Workshop
Energy for Sustainable Science

Energy management for Large Scale Research Infrastructures

13-14 October 2011, ESS-LUND, Sweden

Energy and Climate Challenges for Research Infrastructures

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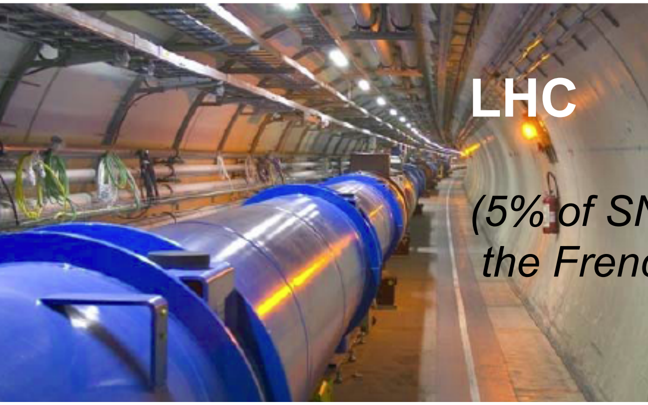


Electric consumption

400 GWh/year

(5% of SNCF consumption, the French railway transport)

63 GWh/year

RI and Climate and Energy challenges

Outline

- Climate challenges
- Sustainable Energy challenges
- RI Contributions to research in this field
- Energy savings in RI's
- Conclusion

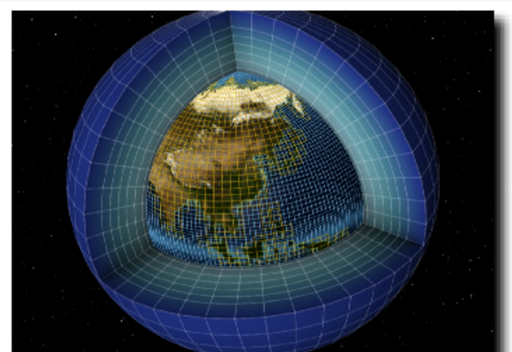
Scientific Challenges of Climate Change

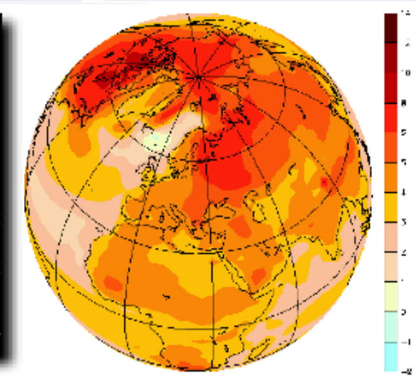
Observations

- Reconstruct past climates
- Observe current climate
- Understand the environment

Modelling

- Represent all components of the Earth System (ocean, atmosphere, ices, …)
- Understand relationships between climate and Green House Gases
- Quantify and predict impacts of climate change on the environment



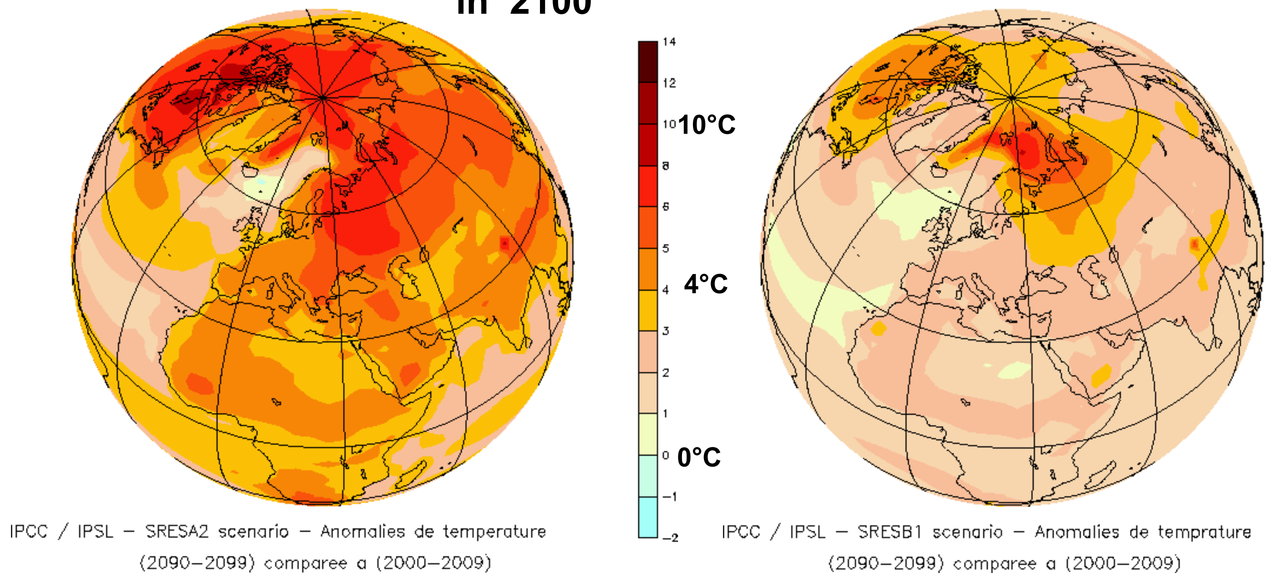


Several scenarios of society development and fossil fuel consumption, and thus of GHG emissions, are considered by IPCC to simulate the 2100 climate

International Panel for Climate Change

Scenario A2 « business as usual » :
+3,5°C
in 2100

Scenario B1 « strong society changes » :
(economy, technology, behavior)
+2°C
in 2100



However: **Uncertainties (strongly non linear problem; sea level, clouds, carbon sinks…)**

Environmental consequences ?

Major challenges beyond climate change

Challenge 1: Use IPCC simulations to anticipate regional impact of climate change

- Extreme events ➔ Adaptation issue ➔ need for new climate services

Challenge 2: Monitoring Green House Gas emissions

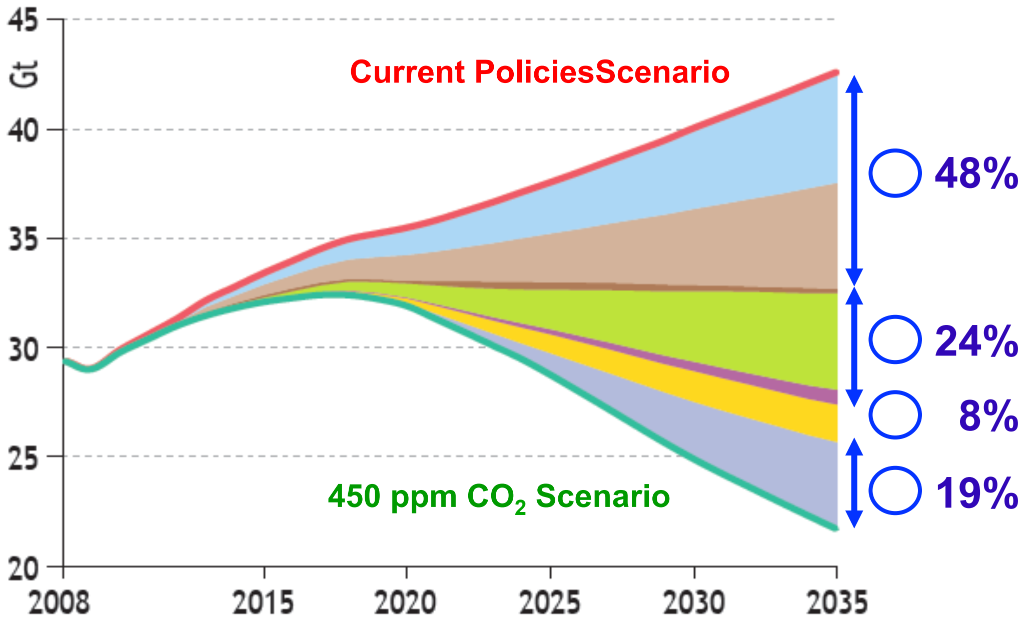
- Efficiency of new mitigation policies to be verified by independent estimates
- **Large station network infrastructures** are needed, deploying innovative technology

Challenge 3: Create a dynamic between society, industry and research around these adaptation and mitigation issues.

