
	system is considered the prime candidate for large scale hydrogen production. The VHTR is a graphite-moderated, helium-cooled reactor with thermal neutron spectrum. It can be used for heat applications such as process heat for hydrogen production - the heat application process is generally coupled with the reactor through an intermediate heat exchange The VHTR can produce hydrogen by using thermochemical processes, combined thermochemical and electrolysis, high temperature steam electrolysis, or from heat, water and					
	natural gas by applying the steam reformer technology (NEA, 2014).					
RL level 2020	systems and the degree of technic phases, whereas basic concepts a none of them would have reached the aim of bringing it to the comm R&D and demonstration. The viab	cal progress has re being tested u d the 'demonstra nercial deployme pility of using nuc	eactors is not foreseen before 2030. Over the not been uniform. Therefore by 2020, some under relevant conditions and engineering-so ation' phase, whereas a detailed design is co ent stage. In particular, heating of chemical r clear process heat to produce hydrogen need ts and valves will be necessary for isolation of	of these technologies will still be situated in cale processes are optimised under prototype mpleted and licensing, construction and ope reactors by helium is a departure from current ds further study. Any contamination of the p	n between the 'viability' and 'performan bical conditions, respectively. By that time eration of the system are carried out wit ent industrial practice and needs specific product will have to be avoided.	
ECHNICAL DIMENSIONS						
	Functional Unit			Value and Range		
Capacity	MW			850	4.500	
	Global	MW	300 Current	- 2030	1,500 <b>2050</b>	
otential			-	Unlimited	Unlimited	
larket share	Electricity production in OECD	%	25	N/A	N/A	
apacity utlization factor	Europe		25 – 25		<u>-</u> <u>-</u> <u>-</u> <u>-</u> 0.90	
Ill-load running hours per year					8,000.00	
nit of Activity	PJ/year					
echnical lifetime (years)					60.00	
rogress ratio	No				0.90	
Hourly profile Explanation	The main reference of capacity represents the rounded average plant capacity (MWe) from leading advanced reactor companies that are currently pursuing commercialization (EI 2017). The potential for the generation-IV technology is regarded as unlimited and the market share value of 25% is attributed to the current share of nuclear energy from electric production within OECD EU (including less advanced technologies i.e. generation-III) (NEA, 2015).					
	The capacity utilization, lifetime and full-load running hours are based on the specifications for JAEA's VHTR for hydrogen production 'GTHTR300C' (IAEA, 2013). In terms of progree ratio, according to Lang, P. A. (2017), "if both the pre-1970s learning rates and the Linear or Accelerating deployment rates had continued, OCC in 2015 could have been around 2 10% of actual", whereas OCC refers to Overnight Construction Costs.					
OSTS	10% of actual , whereas occ refe	ers to overhight (				
ear of Euro	2015					
	Euro per Functional	Unit	Current	2030	2050	
vestment costs	mln. € / MW		N/A	2.76	2.76	
ther costs per year	mln. € / MW		 N/A 	1.50         -         4.27           N/A         -         -	1.50 – 4.2 N/A	
ixed operational costs per year	mln. € / MW		N/A	0.12	0.12	
excl. fuel costs)			N/A	-	0.00	
· · · · · · · · · · · · · · · · · · ·	mln. € / MW				-	
·		wards as the star	rt of the deployment of all generation-IV rea	Min         –         Max           ctors is not foreseen before 2030 (NEA, 202)	- Min – Max 15).	
/ariable costs per year	Costs are specified from 2030 on The main reference on costs is ba deployed systems) using the GIF p \$2,053/kW and a maximum of \$1 construction costs and financing o	sed on a recent s plant cost accour 5,855/kW. Capita costs have been o	rt of the deployment of all generation-IV rea study from EIRP (2017) where costs are estir nting framework. In the study, costs are estir al costs consist of direct construction costs, i deducted from the total capital costs, resulti are \$21/MWh on average, and \$14/MWh as	ctors is not foreseen before 2030 (NEA, 202 mated for Advanced Nuclear Plants (on a NO mated on average as \$3,782/kW (used for n indirect services costs, owner's costs and su ng on \$3,063/kW as main reference. Fixed o	15). DAK or Nth-of-a-kind basis i.e. mature w nain reference) with a minimum of pplementary costs (EIRP, 2017). Pre- operational costs include O&M costs tha	
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ariable costs per year osts explanation NERGY IN- AND OUTPUTS hergy carriers (per unit of main utput)	Costs are specified from 2030 one The main reference on costs is baddeployed systems) using the GIF p \$2,053/kW and a maximum of \$2 construction costs and financing of represent ~74% of the total operation <b>Energy carrier</b> Main output: Hydrogen Uranium Energy in- and outputs are specified The main reference for energy in- tonnes/day (World Nuclear Association 41% for the same technology and	sed on a recent solant cost accour 5,855/kW. Capita costs have been of ating costs that a PJ PJ PJ PJ ed from 2030 or c and outputs is b ciation, 2017) and I hydrogen produ	study from EIRP (2017) where costs are estimating framework. In the study, costs are estimated costs consist of direct construction costs, is deducted from the total capital costs, resulting framework. In the study, costs are estimated costs consist of direct construction costs, is deducted from the total capital costs, resulting framework. In the study, costs are estimated costs consist of direct construction costs, is deducted from the total capital costs, resulting framework. In the study, costs are estimated costs consist of direct construction costs, is deducted from the total capital costs, resulting framework. In the study, costs are estimated costs consist of direct construction costs, is deducted from the total capital costs, resulting framework. In the study, costs are estimated costs consist of the total capital costs, resulting framework. In the study, costs are estimated costs construction of 126 tonnes/day.         Current       Current	ctors is not foreseen before 2030 (NEA, 203 mated for Advanced Nuclear Plants (on a NC mated on average as \$3,782/kW (used for n indirect services costs, owner's costs and su ng on \$3,063/kW as main reference. Fixed of minimum and \$14/MWh as maximum (EIR 2030 -1.00 - 1.00 -1.00 - 1.00 2.00 2.00 - 2.44 N/A  generation-IV reactors is not foreseen befor tricity cogeneration 'GTHTR300C' (IAEA, 203 EA, 2013). A report from the IAEA/ARIS (20 2030	15). DAK or Nth-of-a-kind basis i.e. mature w nain reference) with a minimum of pplementary costs (EIRP, 2017). Pre- operational costs include O&M costs that P, 2017). 2050 -1.001.0 -1.001.0 2.00 - 2.4 N/A  N/A  re 2030 (NEA, 2015). 13) with a hydrogen production of 120 11) gives a hydrogen conversion efficien	
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World Nuclear Association (WNA), 2017. Nuclear process heat for industry. Link: http://www.world-nuclear.org/information-library/non-power-nuclear-applications/industry/nuclear-process-heat-for-industry.aspx