

POSITION OF THE FRENCH NUCLEAR SECTOR

INSIDE AND OUTSIDE FRANCE

.....
A FRENCH VISION ON NUCLEAR POWER RENAISSANCE



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FOREWORD

A STRONG EVOLUTION IN 2005

➤ TWO IMPORTANT ENERGY BILLS

- The US Energy Policy Act - Nuclear power : a central component of the US energy strategy
 - Long term investment in the hydrogen economy
 - Broad approach to developing new energy resources and encouraging conservation
- The French Energy Bill - Nuclear power remains a central factor of the French Energy supply
 - Renewables and energy conservation are strongly encouraged

➤ MANY DECLARATIONS FAVORABLE TO NUCLEAR POWER

- IAEA meeting in Paris (march) – 70 energy ministers from all around the world
- G8 meeting in UK (june) – Recognition of nuclear power to limit the greenhouse effect
- President G.Bush (several times) – « It is time for that country to building NPPs again »
- President J.Chirac (december) – « We want to build a prototype of GEN 4 reactor for 2020»
- Prime Minister T.Blair (several times) – « UK has to come back to nuclear »
- President Bush again at lot of time in favor of nuclear and, several times, questions, France as an example

➤ TWO INTERNATIONAL CRISIS AROUND NUCLEAR WEAPONS AND NON PROLIFERATION

- North Korea
- Iran

➤ TWO INTERNATIONAL CRISIS ON THE SUPPLY OF GAS BY RUSSIA TO THE EUROPEAN UNION

- The Ukraine crisis
- The Siberia crisis

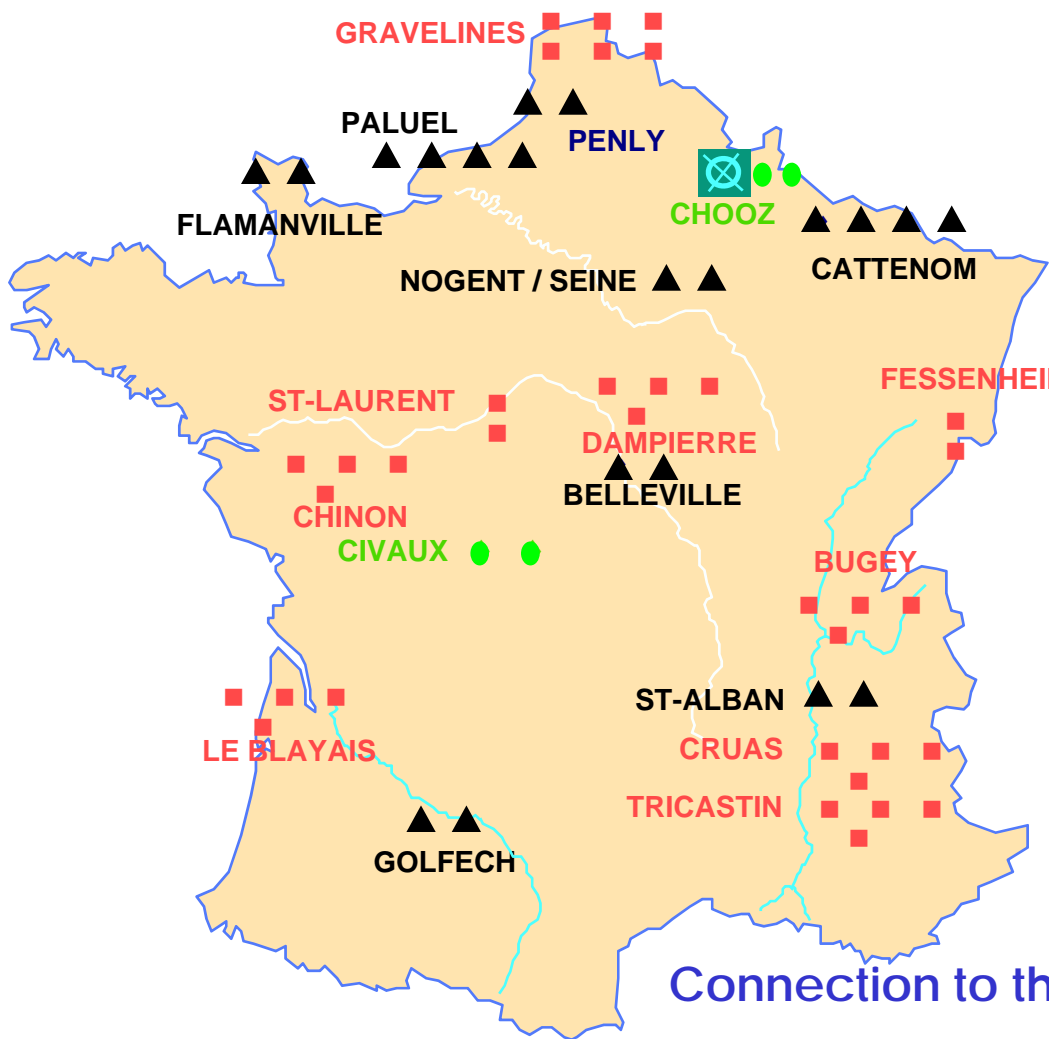
FIRST PART

THE FRENCH NUCLEAR SITUATION

NUCLEAR POWER: A FRENCH ECONOMIC CORNER-STONE

- 78% of the KWh produced in France come from nuclear (2004: 448 TWh nuclear versus 572 TWh in total)
- 58 nuclear power plants totalling 63 GWe are operated by Electricité de France which is presently the biggest nuclear power utility in the world
- 77 billions euros have been invested in the nuclear units of EDF
