



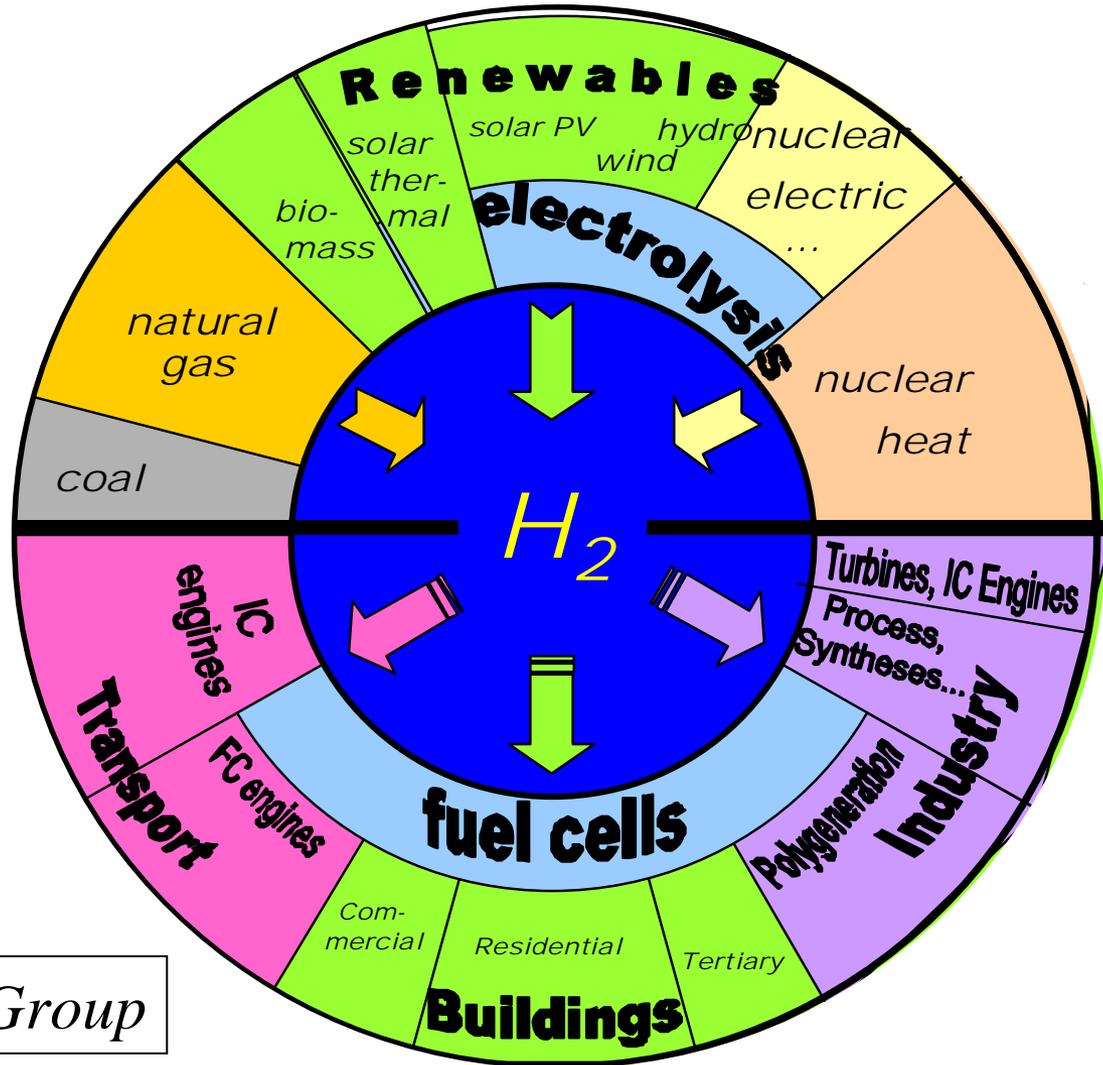
The Potential of Nuclear Hydrogen

Patrice BERNARD

Director of Nuclear