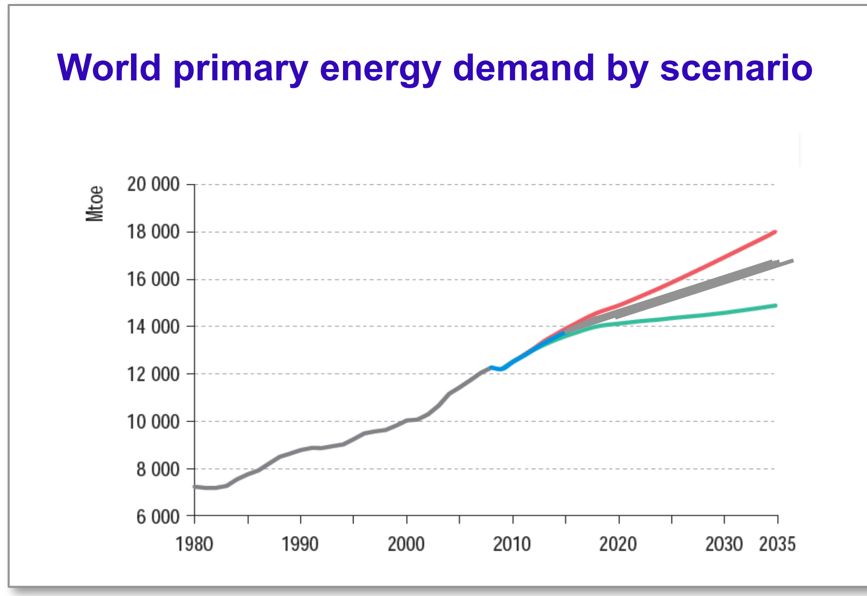
Energy challenge: World energy-related CO_2 emission savings

From 3.5Gt in 2020 to 20.9Gt in 2035:

- **Efficiency measures**
- **Renewables and biofuels**
- **Nuclear**
- **$C0_2$ capture and sequestration**