- 10 billions euros have been saved in 2003, compared with gas power plants producing the same quantity of electricity
- 32 millions tons of CO2 emissions in the atmosphere have been avoided compared with the same gas power plants
- 100 000 people are employed in the nuclear sector (about 20 000 for power generation, 20 000 for maintenance; 20 000 for research, safety and waste ; 40 000 for design, equipments, fuel, cycle...)
- The exports of the nuclear sector amount from 3 to 4.5 billions euros per year
- The French energy independence from imported coal, gas and oil has grown from 26% in 1973 to 50% since the beginning of the 90's
- The cost of nuclear electricity produced in France is competitive when compared to electricity generated in Europe

THE FRENCH NUCLEAR POWER FLEET AT A GLANCE



- 34 900 MWe units
- ▲ 20 1300 MWe units
- 4 1500 MWe units

58 units
63184 MWe installed

426,8 TWh sold out in 2004

About 80% of electricity is from nuclear

Connection to the grid:

- Unit 1 (Fessenheim1): April 1977
- Unit 58 (Civaux2): December 1999

SOME BASIC FEATURES OF THE FRENCH NUCLEAR FLEET

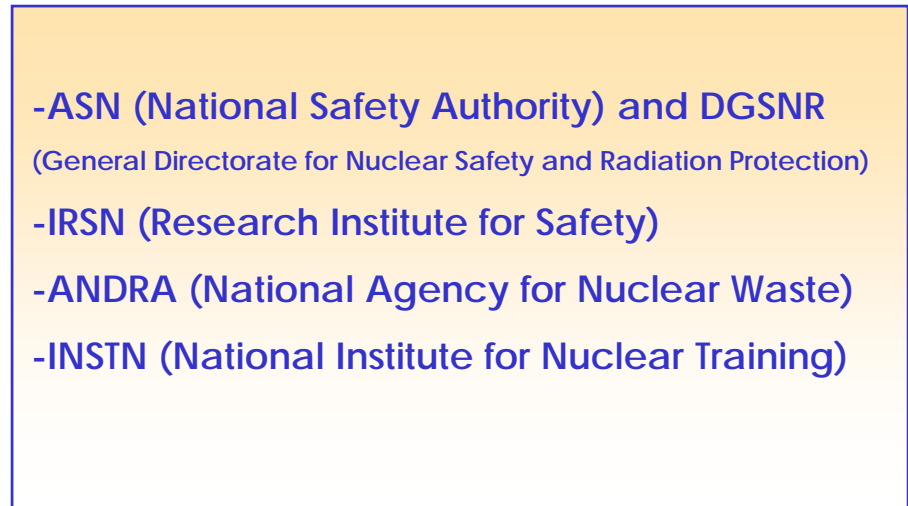
- The choice of successive series of standardized reactors of the pressurized water technology, so that the investment cost was reduced as well as the maintenance cost (the first serie was built with a licence granted by Westinghouse)
- A systematic treatment of the spent fuel based on the Purex process (CEA-COGEMA), allowing the partition of the plutonium and of the uranium existing in the spent fuel
- A recycling of the extracted plutonium in MOX fuel elements used in 20 reactors. For the moment, the used MOX assemblies are stored waiting a future treatment (for recycling or use in GEN 4 reactors)
- The vitrification of the fission products and the storage of the corresponding containers
- The implementation of every tested improvement on the whole fleet in a very short period of time