Development & Innovation

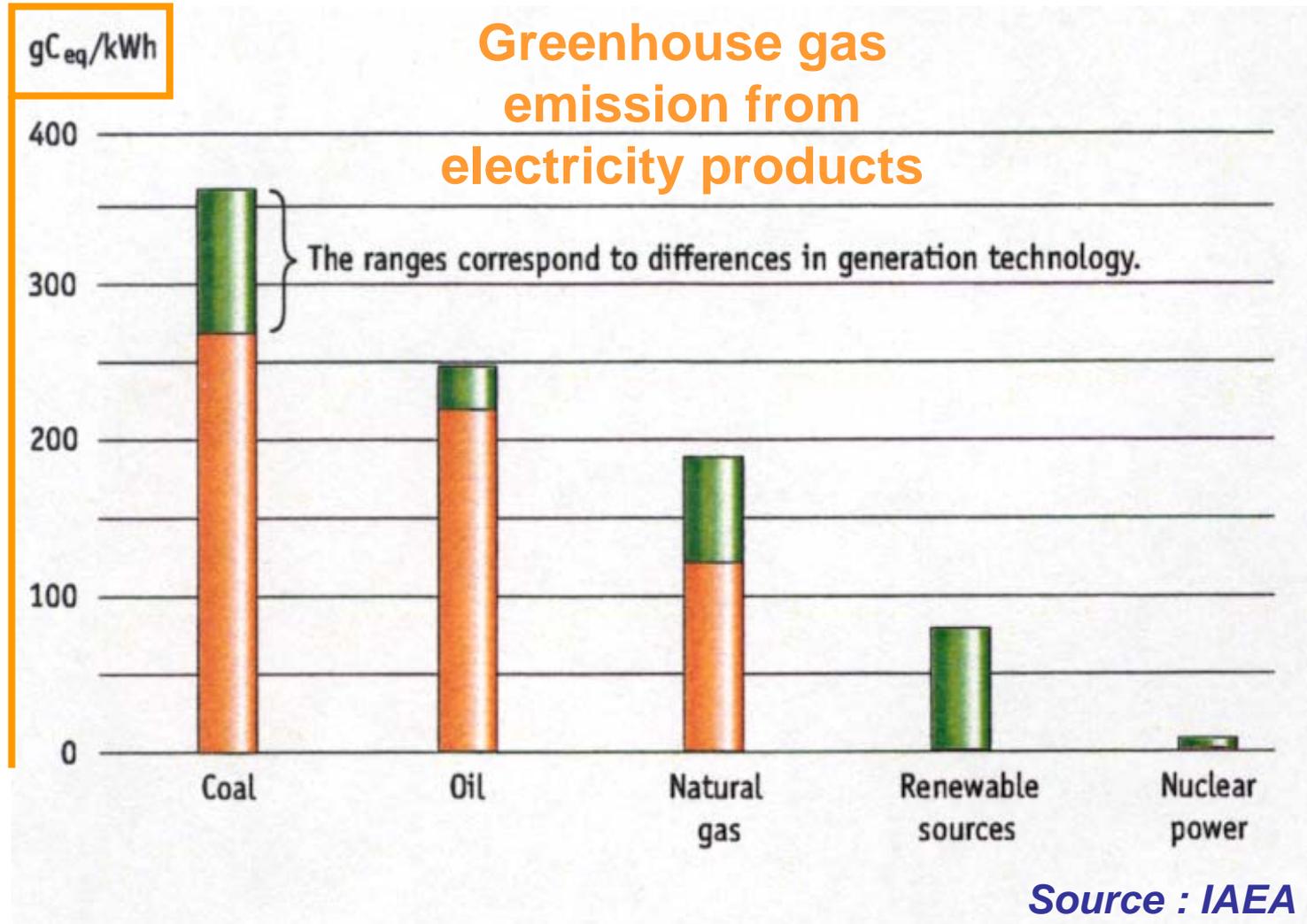
Commissariat à l'Énergie Atomique (CEA), France

