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ГОСУДАРСТВЕННАЯ КОРПОРАЦИЯ ПО АТОМНОЙ ЭНЕРГИИ «РОСАТОМ»

Russian HTR Programme

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Nuclear Energy Beyond Electricity

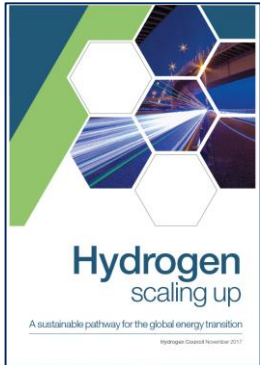
24.09.2019

Warsaw, Poland

Major Tracks of Hydrogen Power Development



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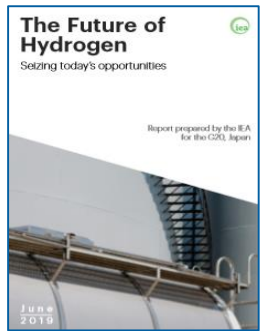


2017
Hydrogen
Council

World hydrogen production by 2050:
250 – 550 mln t/ yr

Rosatom Perspective:
H₂ production from H₂O and CH₄

International Cooperation



2019
IEA

Governmental support of H₂
production

Governmental support of H₂
utilization



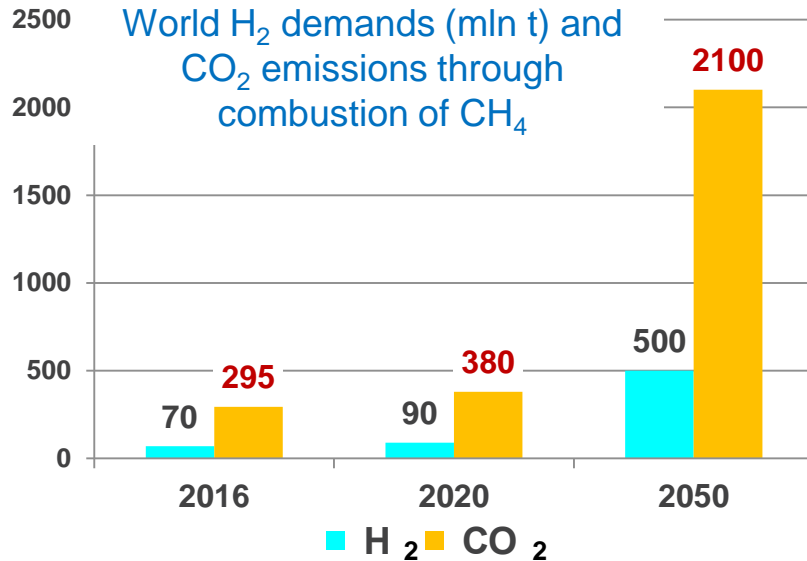
2019
Skolkovo

Integration of hydrogen power into world
market

Large Scale Environmentally Friendly Hydrogen Production

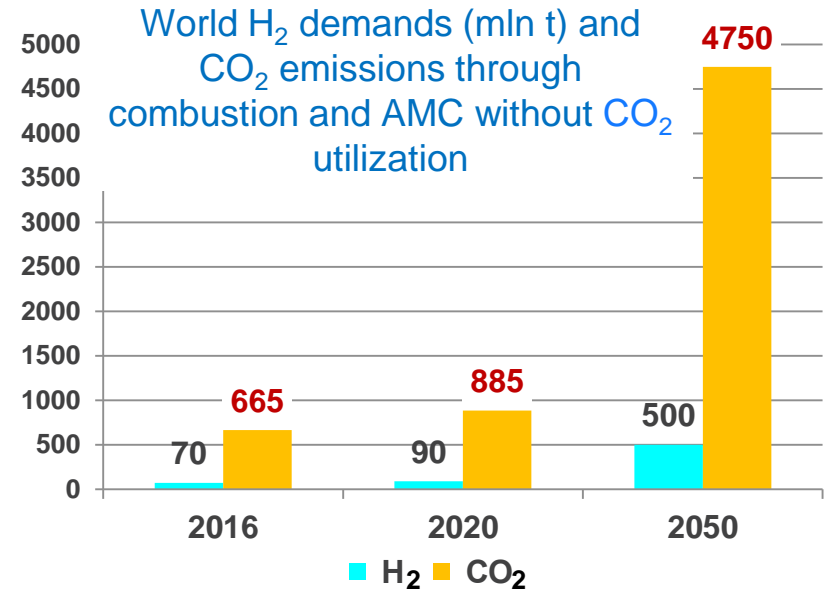


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CO₂ emission:

- combustion of methane 4,2 kg_{CO₂} per 1 kg H₂
- combustion of coal 7,7÷11,9 kg_{CO₂} per 1 kg H₂



CO₂ emission:

- for methane 9,5 kg_{CO₂} per 1 kg H₂
- for coal 22 kg_{CO₂} на 1 per H₂

Solution: introduction of large scale environmentally friendly hydrogen production based on nuclear-hydrogen generation developed in RF

**Nuclear
Power Producing
Complex (NPPC)**

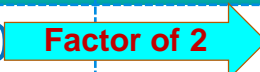



HTGR



**Adiabatic conversion
of methane + CO₂
utilization**

World consumption within industries and

	2016	2025-2035	2050
Annual H ₂ production, mln. t/year	70	130 	500 *
Annual market H ₂ , bln. \$	120	170	-
industrial /marketable, %	95 / 5	65÷70 / 30÷35	25 / 75
Marketable H ₂ , mln. t/year	3,5	39÷45,5 	375

Current major hydrogen consumers – chemical and petroleum industries (90 % H₂ world consumption)

* Report «Hydrogen Scaling Up», 2017

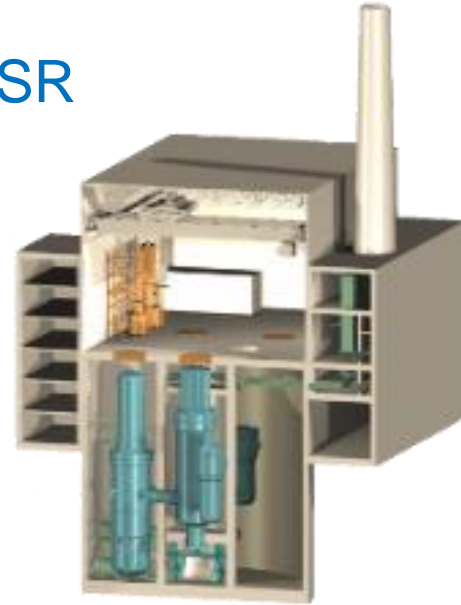
Russian HTR Projects



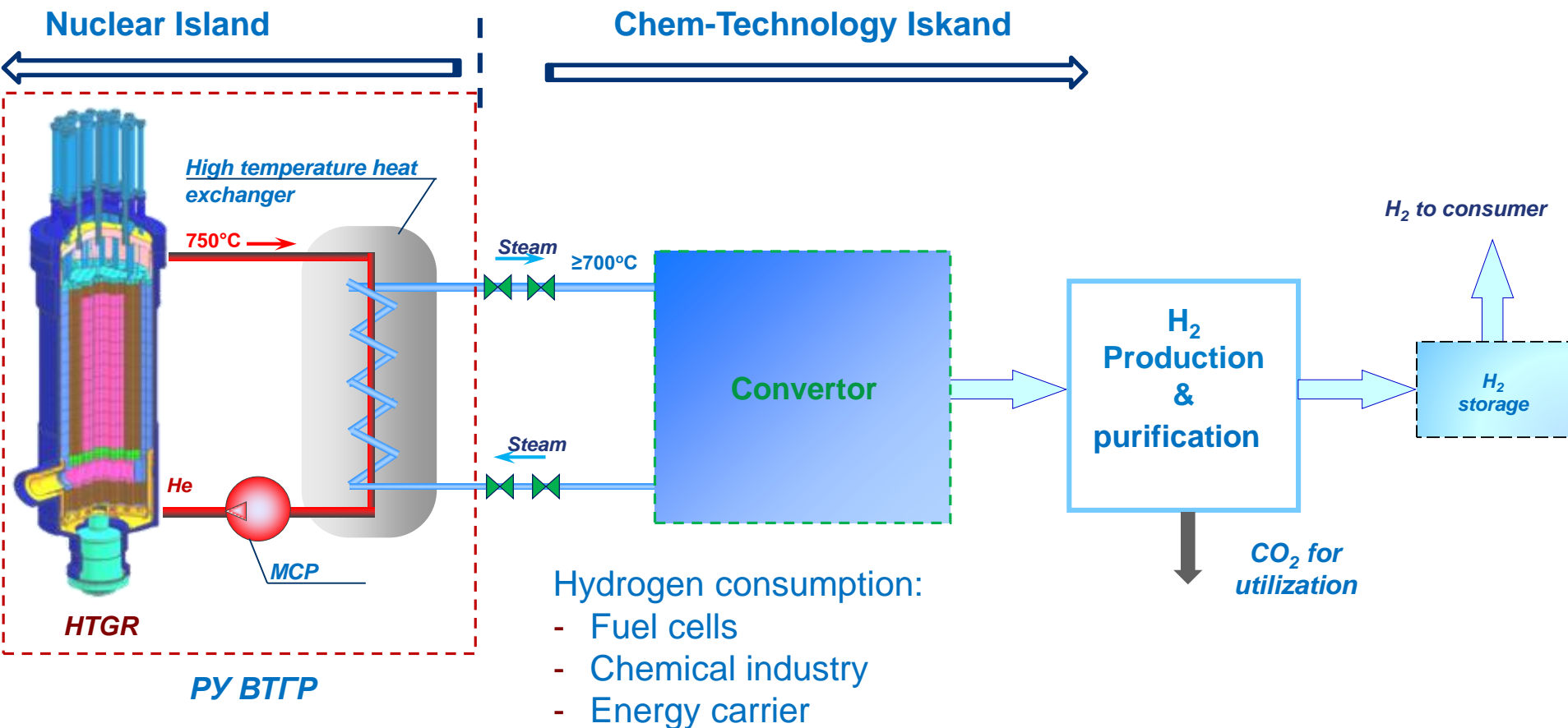
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Project/ Characteristics	VGR-50	VG-400	VGM	VGM-P	GT-MGR	MGR-T
	БГР-50	БГ-400	БГМ	БГМ-П	ГТ-МГР	МГР-Т
	VNIIAEM	OKBM Afrikantov				
Thermal Power, MWt	136	1060	200	215	600	600
Purpose	Electricity & transmutation	Electricity & Process heat application	Electricity & Process heat application	Heat for petroleum refinement	Electricity	Electricity & hydrogen production
Fuel/ Enrichment, %	U / 21	U / 6,5	U / 8	U / 8	U / 14, Pu / 93	U / 14
Coolant	He					
Outlet He temperature, °C	810	950	950	750	850	950
Status	Tech.Project 1978	Tech.Project 1987	Tech.Project 1992	Tech Proposal 1996	Conceptual design , 2002	Tech. Proposal 2004

- ❑ 1970s – adopted Programme «Hydrogen Power».
Coordinator – Commission for Hydrogen Power, USSR Academy of Sciences
- ❑ Within the Programme:
 - Technical projects of HTGR were developed
 - Key R&D were performed
 - Ceramic fuel for HTGR was developed