A FRENCH COHERENT SET OF ACTORS

MAIN COMPANIES



GOVERNMENTAL INSTITUTIONS

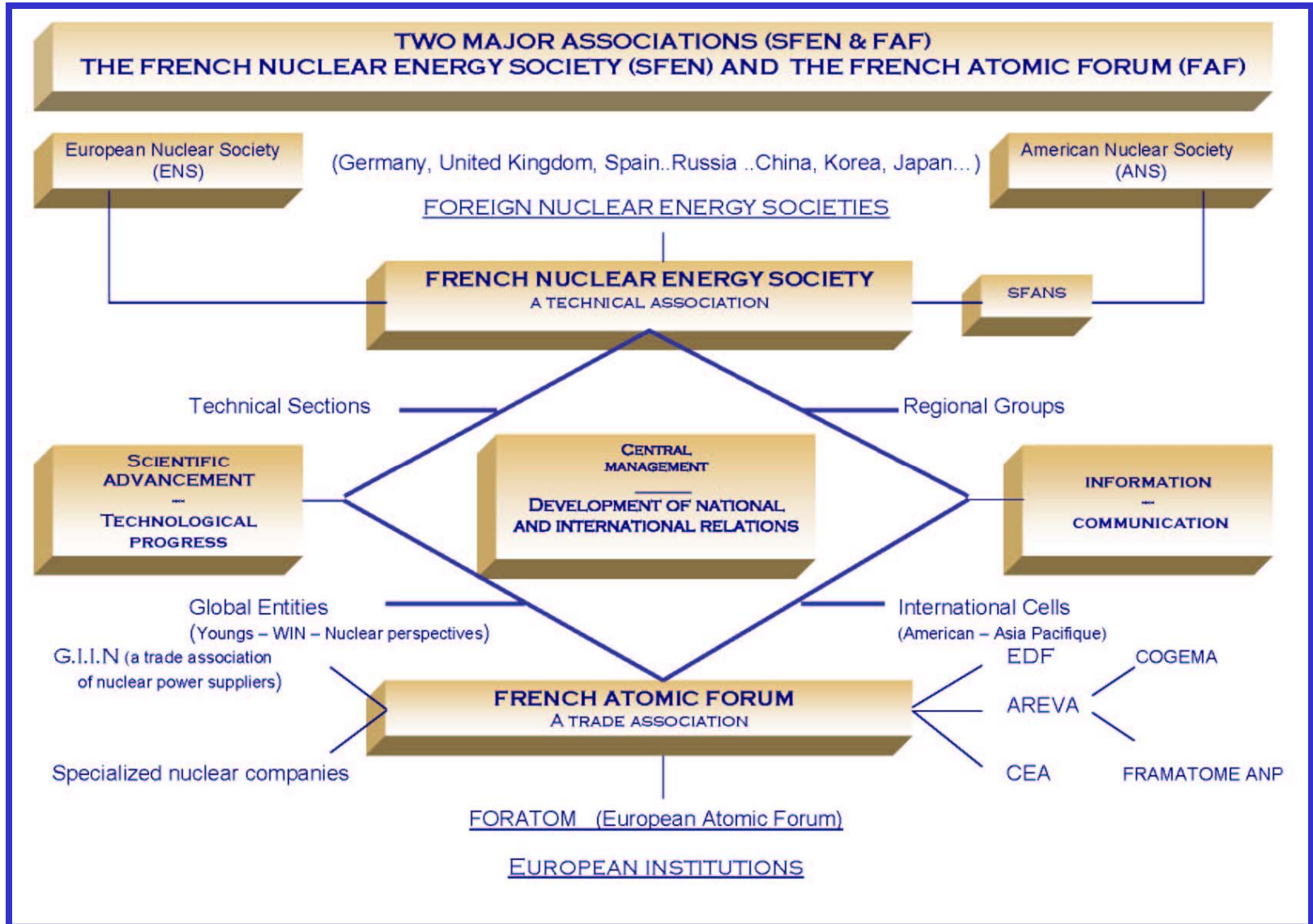


A NETWORK OF SPECIALIZED SUPPLIERS

A NATIONAL NETWORK OF ASSOCIATIONS



AN ACTIVE ASSOCIATIVE LIFE



A TREMENDOUS CHANGE IN NUCLEAR COMMUNICATION

Since the beginning, the nuclear power community has extended its fields of communication :

- TECHNICAL** design and manufacturing of reactors, building of nuclear plants, fuel cycles implementation, radioprotection...
(performances, safety, quality assurance, health physics...)
- ECONOMICAL** investment financing operation and maintenance costs, dismantling, funds waste management provisions ...(investment policy, competitiveness...)
- ENVIRONMENTAL** greenhouse gas, air and water pollution, soils damages, fauna impacts
(climate change, sustainable development)
- GEOPOLITICAL** security of supply, proliferation, terrorism...
(access to resources, international safeguards, cooperation ...)
- SOCIOLOGICAL** uncertainties and risks, health, irrational feelings, mass reactions...
way of life, cost of living, unemployment life span, future generations

AN ANSWER TO THE PUBLIC DEMAND: DEBATES ON NUCLEAR POWER

- 2003-2004
 - A global national debate on the French energy policy
 - Six high level regional contradictory meetings
 - Hundreds of local meetings, lectures and exhibitions
 - A debate within the French parliament
 - An Energy bill voted in two times (2004-2005)
- 2005-2006
 - A national debate on high level, long life waste management
 - Many meetings all over France
 - A Waste bill forecast for 2006 (following « Loi Bataille » of 1991)
- 2005-2006
 - A national debate on the siting of a new nuclear power plant fitted with an EPR reactor, in Flamanville in Normandy
 - A regional debate for the siting of ITER in Cadarache in Provence

TO GIVE CONFIDENCE : A SCENARIO UNDER INVESTIGATION FOR THE HLW MANAGEMENT

1950 → 2015

Industrial storage (50 years period)

2015 → 2020/2025

Industrial storage → Long term storage
(300 years period)