Hydrogen : primary energy sources, energy converters and applications

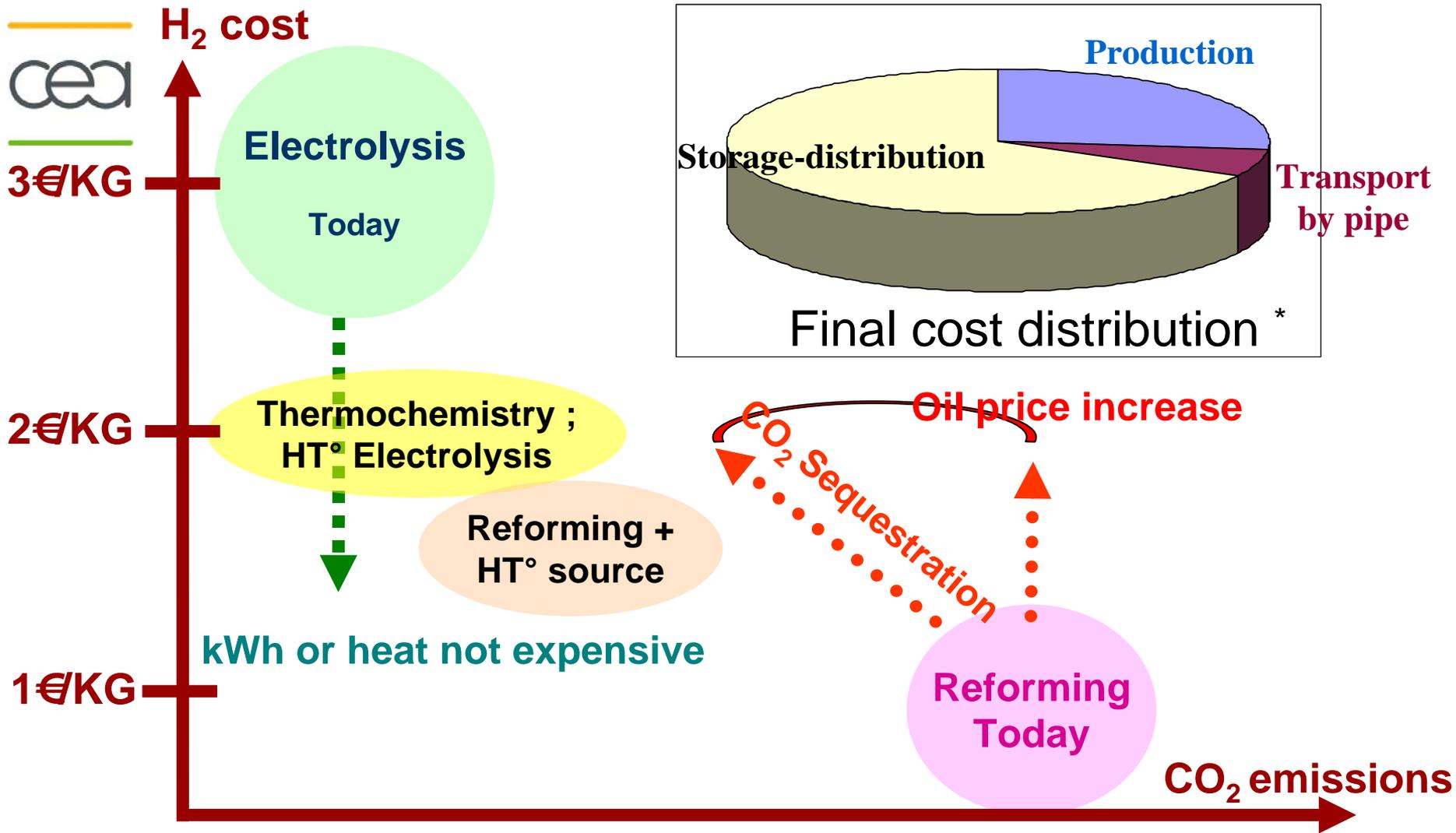


From High Level Group

Fossil: environmental consequences



Cost of Hydrogen massive production



* For a centralised production from natural gaz reforming

Future Nuclear Energy Systems : the Generation IV initiative

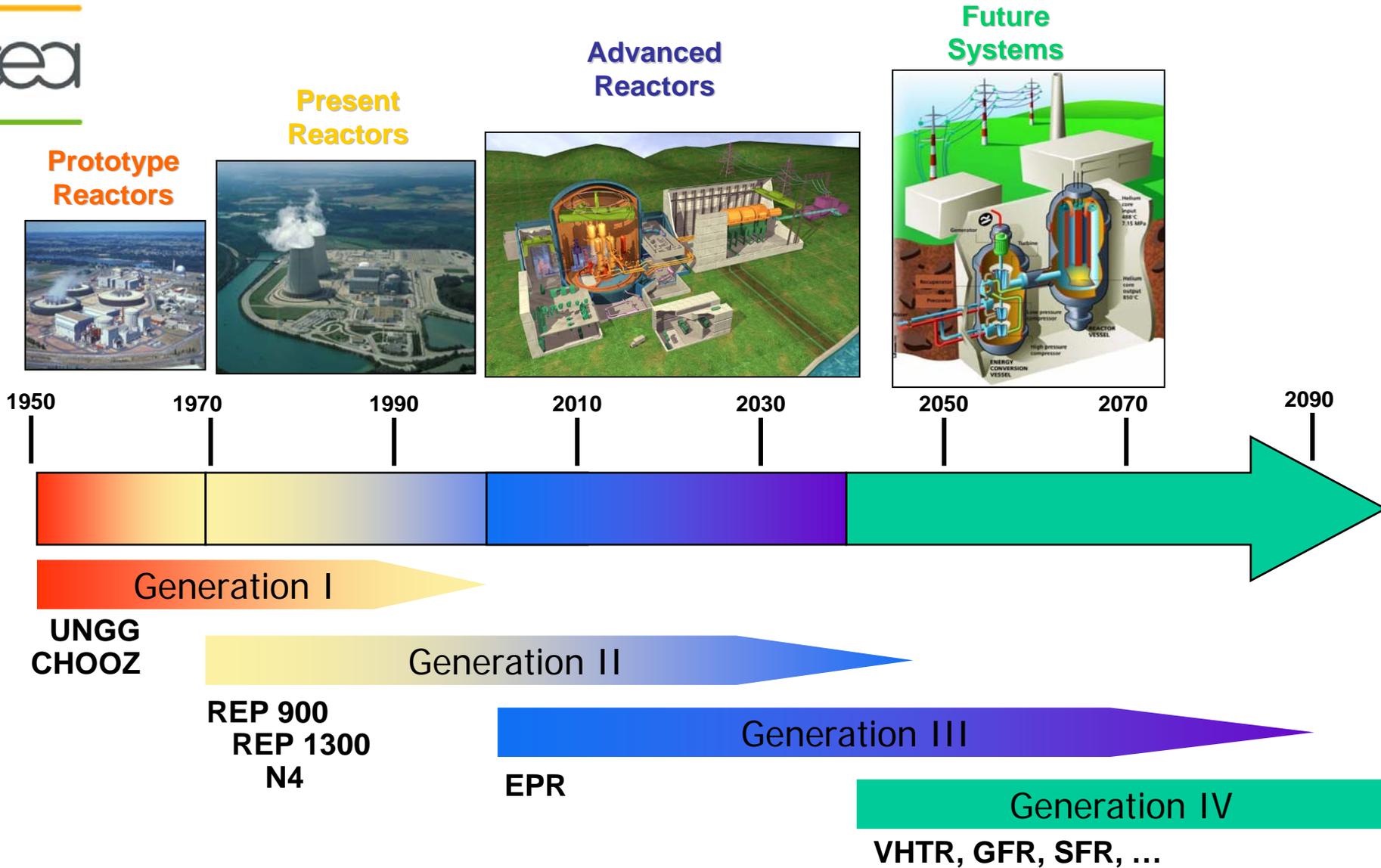