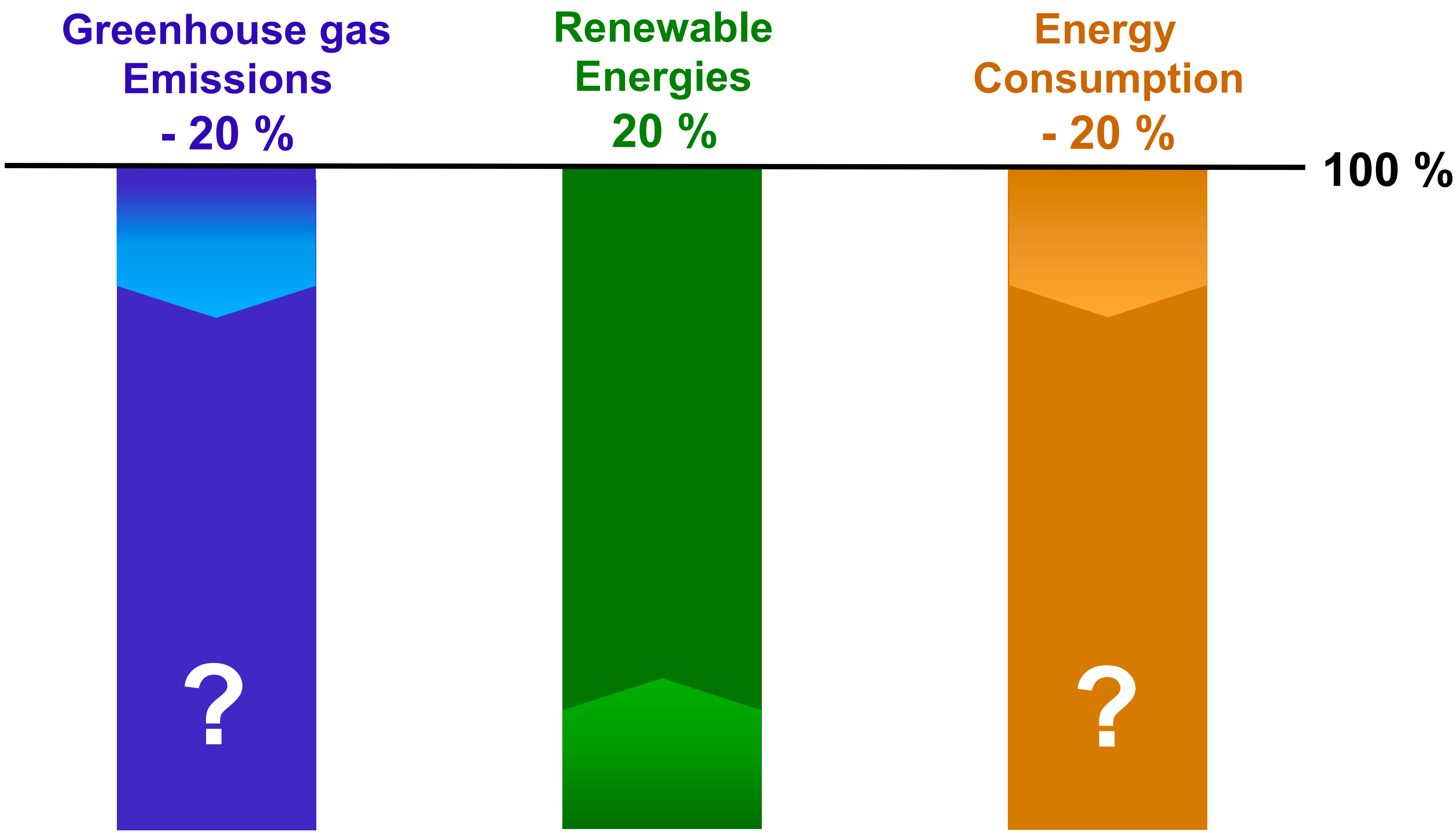


Source : IEA, World Energy Outlook



European targets: the 20-20-20 in 2020

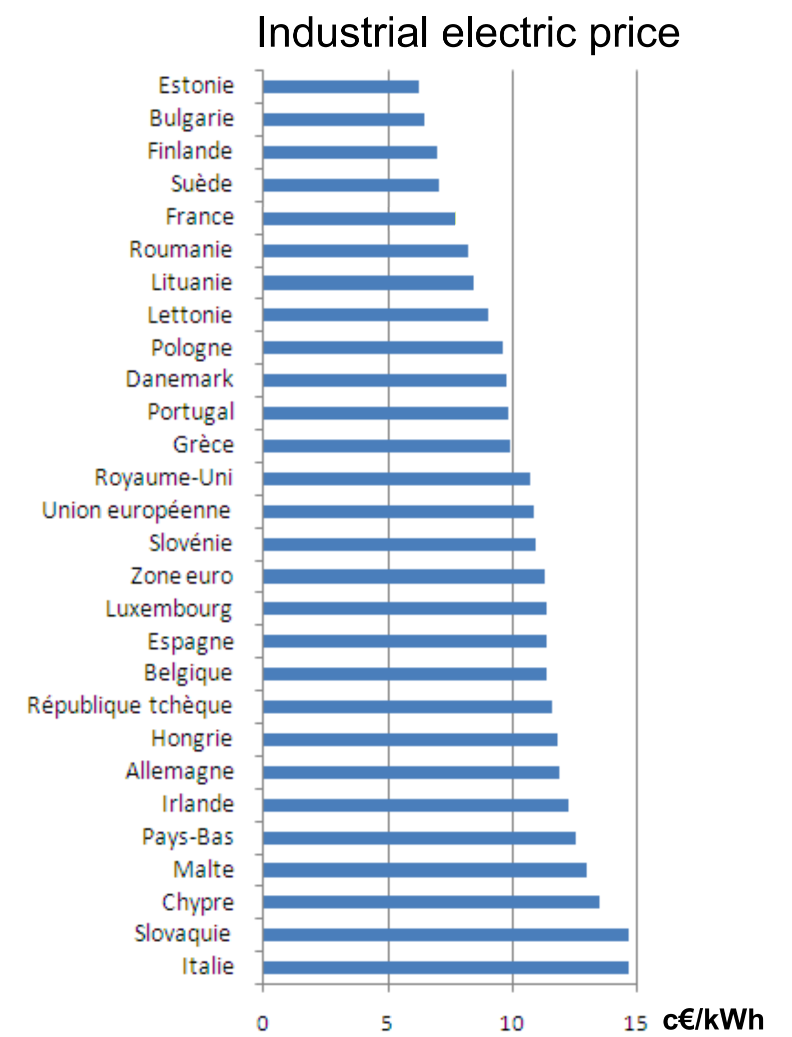
European Parliament, 18 December 2008

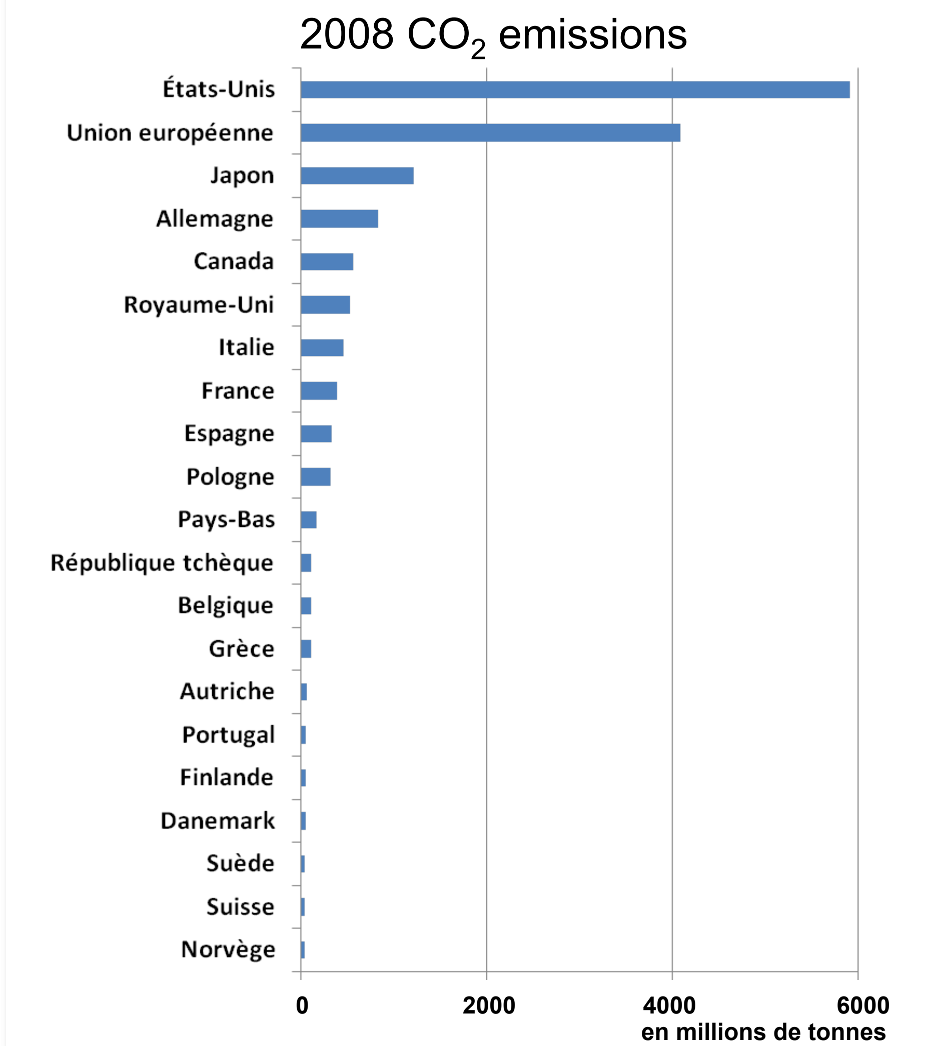


But: **are these targets still reachable?**

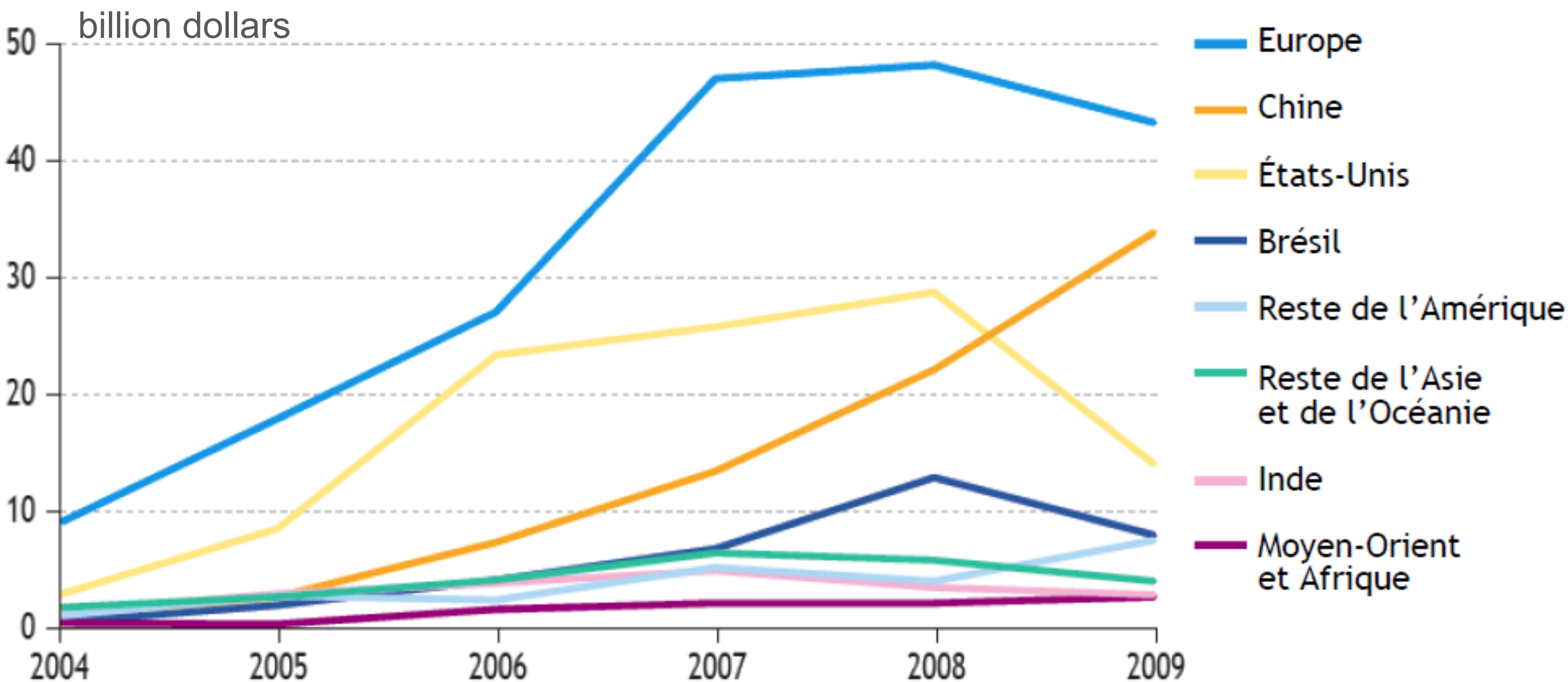
Energy comsumption and CO_2 emissions

Great European energy disparities !