 - 70 facilities to support R&D were built
- ❑ Based on the HTR technical projects was issued a Special Government Decree on Development and Implementation of Nuclear Power Technological Complexes with HTGR (16.07.1987) in Dimitrovgrad, Kirovo-Chepetsk, Kotlas, Novopolotsk, Nizhnekamsk



Nuclear-Hydrogen Technological Complex Based on Adiabatic Conversion of Methane



HTGR application reduces the consumption of methane in a steam conversion (~4 kg methane per 1 kg Hydrogen)

- Hydrogen power is among the priorities of technology development in Russia
- Objective: nuclear power application beyond electricity- process heat, hydrogen production, synfuels, fuel cells, etc
- Objective: R&D and demonstration of key solutions in nuclear-hydrogen power system

Stages of New Programme for Development of Hydrogen Technologies in Russia



- 2019 – project developments of HTGRs for hydrogen production, feasibility studies, roadmaps
 - 2020 – 2024: R&D
 - Design of the Reference Unit
 - Key elements of Nuclear Island, methane steam conversion, hydrogen storage and transport, CO₂ utilization, marketing of key elements of hydrogen generation
 - 2024 – 2030: construction and commissioning of HTGRs for hydrogen production, establishing infrastructure for hydrogen economy
 - 2030 and beyond: Large scale environmentally friendly hydrogen production and further infrastructure development for hydrogen economy
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- ✓ Non-electric application of HTGRs for large scale environmentally friendly hydrogen production – expands the potential of nuclear power
- ✓ International cooperation in the HTGR development is a basis for energy transitions of our energy systems into affordable, reliable, sustainable and low GHG emissions systems



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Thank You for Your Attention