2025 → 2040

Industrial storage → Long term storage

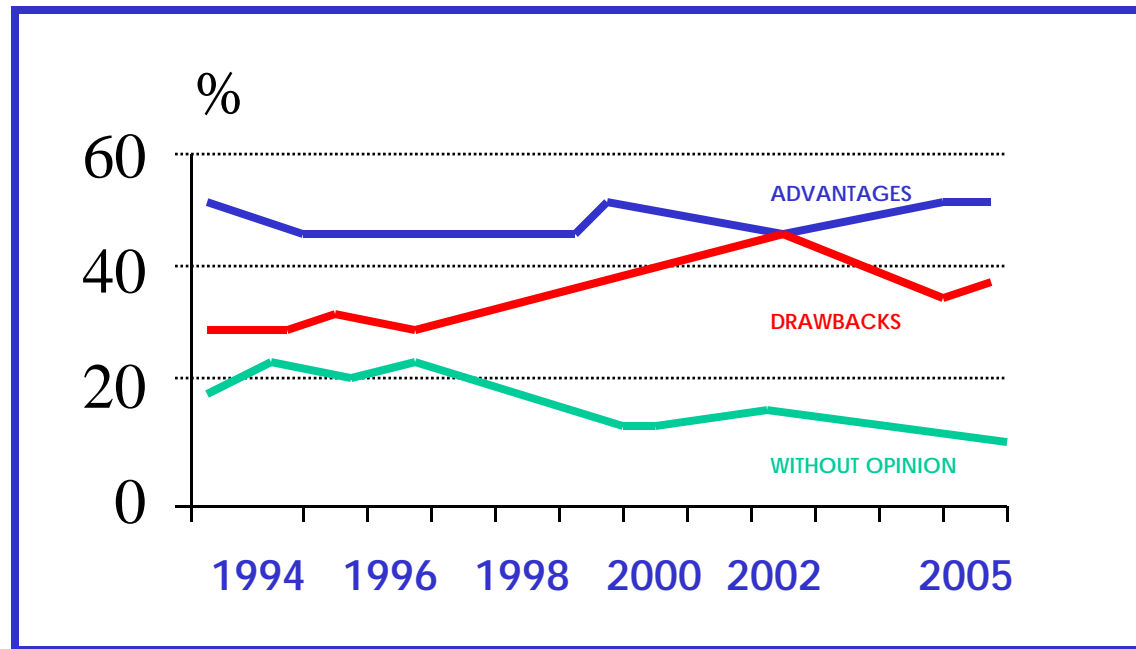
Geological Repository
(with reversibility)

2040 →

Industrial storage → Long term storage

Geological storage ← Transmutation

EVOLUTION OF THE FRENCH PUBLIC OPINION



QUESTION : According to you, does the choice of nuclear power to generate three quarters of the French electricity present others advantages or drawbacks?

Views of the main advantages:
of KWh

energy independence and low cost

Views of the strongest disadvantages:

wastes, risks of severe accidents

THE FRENCH NUCLEAR SECTOR: A MAJOR EUROPEAN PLAYER

- About 45% of the European nuclear electricity is generated in France
- Through Electrabel, the Suez group operates the Belgian nuclear power plants
- EDF has nuclear interests in nuclear electricity generation in Germany (EnW)
- Interconnexion allows increased exchanges between all the countries around France, and France exports (much electricity) in Germany, Italy, Spain and UK
- AREVA has industrial subsidiaries in many European countries, especially in Germany through Framatome-ANP GmbH
- The first order of a reactor of generation 3, EPR, has been purchased by the Finnish TVO Company
- La Hague reprocessing plant treats spent fuel for several European countries
- CEA participates to a lot of European research programs, and runs several large nuclear equipments used by the European
- The site of Cadarache has also been chosen as the site of the ITER facility .

THE FRENCH NUCLEAR SECTOR: A WORLWIDE PRESENCE

European Union : . 25 European countries /Euratom/Treaty European Commission

All types of nuclear activities from power presentation to maintenance, RD and participation to the associations

Commonwealth of Independent States and Russian Federation:

. Russia,, Ukraine, Kazakhstan...

Specific activities: Mining, Engineering, Services, R&D collaboration

North America: United States, Canada:

Very diversified types of activities: Mining, Engineering, Fuel manufacturing, Maintenance, Services... R&D collaboration – Exchanges of information...

Africa and Middle East

. Egypt, Morocco, Niger... South Africa, Tunisia

Specific activities: Mining, Engineering, Services

Asia-Pacific and South of America:

. China, Japan, Korea, Indonesia, Argentine, Australia, Brazil.

Specific activities: Mining, Engineering, Design, NPP, Fuel, Maintenance, Services... and R&D collaboration

India: Activities only on safety for the moment

Strong participation to International Organizations

IAEA (International Atomic Energy Agency)-NEA (Nuclear Energy Agency)-IEA (International Energy Agency) WNA (World Nuclear Association) - NucNet (Nuclear Communication Network) - WANO (World Association for nuclear operations)

THE FRENCH NUCLEAR SECTOR AND THE UNITED STATES

Many diversified activities

• Fuel Manufacturing	Areva's sites in Lynchburg and Richland
• Engineering	Areva's sites in Lynchburg, Atlanta, Charlotte, Las Vegas
• Services	Areva's site in Lynchburg
• R&D agreements & contacts	CEA with Savannah River, Oak Ridge, Los Alamos...
• Education and Training	Exchanges of students, journeys of teachers in France
• Supply	Many purchases between the two countries
• Collaboration with or between companies and associations	ANS, NEI, EPRI, SFEN, FAF, UNISTAR...