Renewable energies: evolution of investments

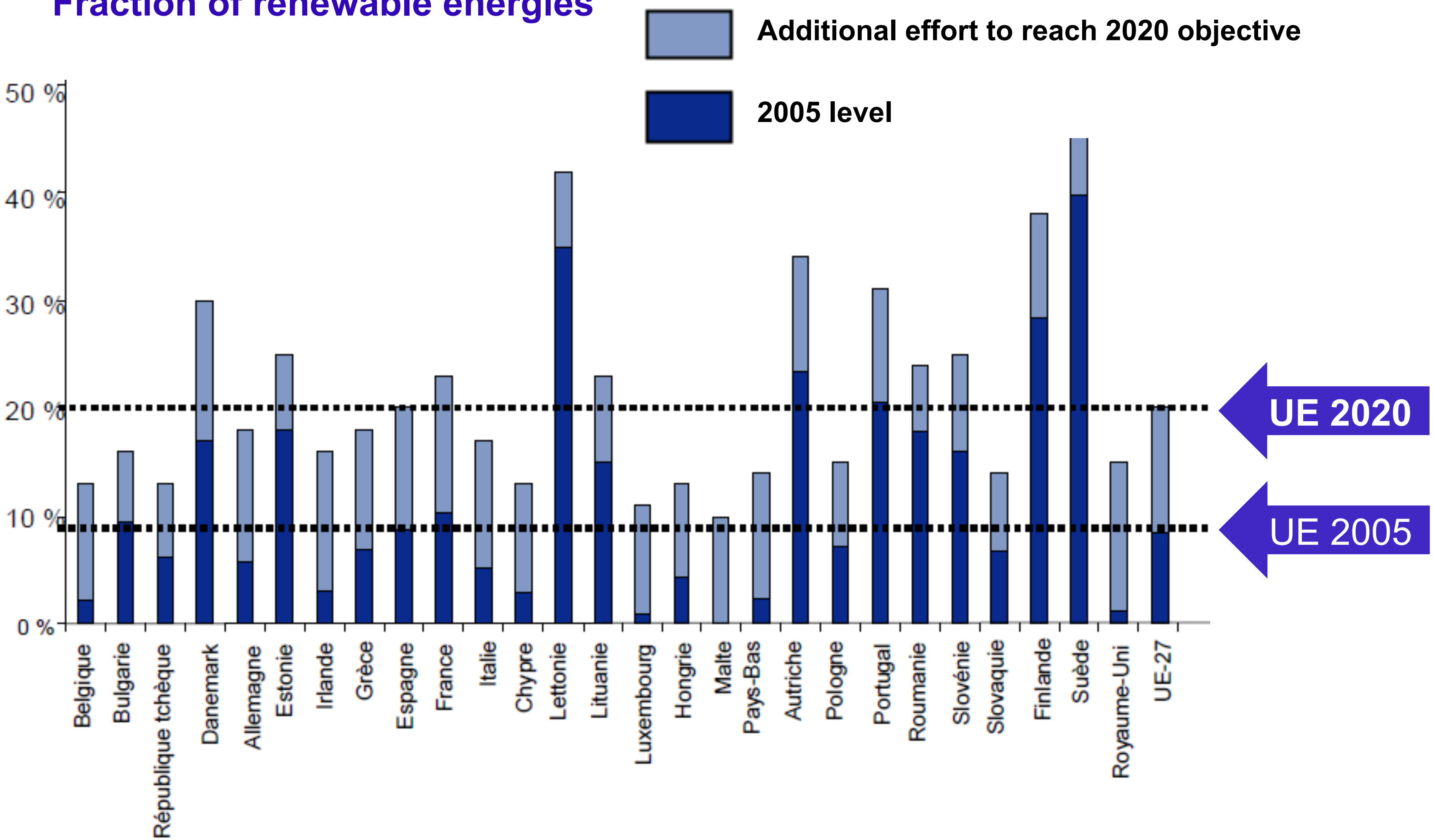


Source: International Energy Agency

Warning: **need to maintain a collective effort !**

Renewable energies: European countries objectives

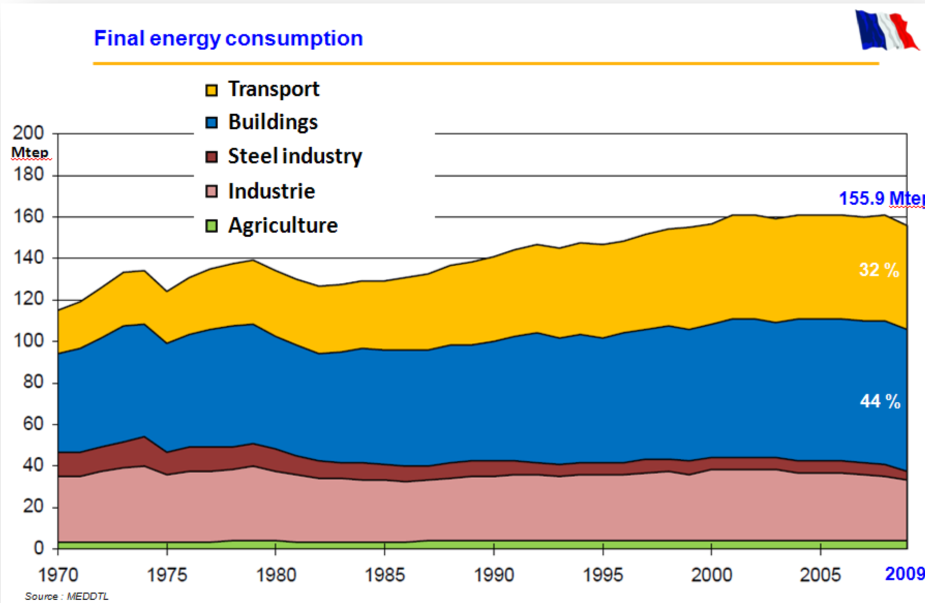
Fraction of renewable energies

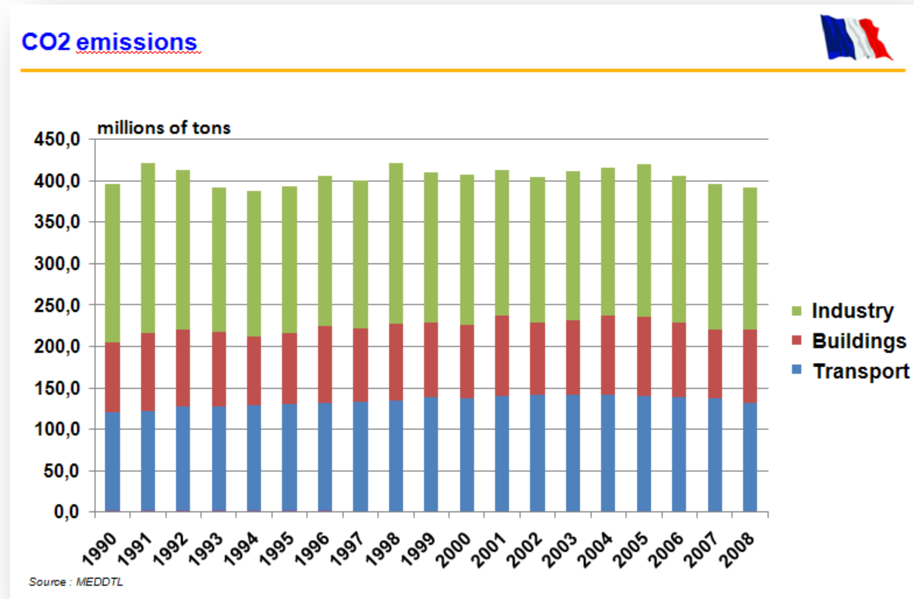


Energy comsumption and CO_2 emissions

Major energy consumers and CO_2 contributors = priorities

transport + buildings + industry





How Ris take into account energetic constraint ?

Heat and power recovery, on site co-generation, local energy storage,
Reduction of energy use (ex superconducting technology used in accelerators)

