KUALA LUMPUR 2012 WORLD GAS CONFERENCE

25th world gas conference

"Gas: Sustaining Future Global Growth"

HYDROGEN ENERGY DEVELOPMENT FORECAST

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HYDROGEN ENERGY DEVELOPMENT FORECAST

Hydrogen is an energy carrier of the most stars in observable Universe

LONG RUN PROSPECT EXPECTATIONS OF WORLD COMMUNITY

- **Solution of environmental, economic and social problems**
- **Sustainable development and energy safety guaranteeing**

CONFORMING THE PRESENT KNOWLEDGE THERE IS NO ALTERNATIVE TO THE HYDROGEN ENERGY IN THE FORESEEABLE FUTURE

HYDROGEN AS A FUEL

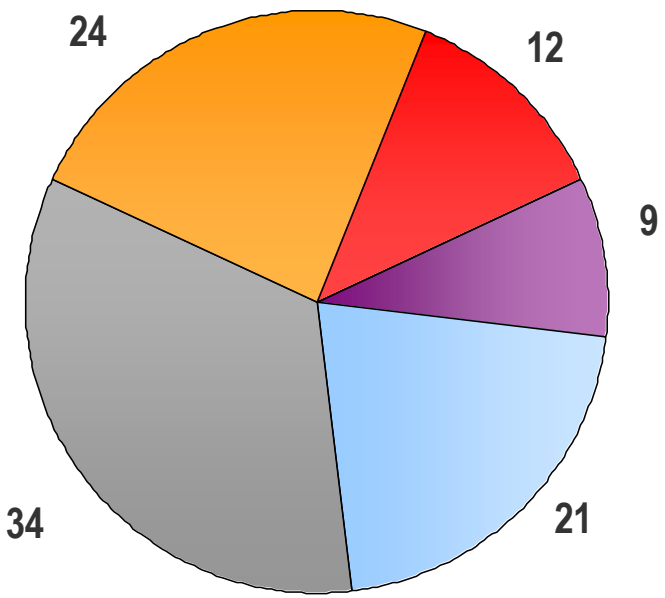
Russian space-shuttle "Buran"

- High energy efficiency
- Zero emissions
- The exhaust is water
- Fuel cells
- Rocket engines
- Internal combustion engines and etc.

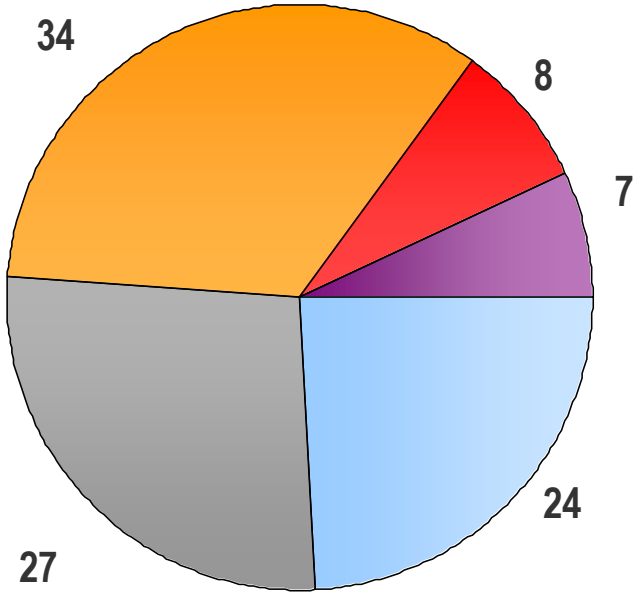
STRUCTURE OF FUEL BALANCE IN THE WORLD

(Under forecasts of International Energy Agency)