Three specific actions in 2005:

- Participation to the « MOX for Peace » program
- Positioning of the EPR reactor on the US market
- Increase collaboration (Generation 4 program, Common topicals meetings, in R&D and large congress...)

THE FRENCH PARTICIPATION TO THE “MOX FOR PEACE “PROGRAM

- In the wake of the START agreement on nuclear weapons, the USA and the Russian Federation signed, in September 2000, an agreement for the elimination of 34 metric tons of weapon grade plutonium with 2 programs in parallel in the USA (« MOX for Peace ») and in RF (« AIDA »)
- The final aim of the 2 programs is to mix plutonium in MOX fuel to use it in power reactors
- The French technology for manufacturing MOX (AREVA NC – COGEMA) has been chosen for the design of the plants which have to be implemented in the two regions
- Today, Russian is late but the USA go ahead:
 - Experiments on MOX fuel are in progress (some assemblies have been manufactured in France and are experimented in the US plant of Catawba (Eurofals operation))
 - A set of facilities (P.T disassembly – conversion facility and a MOX fuel fabrication plant) is in progress on the Savannah River National Laboratory site in South Carolina
 - A consortium with Duke Energy and AREVA NC, Stone&Webster is in charge of the MOX fuel plant which will belong to the DOE and will be run under the control of NRC and IAEA.

POSITIONING THE EPR REACTOR ON THE US MARKET

- AREVA's goal is to deploy EPR plants in the USA and therefore to licence the EPR design
 - Design Certification Application: end 2007

- AREVA and Constellation have formed UniStar Nuclear - a unique business model - to market the U.S. EPR in the USA



- Several US utilities have expressed strong interest and consider EPR as a viable option for future needs.
- The U.S.EPR will be 100% American:
 - Re-engineered to conform US codes and standards
 - 80% of supply to originate from the USA
 - Long-term industrial partnership contemplated

THE FRENCH NUCLEAR SECTOR IN CHINA

Many orders for nuclear reactors and services

Contacts since 1973. A « memorandum of nuclear cooperation » signed in 1983 at a minister level and several business agreements implemented with EDF, CEA and AREVA

Electricite de France (EDF) acts as a service supplier in all fields interesting large electricity production, nuclear and also hydroelectricity, coal, fuel and gas powerplants, and the distribution network. EDF is also an investor in Chinese joint ventures (ie.with China Light and Power, a Chinese Electricity Power Company)

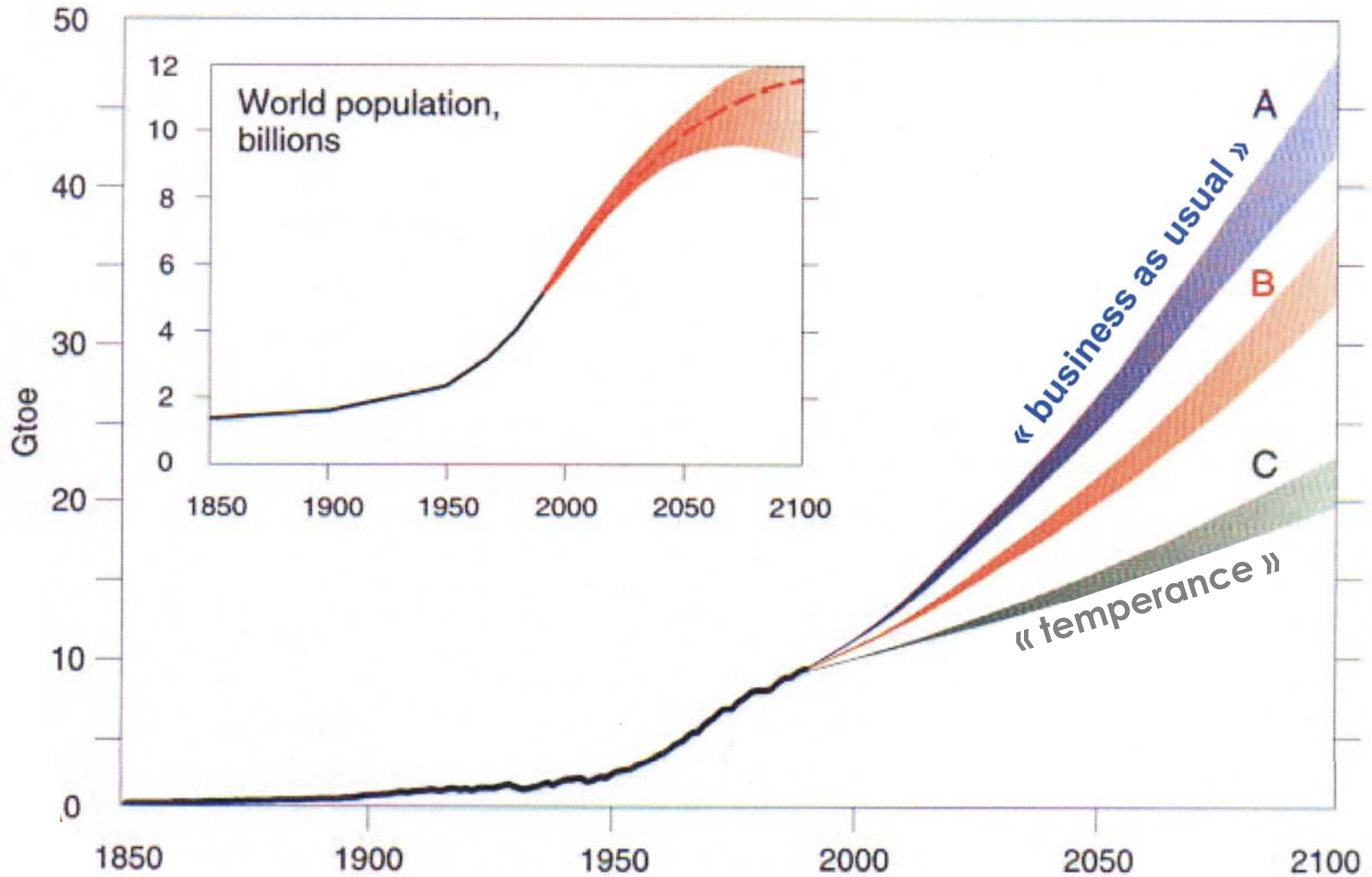
The Atomic Energy Commission (CEA) collaborates with the China Atomic Energy Authority since more than 20 years and the 8th protocole of cooperation has been signed in april 2003. More than 400 Chinese engineers have been trained on the CEA's sites and we assist now at the creation of associated laboratories between CEA and the Chinese Nuclear Research Institutions.