Green House Gases: Emissions and natural sinks

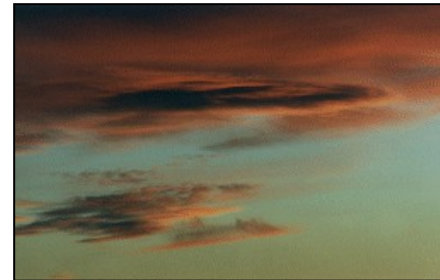
1.5 Pg C y^{-1}

+

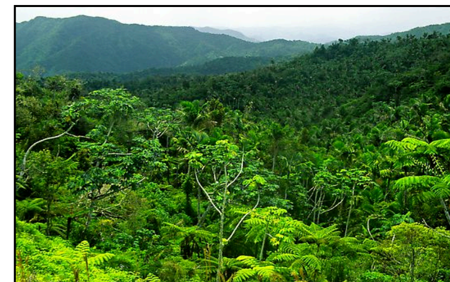
7.5 Pg C y^{-1}

Recent Acceleration of fossil fuel emissions

4.2 Pg y^{-1}
Atmosphere
46%



2.6 Pg y^{-1}
Land
29%

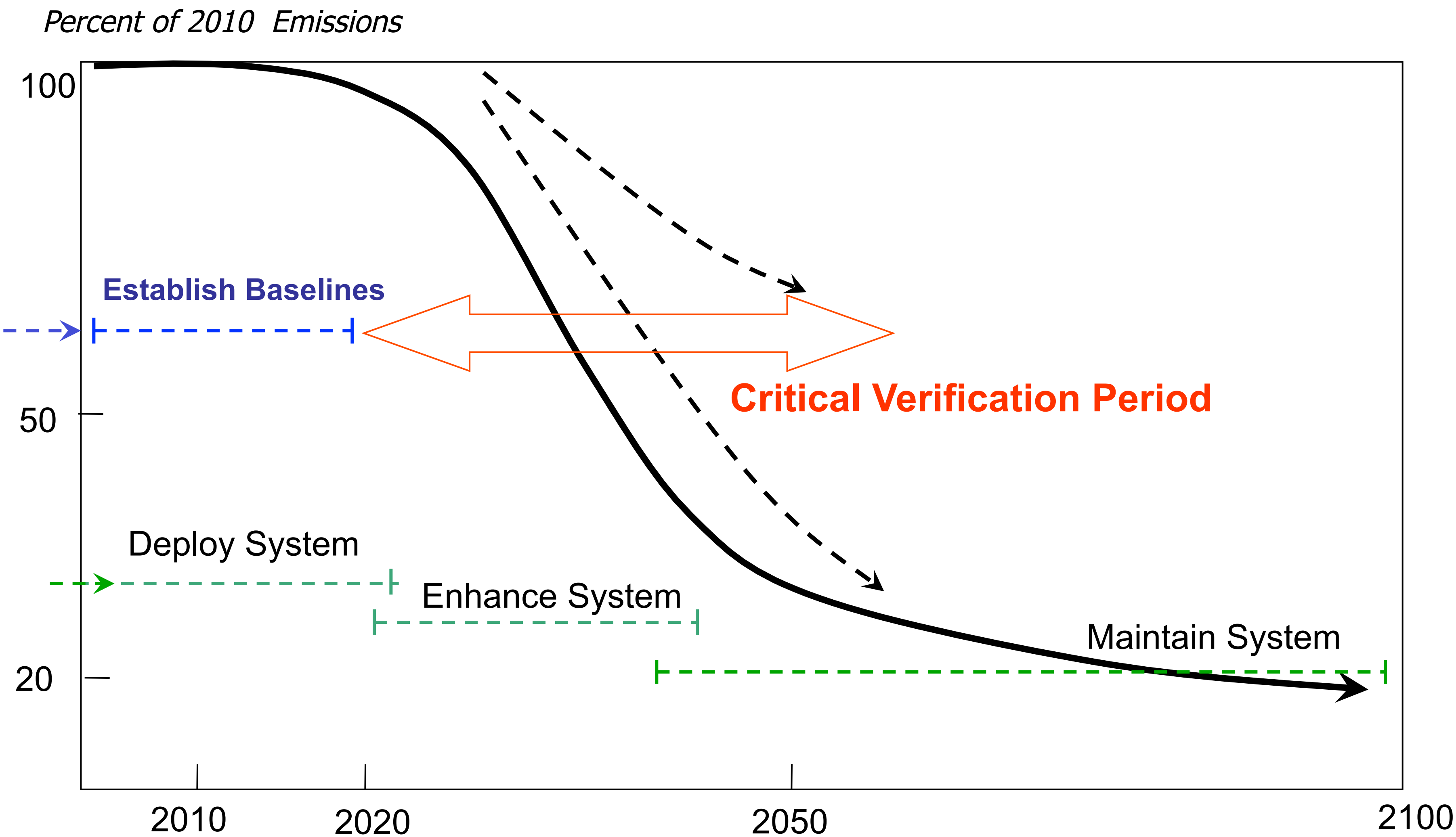


2.3 Pg y^{-1}
Oceans
26%

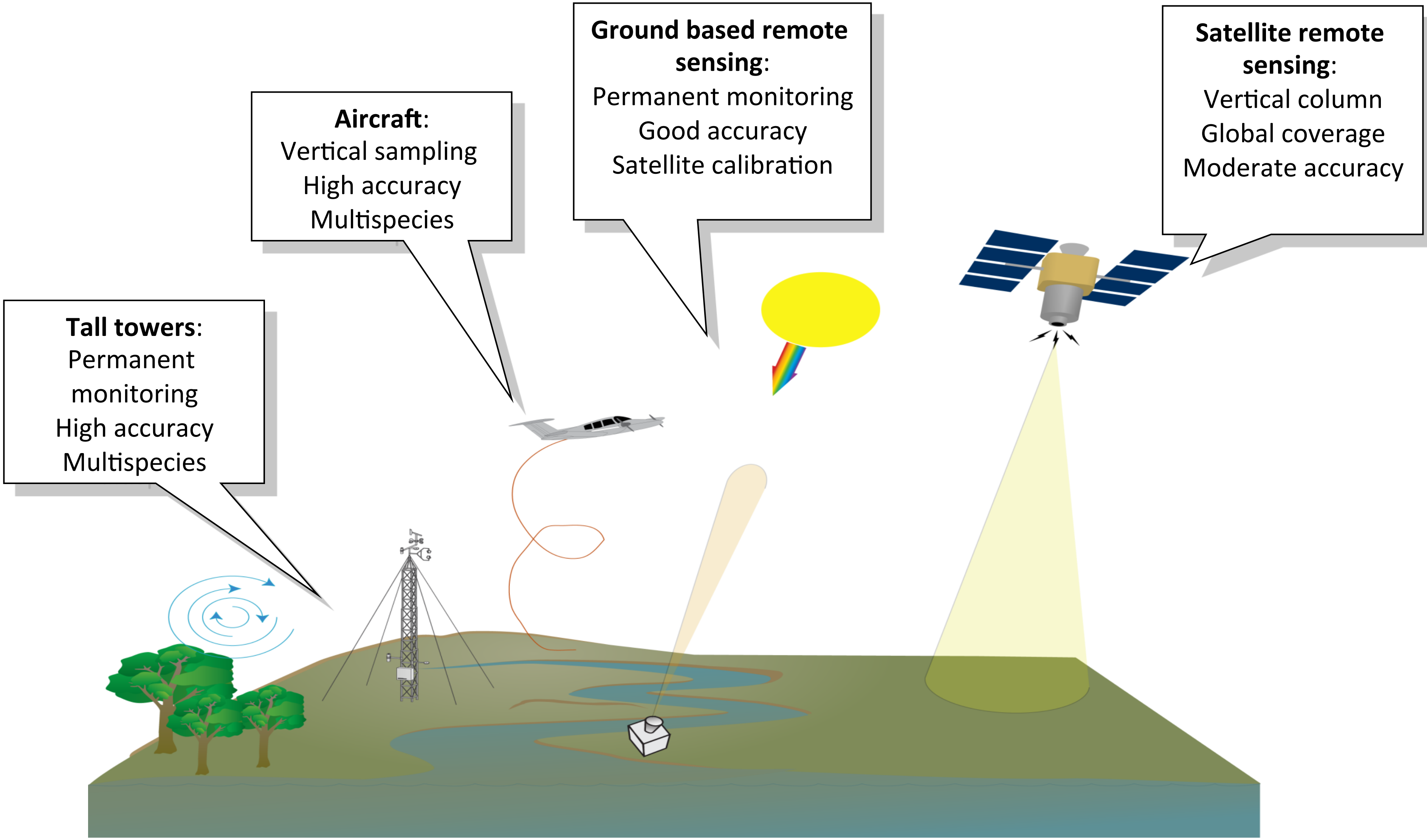
Very LARGE uncertainties on regional budgets

A scenario to track GHG Emissions Reduction

The quality and validation of scientific input will be crucial during Critical Verification Period



Space and in situ observations are complementary



GOSAT

- Greenhouse Gases Observing Satellite
  - Current Ground-based Observation Points (320pts)
    - *Provided by WMO WDCGG*
    - Increase of Observation Points using GOSAT (56,000pts)
- **GOSAT enables global (with 56,000 points) and frequent (at every 3 days) monitoring CO2 and CH4 column density. (Launched in Jan 2009)**
- **TANSO-CAI (Cloud and Aerosol Imager)**
- **TANSO-FTS(Fourier Transform Spectrometer**

International Efforts in monitoring greenhouse gas emissions

US Initiative:

- OCO2 (Orbiting Carbon Observatory 2) satellite relaunch decision
- Boost in NASA Earth Observation Sciences budget
- Federal Climate Agency
- Strong expertise in sensors, models & methodologies (Picarro company, Earth Network initiative)

Japan initiative:

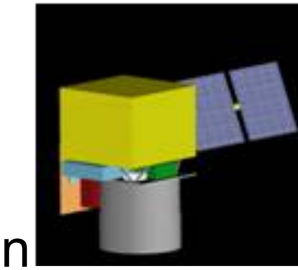
GOSAT2 program

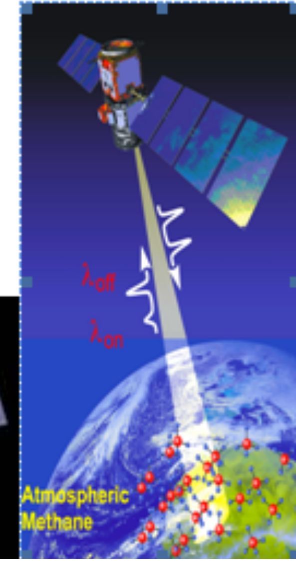
China initiative:

800 M€ R&D in carbon monitoring projects in 2010

Spaceborne measurements

Several forthcoming missions dedicated to column (CO_2 et CH_4) spaceborne observations:

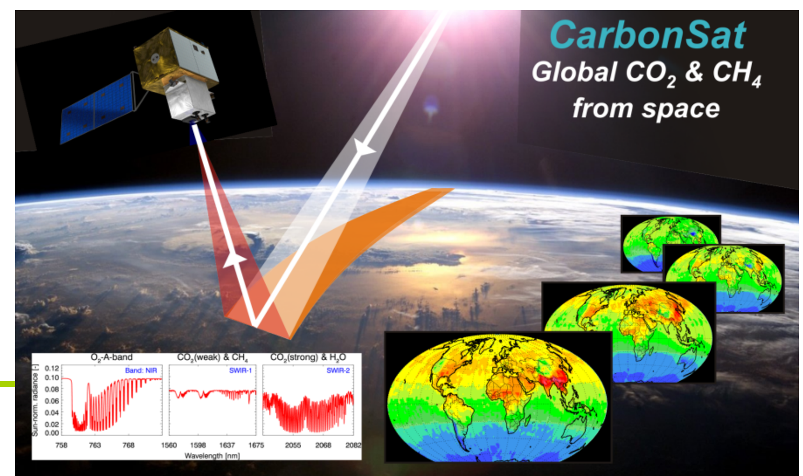




MERLIN Lidar for CH_4 : CNES-DLR mission

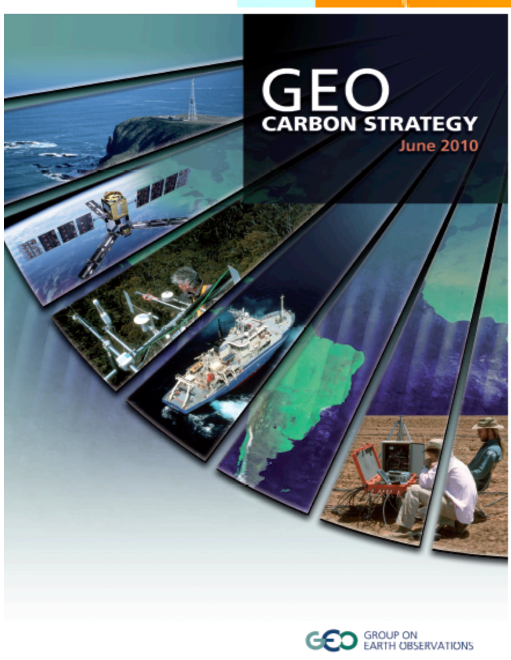
2 missions still at study level:

MICROCARB micro-satellite CO2: CNES project



CARBONSAT: ESA mission

ICOS, a European Research Infrastructure



Environmental Sciences	AURORA BOREALIS	360	2010	18
	EMSO	150	2011	20
	EUFAR	50 - 100	2007	2-4
	EURO ARGO (GLOBAL)	76	2010	6
	IAGOS-ERI (GLOBAL)	20	2008	6
	ICOS (GLOBAL)	255	2010	13
	LIFE WATCH	370	2014	70

ICOS
Integrated Carbon
Observing System

An operational network of 100 stations in Europe

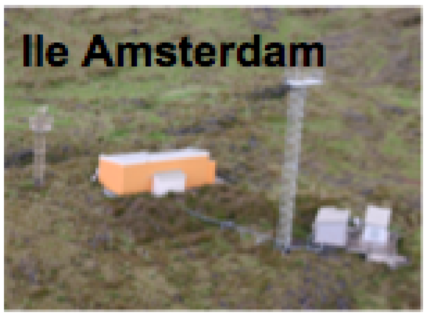
16 European countries

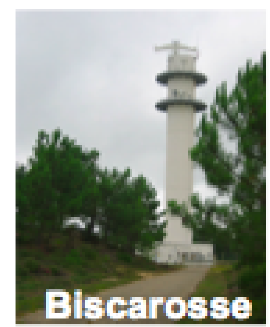
http://www.icos-infrastructure.eu/

In situ networks: ICOS, a European Research Infrastructure

Main challenges:

- Maintain high precision observations over decades
- Develop models for inversion of fluxes using concentrations
- Add stations over poorly observed regions
- Use of observations to improve Earth System Models



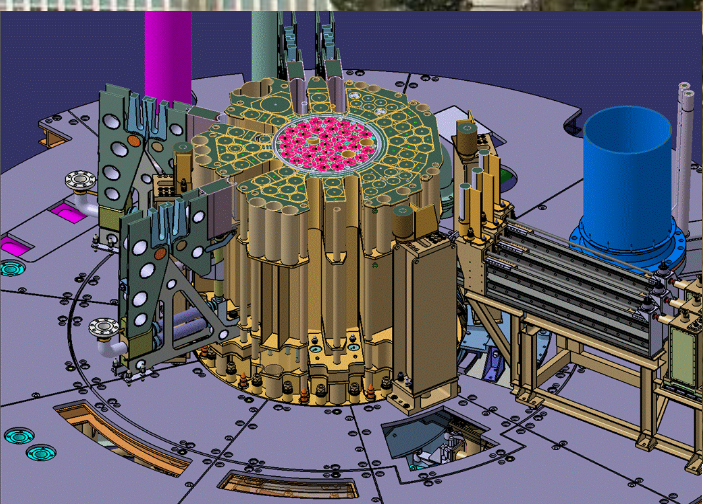


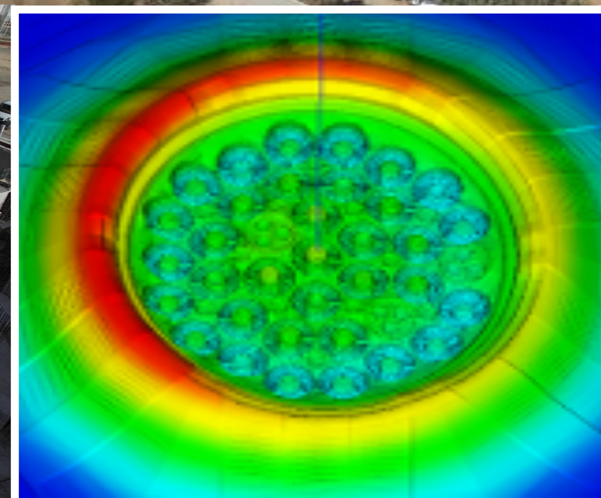
Low carbon energy contribution: Jules Horowitz reactor

High performances European Material Testing Reactor

Main topics:
- *Plant life time management*
- *Fuel evolution and related safety demonstration*

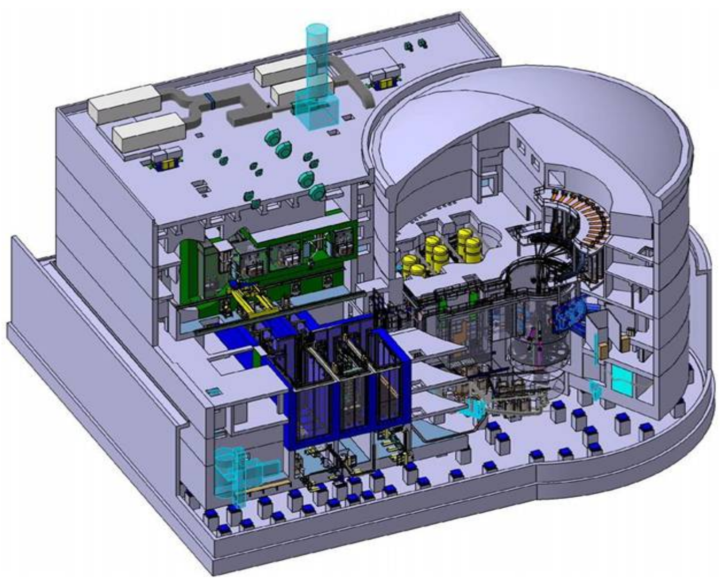
Also:
- *Mo^{99} production for medical purposes*