- Atom
- Coal
- Oil
- Natural gas
- Renewable



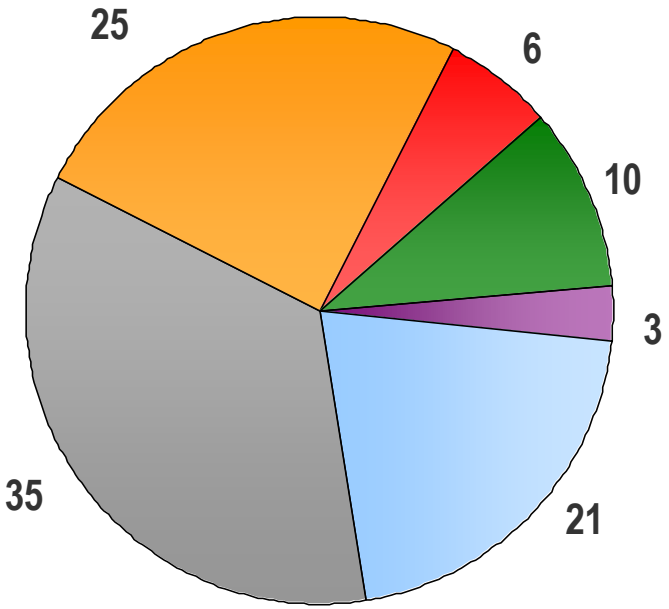
2003 year



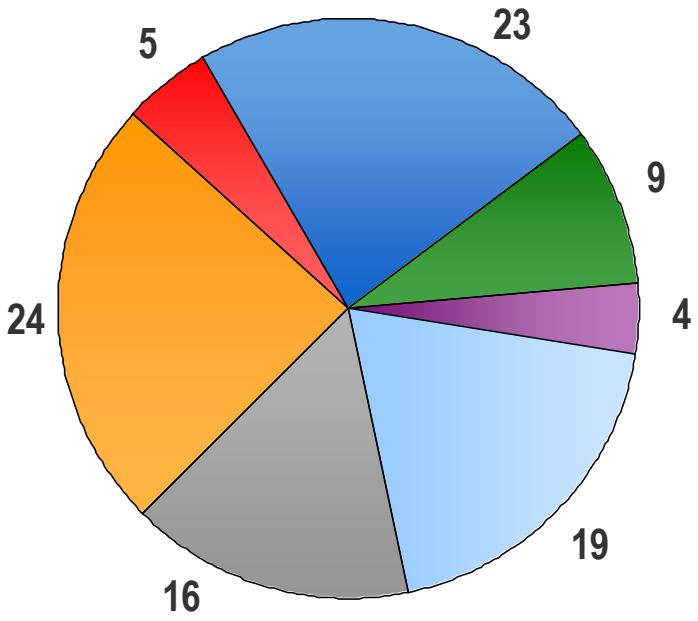
2050 year

STRUCTURE OF THE WORLD ENERGY BALANCE

- Atom
- Coal
- Oil
- Natural gas
- Hydrogen
- Biofuel
- Renewable

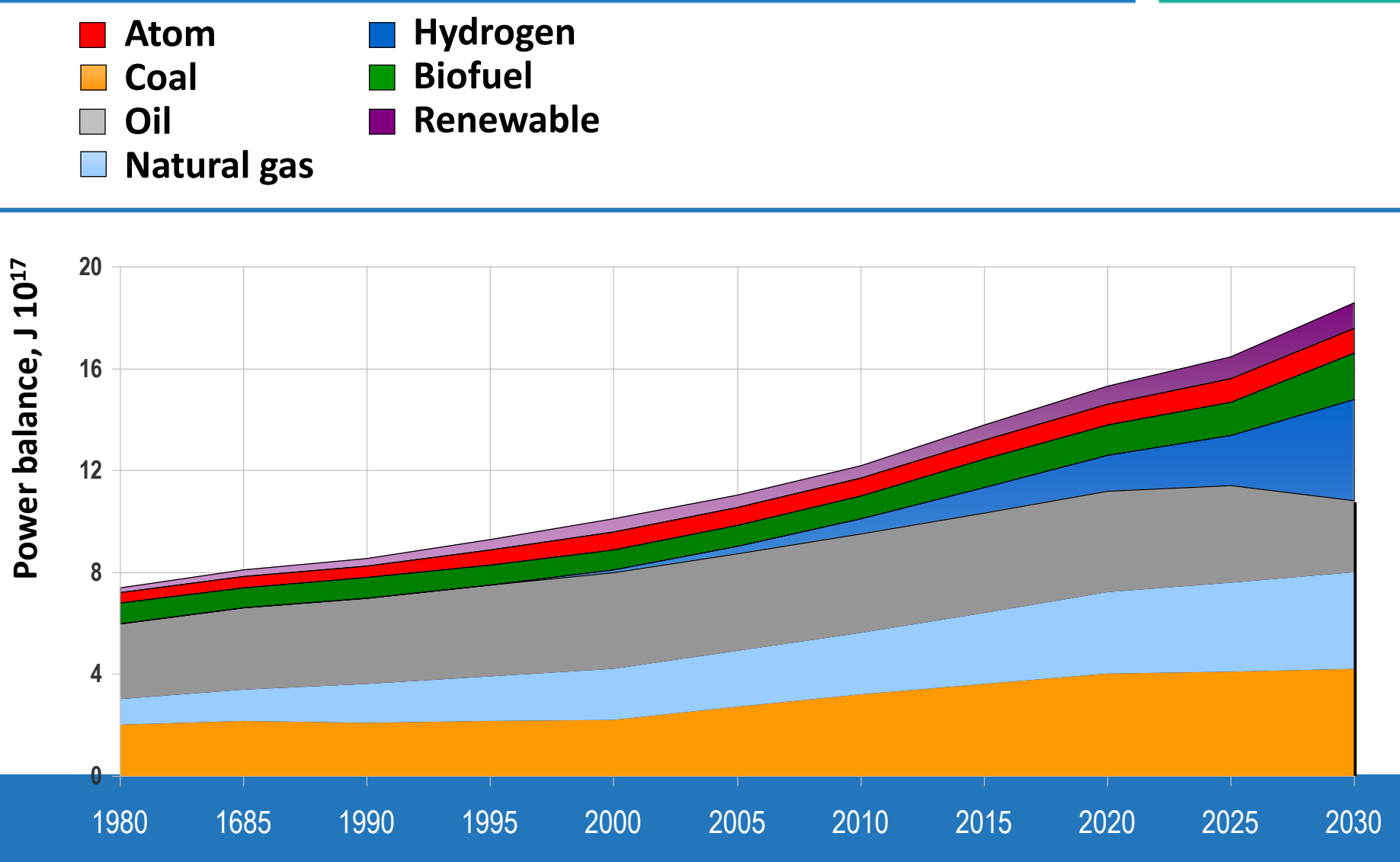


2005 year

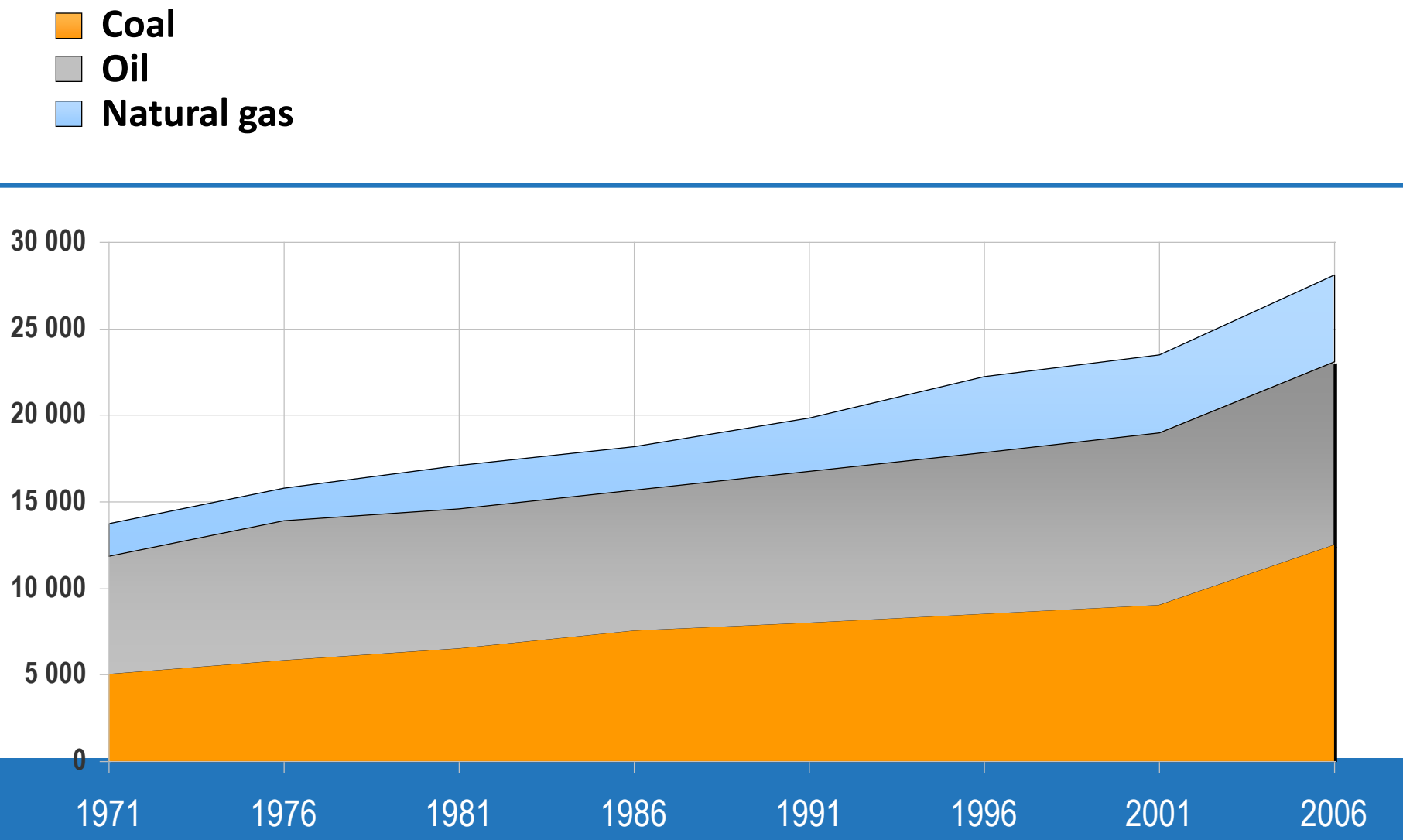


2030 year

DYNAMICS OF THE WORLD POWER BALANCE



CO_2 EMISSION AND ITS SOURCES



THE BASIC MODERN "KNOW-HOW" OF HYDROGEN