In AREVA group, and before COGEMA and Framatome ANP, is a major foreign supplier of the chinese nuclear electricity companies.

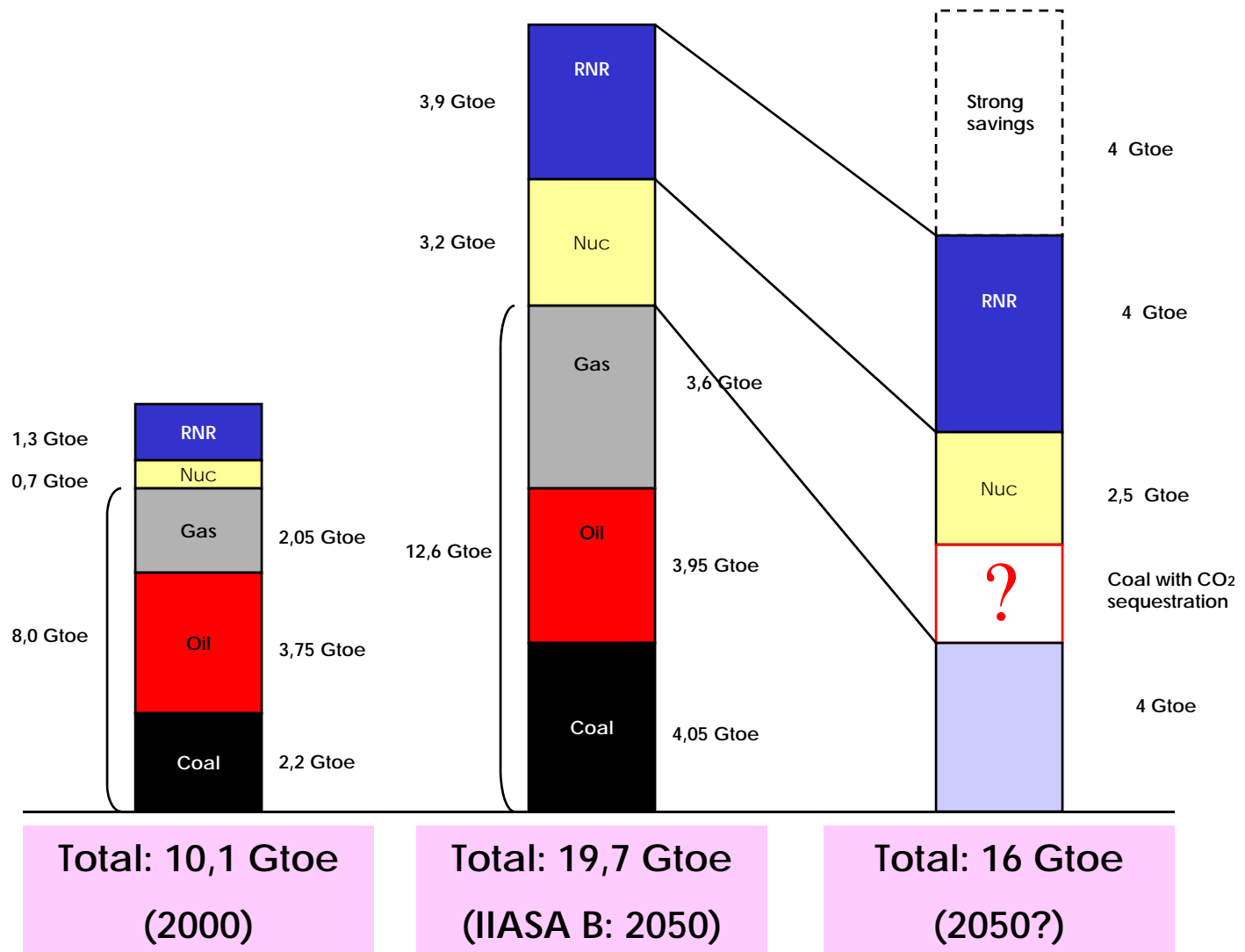
SECOND PART

THE FUTURE OF NUCLEAR POWER IN THE WORLD

EVOLUTION OF THE WORLD ENERGY CONSUMPTION AND NEEDS



A SUSTAINABLE BUNCH OF ENERGIES FOR 2050



ENERGY CONCERNS

- Basic questions:**
- The amount of the physical reserves of oil, coal, uranium other fissile materials, at which cost, in which parts of the world....
 - The possible level of contribution of large and small hydro, of the other renewables, in which conditions, where...
 - The growth of electricity and hydrogen uses
 - The mitigation of the risks for the public health and the natural environment (ionising radiations, CO₂ emissions)

Consequences:

- The technical and economical possibilities (CO₂ sequestration, renewable, breeders)
- The political and geopolitical situations (Versality of democratic elections, extremists)
- The social acceptance and the pace of adaptation of the public

No simple answers and a lot of scenarios

THE PRESENT PERCEPTION OF NUCLEAR POWER

- Recognized advantages:
 - A steady solution for continuous mass baseload production of electricity (availability) with no greenhouse gas emissions (climate change)
 - Less sensitiveness to the geopolitical situation than oil and gas (security of supply) and less versatility of the cost of the KWh produced (competitiveness)
 - Rather small surface on the ground per KWh produced (environment)
- Facing the advantages, the constraints and the drawbacks have been or will have to be reduced to an acceptable level:
 - Safety (severe accidents)
 - Radiation protection (human health)
 - Investment costs (financial possibilities)
 - Waste (sustainable development)
 - Amount of natural reserves (sustainability)
 - National and international control (antiproliferation)