Development of one or more nuclear energy systems

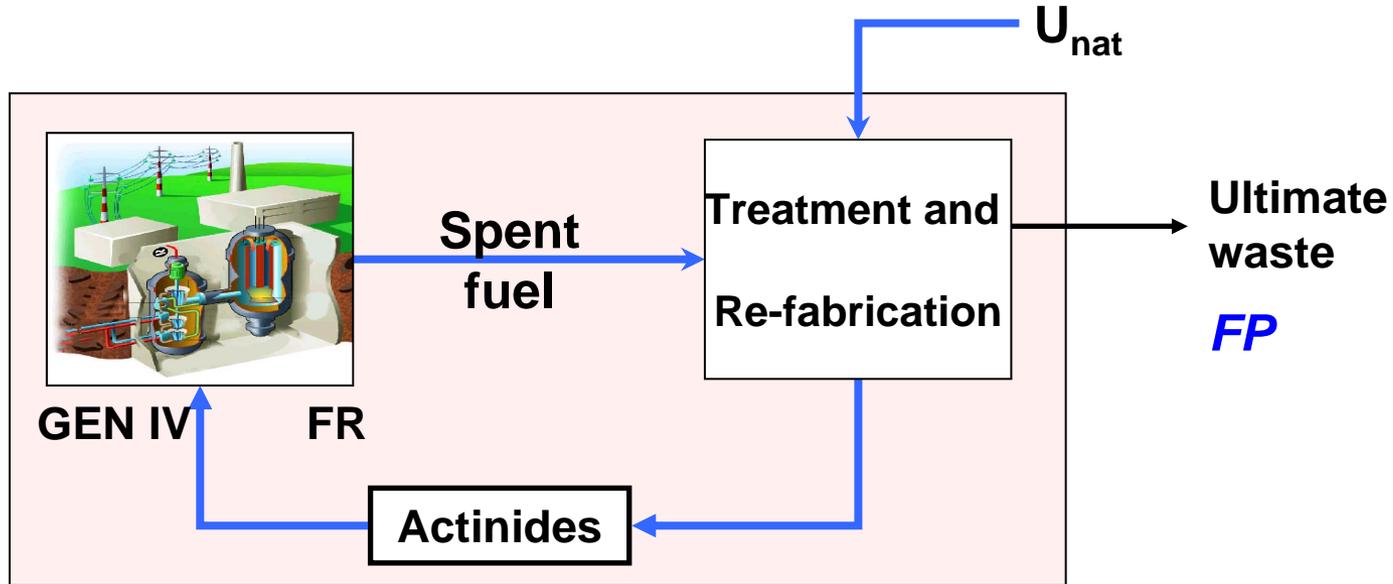
- Deployable by 2030/2040
- With significant advances in :
 - **Sustainability**
 - Safety and reliability
 - Proliferation and physical protection
 - Economics
- Competitive in various markets
- Designed for different applications :
Electricity, **Hydrogen**, Clean water, Heat