ELECTROLYSIS, THERMOCHEMICAL CYCLES
ELECTRIC & THERMAL ENERGY

Water

Fuel-cells and other units

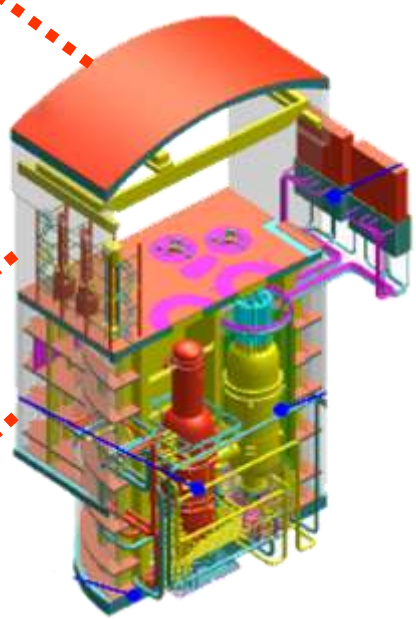
RENEWABLE ENERGY

Biomass, Bioethanol

CONVERSION OF THERMAL ENERGY

Mineral and synthetic fuel

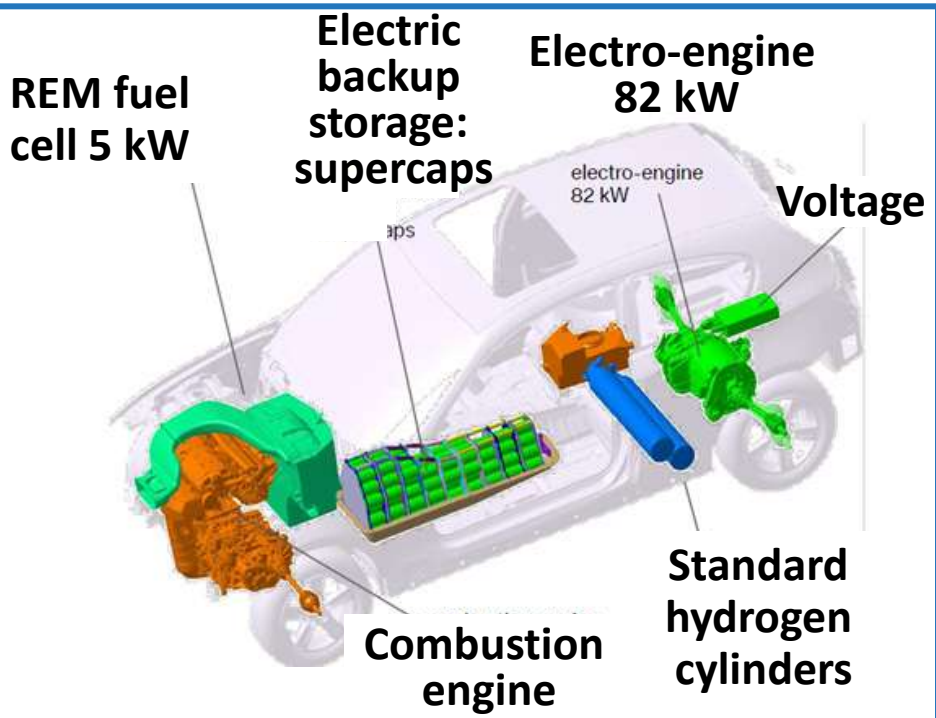
CONVERSION OF THERMAL ENERGY

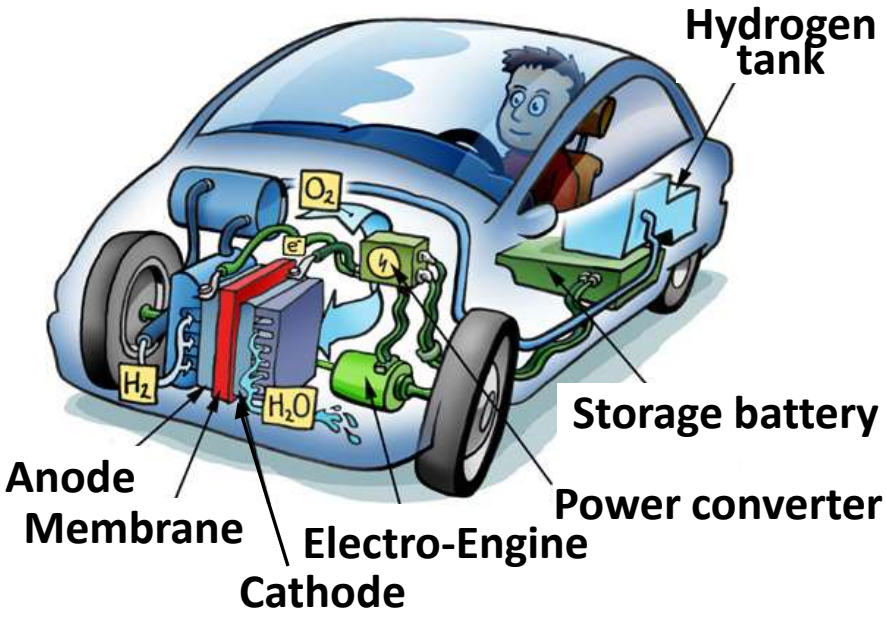


MODULAR HELIUM REACTOR

HYDROGEN VEHICLE – BASIC TECHNICAL SOLUTIONS

- Hybrid vehicles
- Fuel cell electric drive vehicles
- Hydrogen internal combustion engine vehicles





MODERN HYDROGEN VEHICLES

- The USA cut financing for hydrogen car researches

BMW Hydrogen-7 combustion-engine

Ford-focus fuel-cell and electric-engine

THE HYDROGEN ENERGY DEVELOPMENT

CONTRIBUTING FACTORS	OBSTRUCTING FACTORS	CONTRIBUTING AND OBSTRUCTING FACTORS
National energy security	Long-term priority conservatism of the energy policy	Rapid development of hydrogen and competitive energy
Global climate change and its possible connection with GNG emissions	A lack of hydrogen infrastructure and the cost of its development	Opportunity of inevitable fossil fuel depletion
Global growth of population and economy	The high cost of hydrogen production, storage and usage.	Green and relatively cheap energy supply
New green energy at fair price	Hydrogen safety problems	
Reduction of automotive and power plant pollutants	The high cost of carbon dioxide sequestration	