- The public opinion has to support energy policies with a share of nuclear power

MANY SIGNIFICANT IMPROVEMENTS OF THE GENERATION 2 REACTORS

- Enhancing fuel performance
(discharge burn up, time between refueling) ➤ better competitiveness
- Increasing the thermal efficiency of the Nuclear System
(steam generator i.e) ➤ better competitiveness
- Extending the service lifespan
(component replacements, ...) ➤ better competitiveness
- Improvements in the maintenance effectiveness ➤ better competitiveness
- New devices for the containment (filters, pumps...) ➤ better protection
of the environment
- Extension of the amelioration system
(additional tanks for waste discharges) ➤ better protection
of the environment
- Improved centralized data processing ➤ better safety

NEW REACTORS OF GENERATION 3 : THE EXAMPLE OF THE EUROPEAN PRESSURIZED REACTOR (EPR)

An evolutionary reactor integrating the whole experience coming from the french and german nuclear fleet and offering a lot of significant improvements:

- **Technical and economical advances**
 - Power increased to 1600/1650 MWe (previous 1400/1450)
 - Efficiency increased to 36%/37% (previous 34%)
 - Burn up rate increased to 60 GWj/t (previous 45 GWj/t)
 - Maintenance simplified and reduced refueling times

→ Savings in investment, improved use of uranium and better availability factor,
Reduced cost per KWh produced (less 10 to 20% compared to the previous NPPs)
- **Improved safety features**
 - Additional measures to prevent the occurrence of events likely to damage the core (diminution by a factor 10)
 - An extremely robust , leaktight containment (thickness, double shell...)
- **Improved environmental**
 - A spreading area for protection of the basement in case of core meeting
 - A reduction of 15 to 20% of the production of nuclear wastes by a better utilisation of the fuel (with a reduction of the same order of magnitude of uranium core)