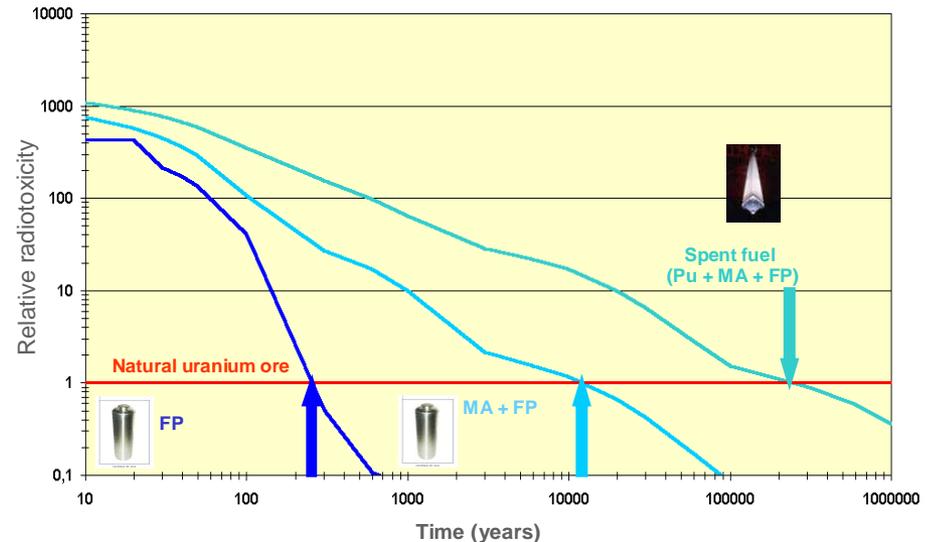
Nuclear Power Plants Evolution



4th generation Systems: an integrated cycle with full actinide recycling



- A drastic minimization of ultimate waste :
 - Very small volumes
 - Heat load reduction