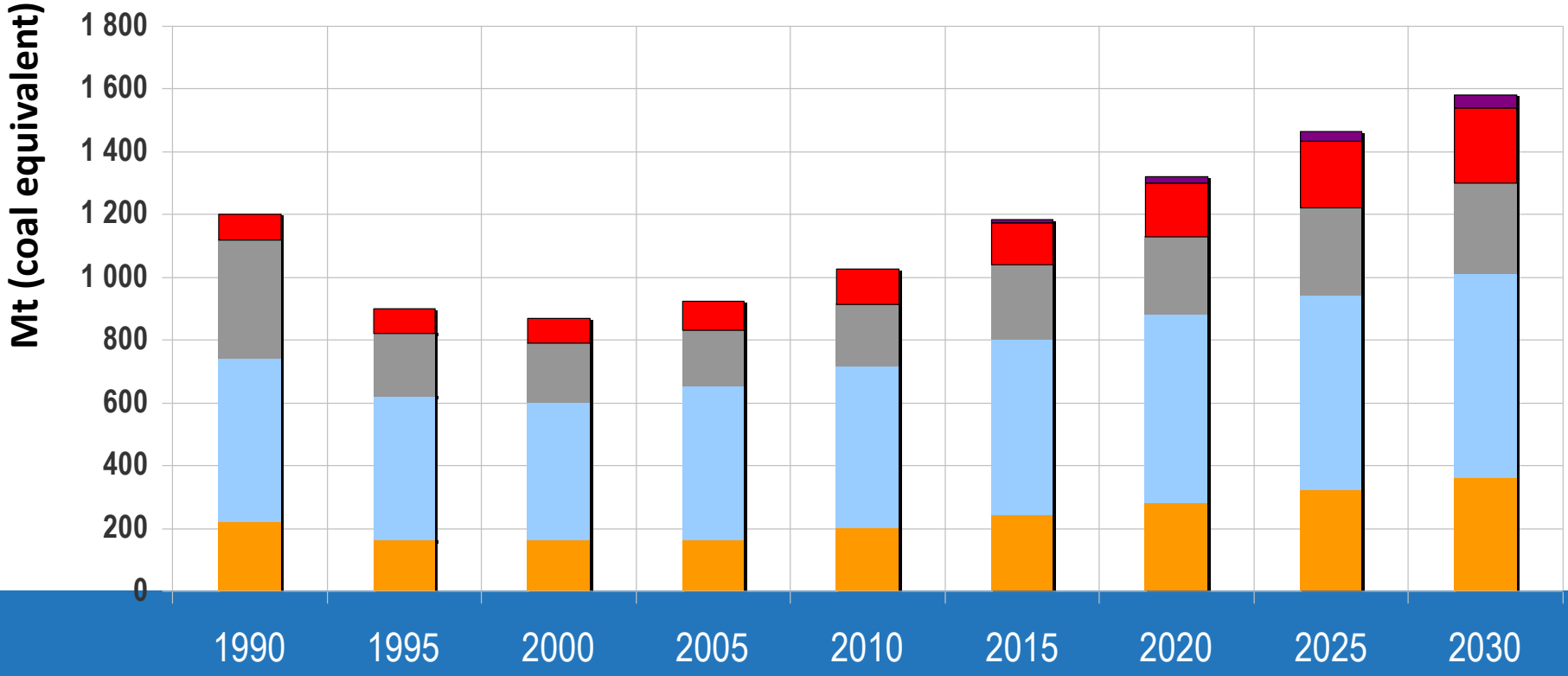
THE HYDROGEN PRODUCTION COST

RESOURCES	TECHNOLOGIES	HYDROGEN PRICES (dollar/GJ)/(dollar/kg)	YEAR OF ADOPTION
NATURAL GAS	Steam reforming, pressure swing adsorption (without sequestration)	5.54/0.75	Current
	Synthetic gas production using membrane technologies, CO_2 sequestration	4.15/0.56	2013
COAL	Gasification, pressure swing adsorption	6.83/0.92	Current
	Advanced gasification, membrane separation, CO_2 sequestration	5.89/0.79	2015
	Advanced gasification, membrane separation, energy production, CO_2 sequestration	3.98/0.54	
BIOMASS	Bio-oil pyrolysis by steam reforming	(9-16)/(1.21-2.16)	
NUCLEAR	S-I cycle (thermochemical process)	9.70/1.31	2020
ELECTROLYSIS	At electricity cost – 4 cents/KWh	(19-22)/(2.56-2.97)	Current