Jules Horowitz Reactor, Material Test Reactor under construction in Cadarache

JHR power :
100 MW



- Sept. 2007 – Building permit
- **July 2009 – First concrete**
- 2014 – Expected operation

➢ International partnership

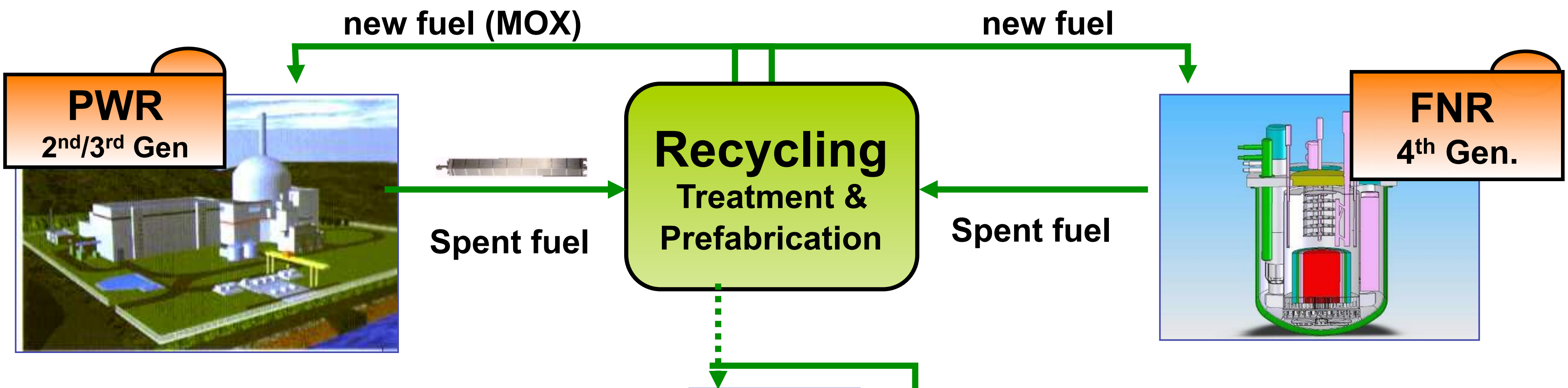
- ⇨ CEA, EDF, AREVA
- ⇨ EU, Belgium, Czech Republic, Spain, Finland, India, Japan, Sweden …

➢ A high performance and flexible reactor

- to address Gen II, III and IV materials testing needs
- to produce radioisotopes
  - ✓ High level neutronic flux
  - ✓ Increased instrumentation
  - ✓ Capability to simulate different environments

Cadarache Dec 2009

The recycling plant of the future

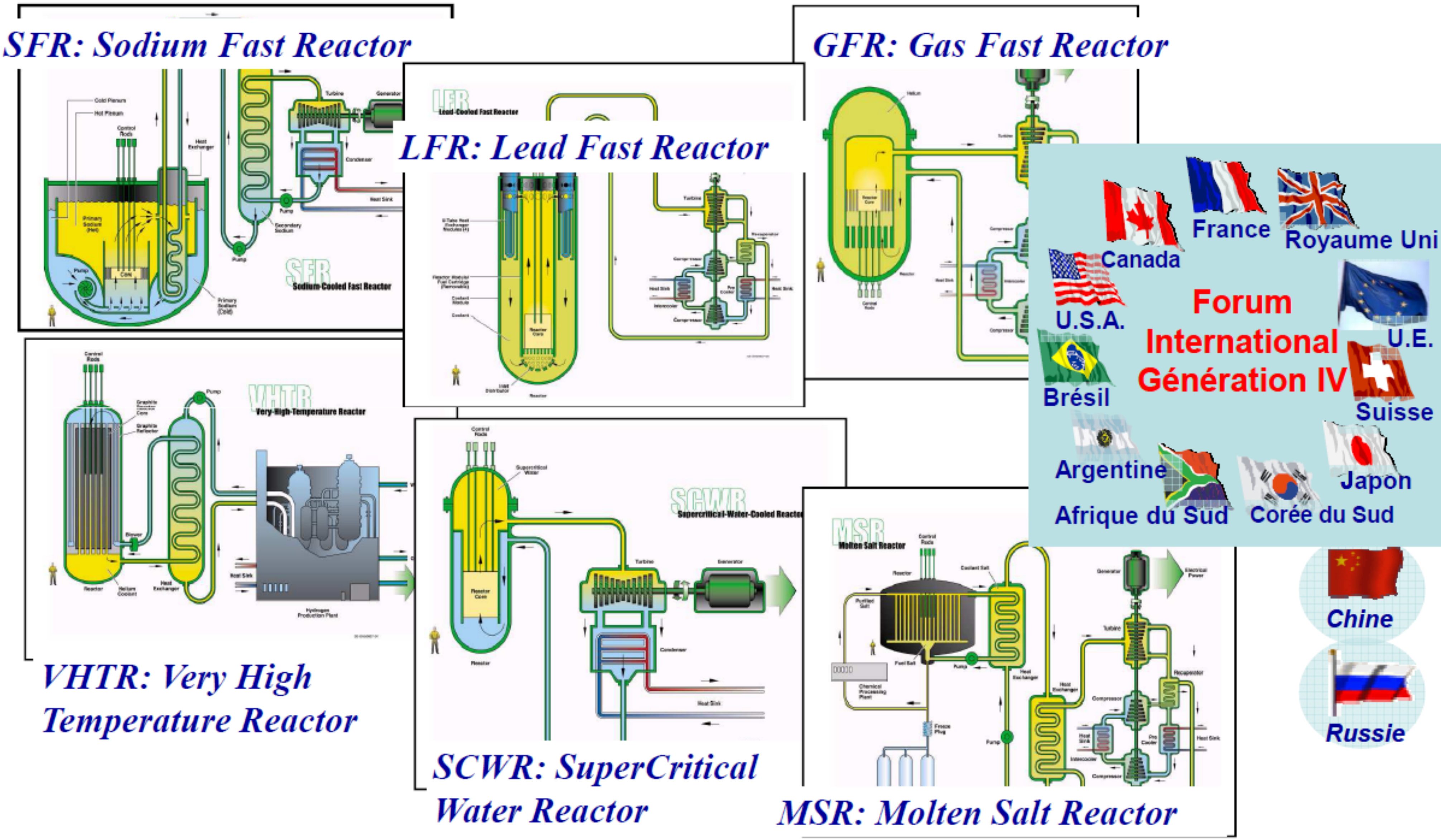


Universal canister
➔ ready for disposal

Consistency with Generation III/III+ reactors
Full U & Pu recycling (decrease the repository impact)

➔ Treatment & Recycling competitiveness
Resistance to Proliferation (Integrated Plant, no Pu alone)

The new generation of nuclear systems: Forum Gen IV



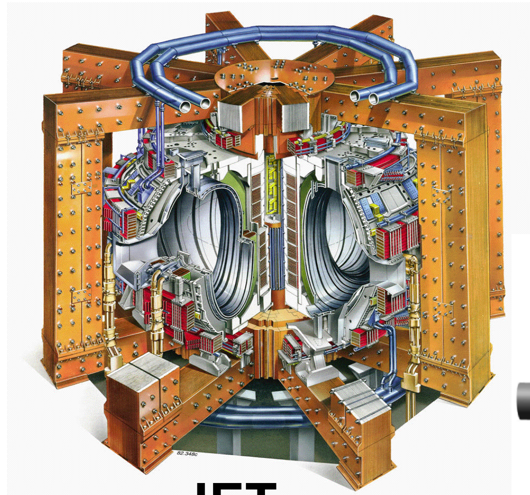
ITER : demonstrating the scientific and technical feasibility of fusion

Fusion
as a sustainable energy source

Almost limitless fuel supply

Intrinsically safe:
- No chain reaction
- Few g of fuelno long term radioactive waste
- production of low activity irradiated materials