 - Drastic decrease of the radiotoxicity : some hundred years versus hundreds of thousands years
- An optimal use of energetic materials
- Proliferation Resistance features

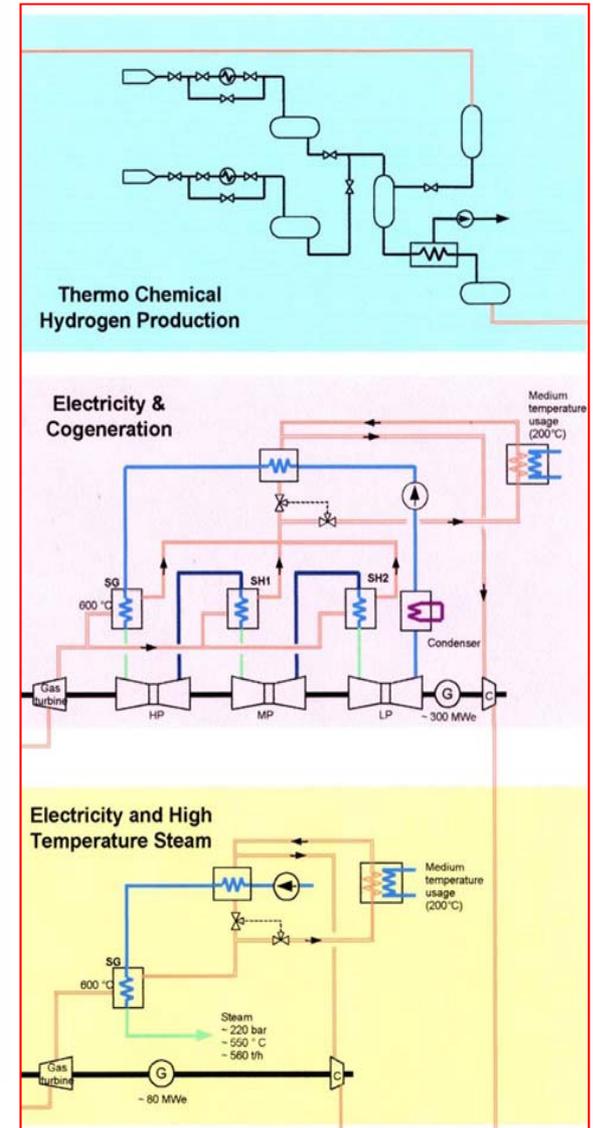
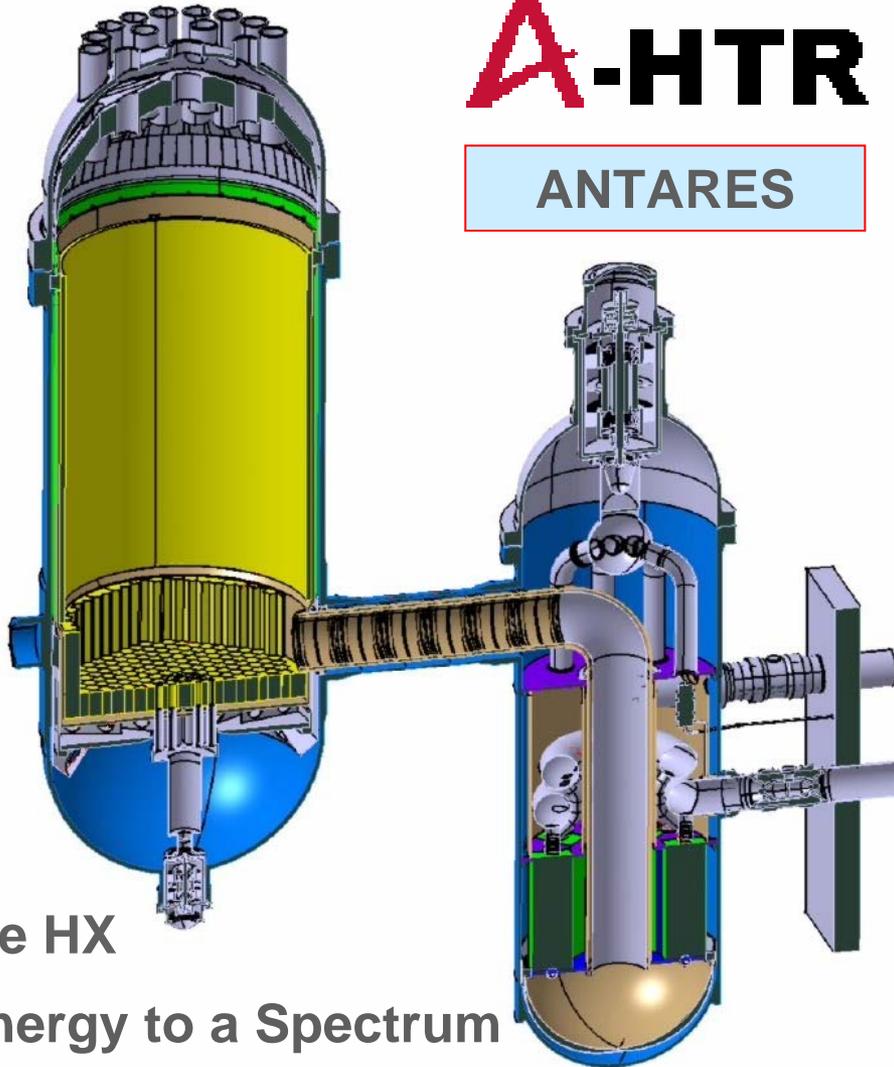