AIMS OF THE FUTURE REACTORS OF GENERATION 4

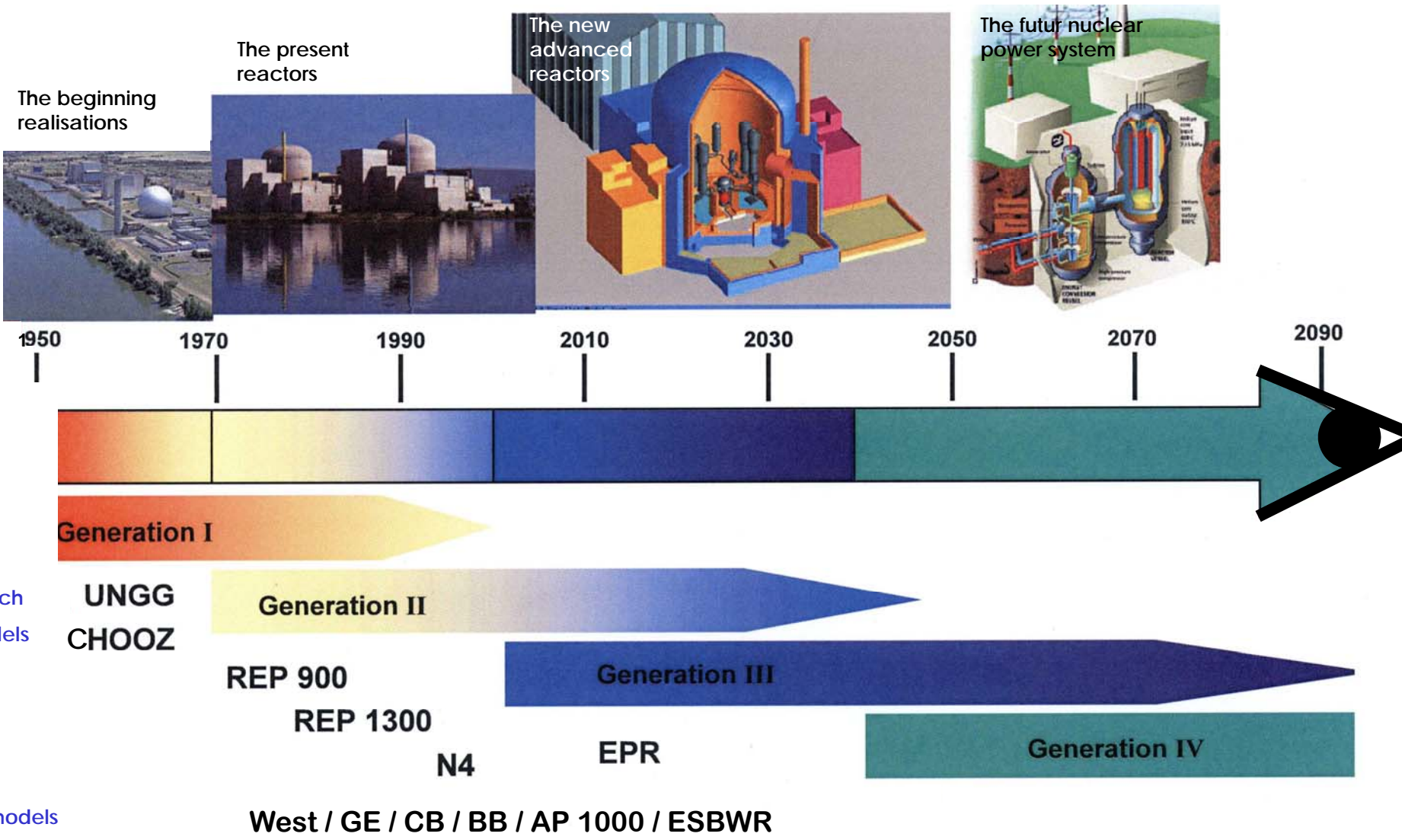
- **Basic improvements**
 - Economic competitiveness
 - Safety and reliability

- **Significant steps forward:**
 - Saving of natural resources (in breeders, uranium is 100 times better used than in thermal fission)
 - Waste minimization (the fast neutrons “eat” the wastes)
 - Increased security: non-proliferation, physical protection (impossible to use recycled materials)

- **An opening to other applications:**
 - High temperature heat for industry
 - Hydrogen vector
 - Drinking water

- **Six innovative concepts:**
 - Sodium fast reactor – Lead fast reactor – Gas fast reactor – Molten salt reactor – Very high temperature reactor – Super critical water reactor

A TIMETABLE OF THE NUCLEAR POWER GENERATIONS



ITER: A LONG TERM BASIC RESEARCH PROGRAM

- After 4 years of discussion, EU, USA, China, Japan, Russia and South Korea signed to launch the ITER (International Thermonuclear Experimental Reactor) program on the site of Cadarache, a research center of the French Nuclear Energy Agency.
- The aim of ITER is to study how it is possible to supply available electricity by maintaining the fusion reaction. In the Joint European Torus located in the UK, it was only possible to maintain 16 MW of fusion power during 1s. In the Tore Supra Tokamak of Cadarache, it was only possible to maintain 340 MJ of fusion power during 3 minutes 33 seconds.
- The main basic problem consists in trapping the impurities from the plasma and to adapt materials to extraction of the heat. The technological problems of longevity are numerous.
- The realization of ITER (800 cubic meters of plasma) will last 10 years and will cost 3 billions euros

The reactor will be used during a minimum of 25 years, so that the total cost will get 10 billions euros, half financed by the European Union.

CONCLUSIONS

- Since forty years, France has developed a nuclear power policy of worldwide level and is ready to support a nuclear renaissance and steady growth.
- We think that nuclear power will play an important role in the energy supply of the humanity because the strong points – available technology for baseload production of electricity, in a greenhouse gases emissions, few dependence of the international geopolitical situation – will overcome the constraints even if these have to be treated with the maximum of care – safety, wastes, heavy investments, few terrorism...
- The nuclear community prepares actively the future with the different generations of reactor – GEN 2, in use reactors; GEN 3, reactors proposed on the market; GEN 4, reactors for the second half of the century; fusion for a more remoted future.
- The role of international collaboration on a multilateral basis as well as on a bilateral basis has to develop. All the nations have to collaborate with the IAEA on safety and non proliferation, even if every state has to take means by itself.
- Due to their position on the world nuclear field, the USA and France have special duties and must reinforce their collaboration.