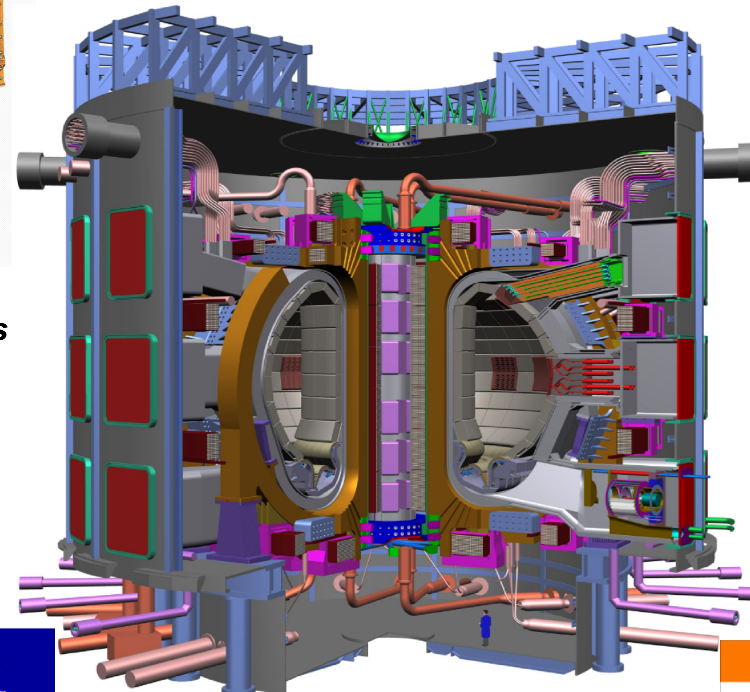
No greenhouse gas emission



JET

P_{fus}~16 MW, Q~1, ~ 30 s

P_{fus} : fusion power
Q : fusion power amplification



ITER

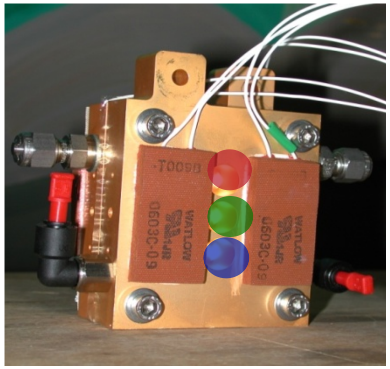
P_{fus}~ 500 MW, Q=10, ~400 s

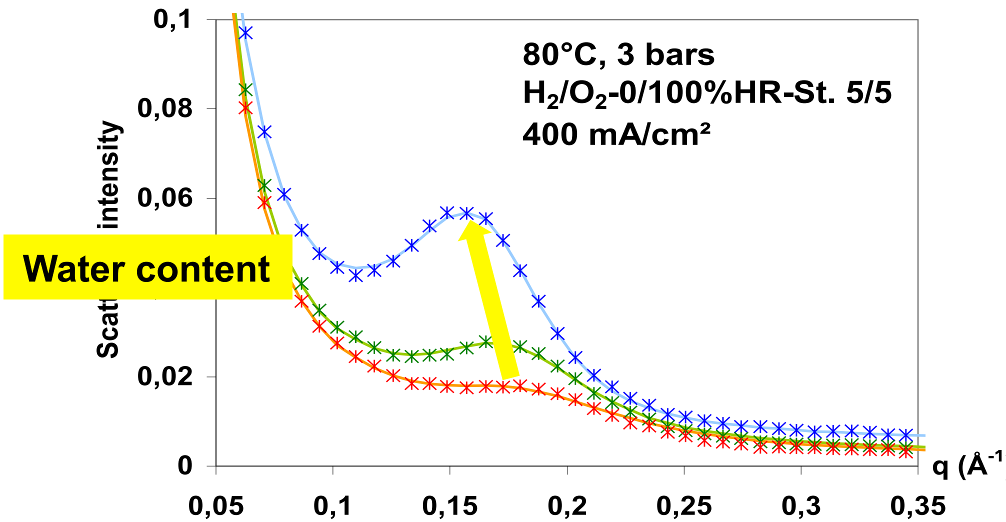
Next step:
DEMO, taking into account energy efficiency

Fuel cell PEMFC and water management: Neutrons probe

SANS spectra are very sensitive to the membrane water content
Acquisition time = 2 min, beam size = 10 mm

Cathode side





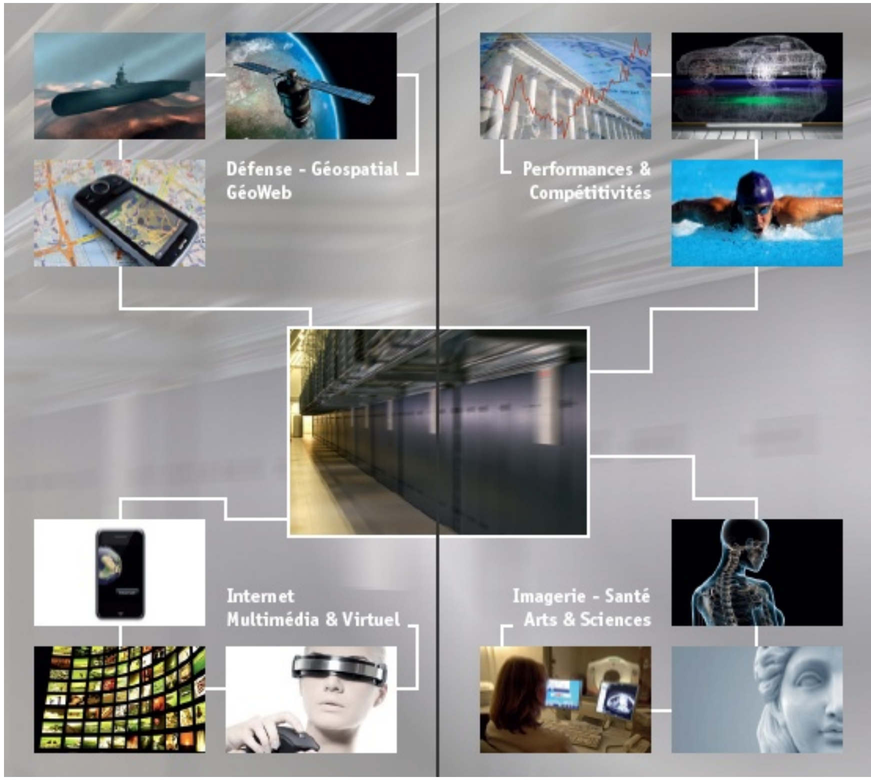
Result: Caracterisation of 3D distribution of water, during operations

Computing resources consume 1.5% of the world energy and this percentage should double in 5 years.

(source: European Codes of Conduct for ICT / 2009)

"The most important data centres of Microsoft or Google can reach 100 000 m².
Their electrical consumption is at the same level than a town like Strasbourg or Newcastle." :
T. Labaume, President of Greenvision

→ **Improve energy efficiency of computing resources: GreenIT**



France for data center 2011

Conclusion

The Research Infrastructures are very appropriate tools for adressing scientific issues to confront global Climate and Energy challenges and for providing validated scientific knowledge, to help the decision making process.

As they are important energy consumers, they are already particularly aware of their responsability in reducing energy use in their installations.

This workshop illustrates this statement by giving encouraging examples.

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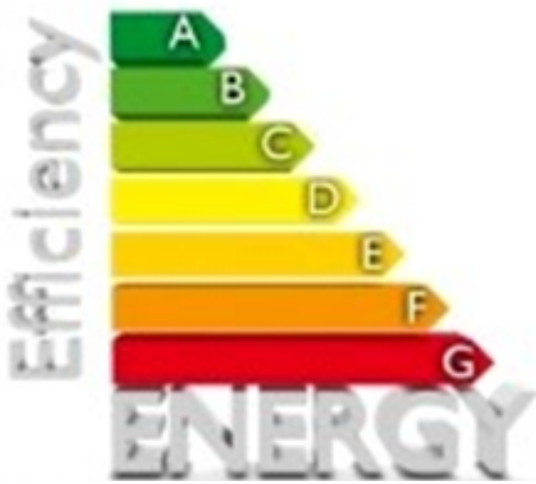

This effort should be be extended to all Ris in Europe.