Areva's New Technology Advanced Reactor Energy System



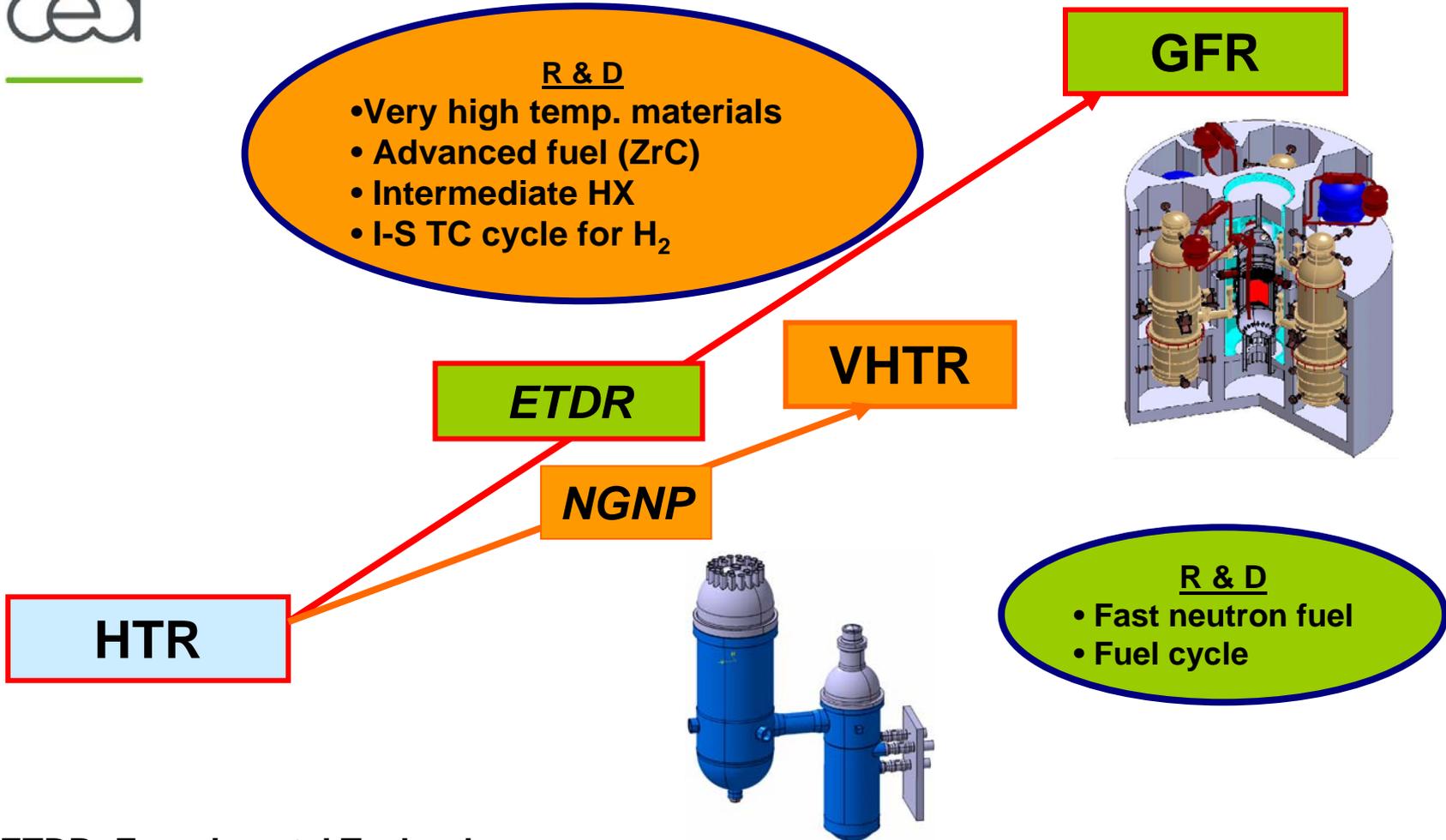
A-HTR

ANTARES



- Power: 600 MWt
- Helium : 850/1000°C
- Intermediate HX
- Supplies Energy to a Spectrum of Applications

A consistent set of advanced gas cooled nuclear systems



ETDR: Experimental Technology and Development Reactor

High Temperature Cycles



Sulfur Family

HTE

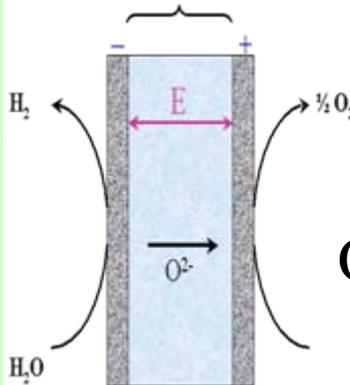
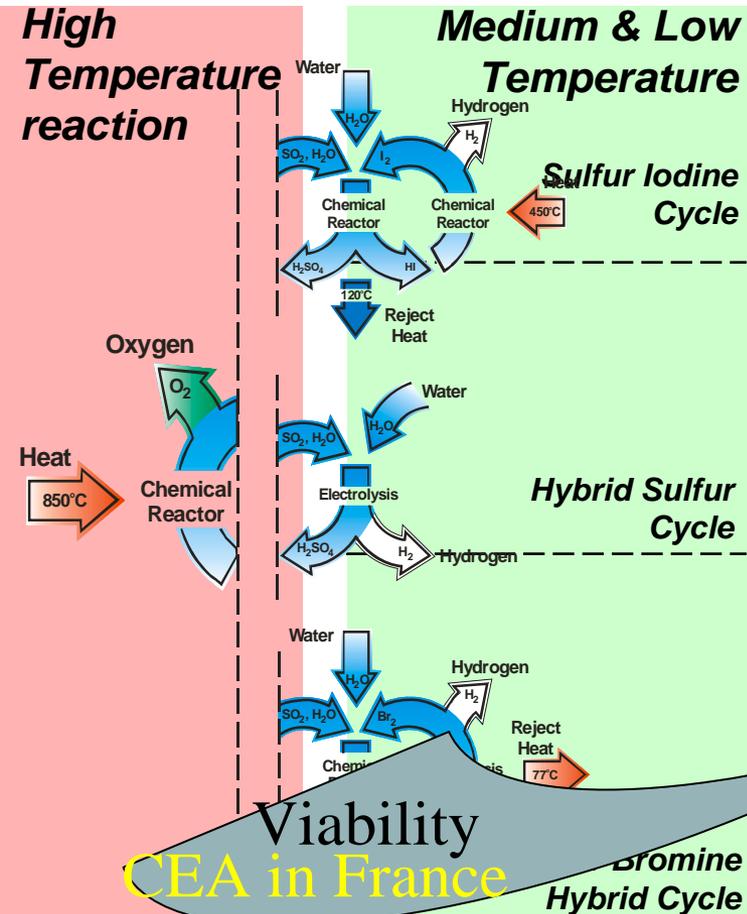


Demonstration

Optimization

Innovation

With JAERI in Japan



Viability
CEA in France



The SushyPro Plateform - Objectives

Propose to European H2 community (research & industry) facilities to develop High Temperature Processes for H2 massive production from solar or nuclear energy