ENERGY CONSUMPTION IN RUSSIA

- Atom & Hydro
- Coal
- Oil
- Natural gas
- Renewable

Rosstat data up to 2008 and the forecast of Russian Academy of Science



THE JAPANESE WE-NET FOR HYDRICITY MODEL

- **INTERNATIONAL CLEAN ENERGY NETWORK USING HYDROGEN CONVERSION — WORLD ENERGY NETWORK**

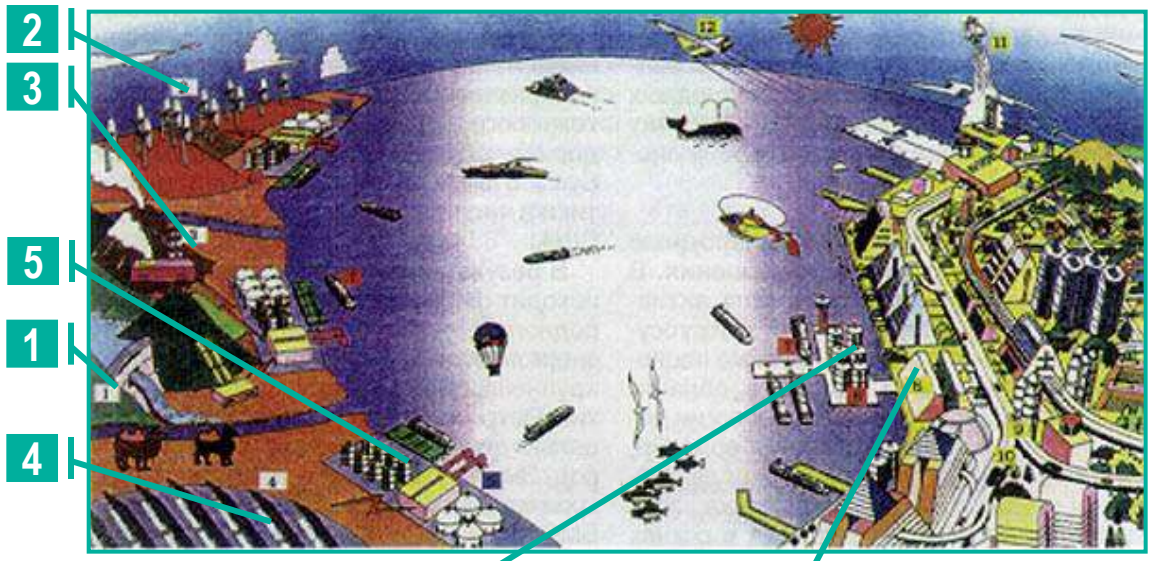
Renewable energy resources:
1 — hydroelectric power plant
2 — wind-driven power station
3 — geothermal power plant
4 — solar power plant

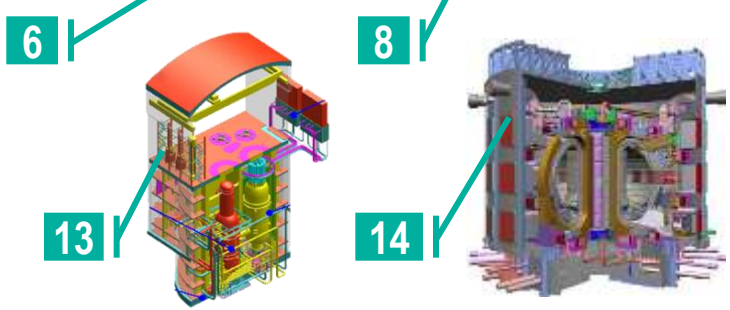
Hydrogen production:
5 — hydrogen production plant

Hydrogen transport and storage:
6 — liquid hydrogen holder
7 — hydrogen tanker

Hydrogen consumers:
8 — electric power plant with hydrogen power installations
9 — hydrogen vehicle
10 — hydrogen bus
11 — hydrogen rocket
12 — hydrogen airplane