Conclusion



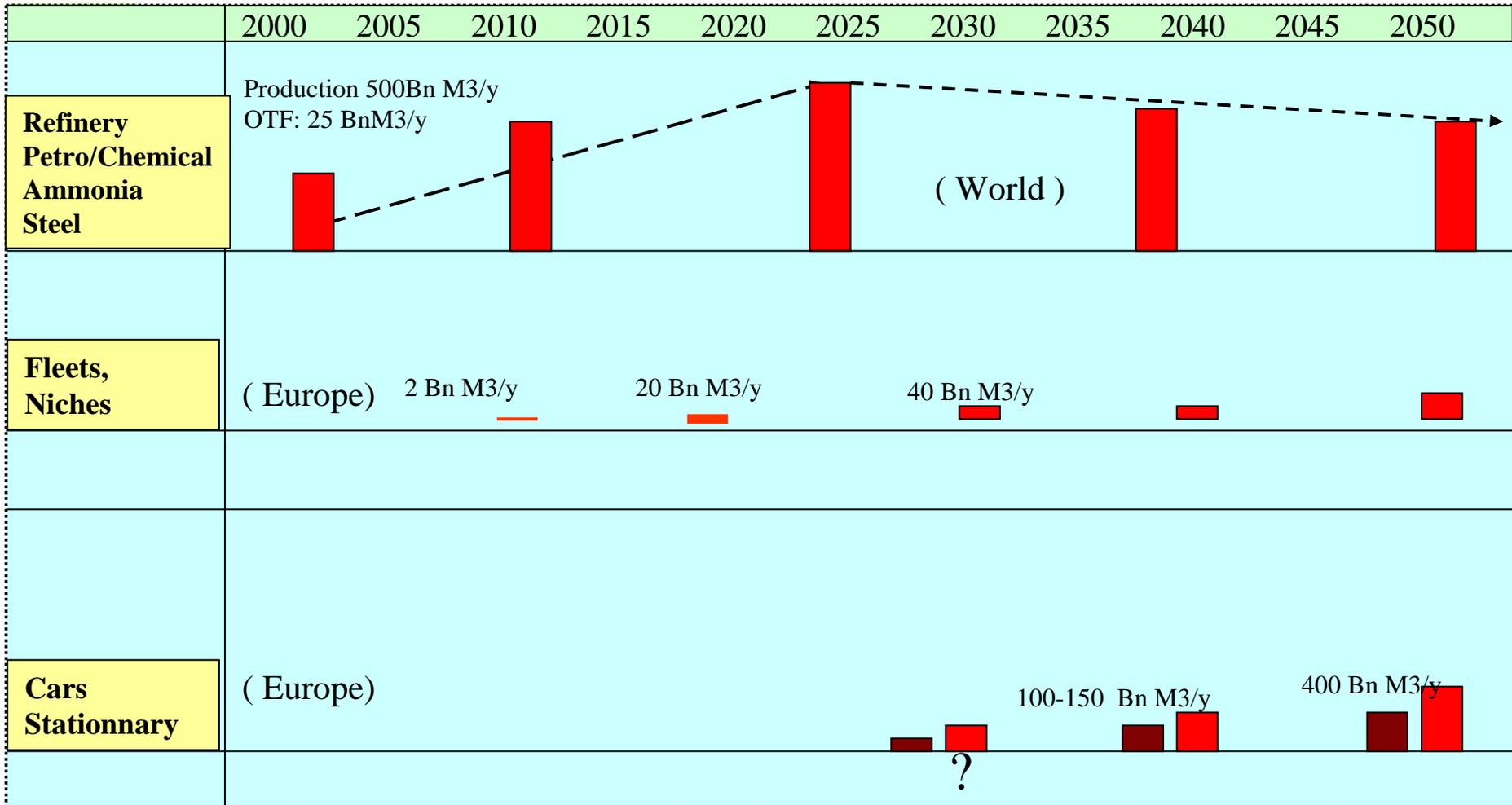
- Nuclear energy has the potential for contributing to take up the major challenges of sustainable energy supply in the 21st century
- 4th Generation systems aim at both :
 - CO2 free sustainable energy production, with drastic minimization of waste and very long term resources
 - Enlarging the energy production capability of nuclear energy : electricity, hydrogen and heat (clean water...)
- Their development is now in progress within effective international cooperation framework



- **Complementary slides**

H2 Production Roadmap

Needs...(High Level Group on hydrogen hypothesis)



	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Thermo-chemical Cycles											
Viability											
<i>Reactive Distillation</i>			◆								
<i>Membranes</i>				◆							
Improvement											
<i>Tools</i>	◆										
<i>Reactions equilibrium</i>			◆								
<i>HYTECH project Results</i>				◆							
Validation											
<i>Reference scheme</i>	DOE-CEA INERI Loop Result				◆						
<i>Innovations</i>	SIMUL Loop- CEA				◆						
Demonstration											
<i>Reactor coupling</i>	HYPRO Loop - CEA					◆					
<i>Process Performance</i>	30 m ³ /h JAERI Loop					◆					
	HTTR Coupling (1 000 m ³ /h) JAERI									◆	
	NGNP Coupling (5 000 m ³ /h) USA										> 2017
High Temperature Electrolysis											
Design	◆										
Demonstration		FP6 geyser project									
1 kW			◆								
5 kW				◆							

Nuclear Power Plant producing hydrogen



Ex : VHTR coupled with a hydrogen producing factory using thermochemical Iodine/Sulfur process