The primary sources of energy:
13 — helium reactor
14 — tokamak





Hydrogen consumers: — heavy and energy intensive industries

GAS INDUSTRY AND HYDROGEN

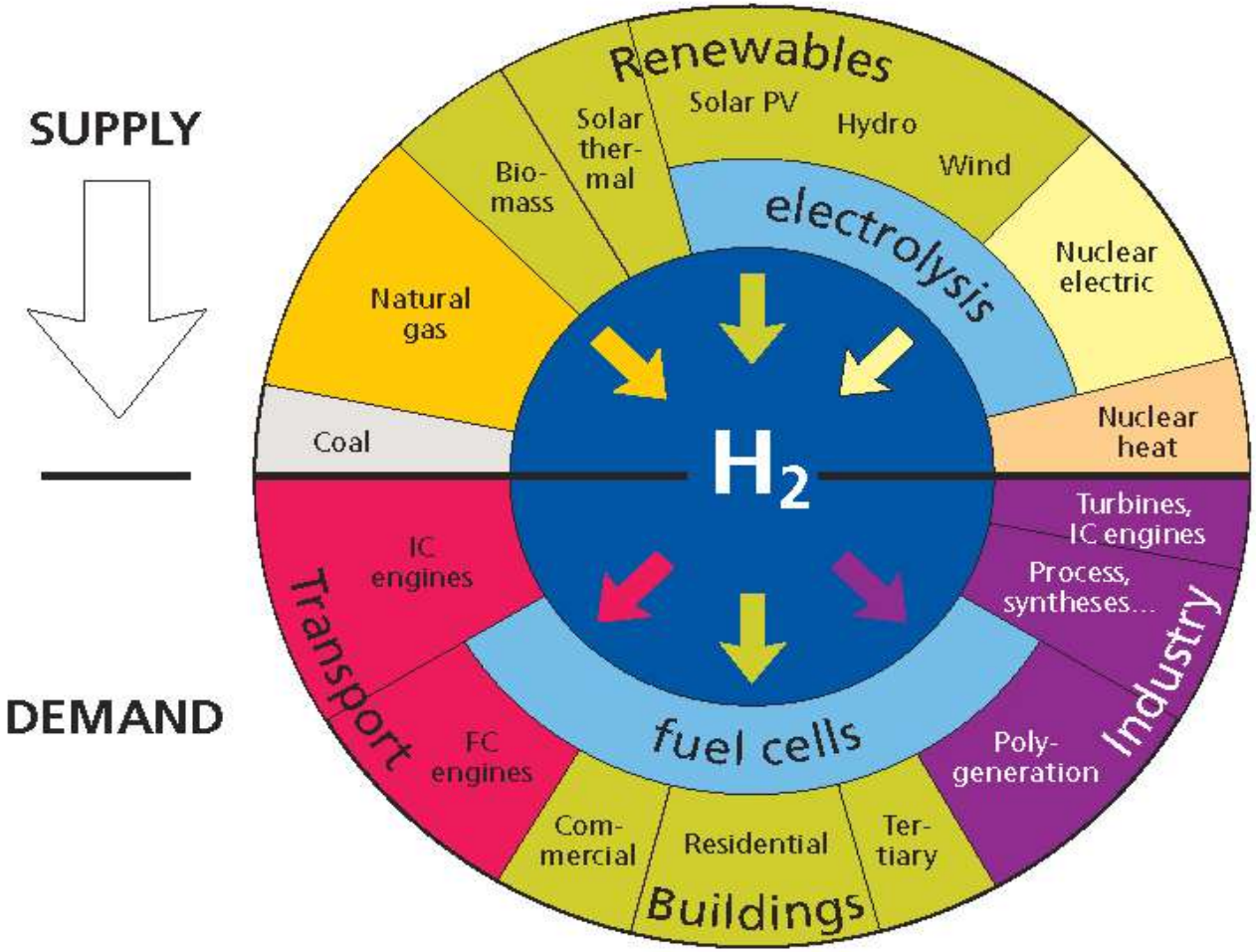
- Today – we produce and transport natural gas
- Tomorrow – we produce, generate and transport natural gas and hydrogen
- The day after tomorrow – we generate, produce and transport hydrogen and natural gas
- In the long term – we generate and transport hydrogen

METHANE

HYDROGEN

HYDROGEN PRODUCTION AND CONSUMPTION

The average rates of hydrogen production and consumption in the midterm – in compliance with hydrisity model



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THANK YOU

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