Using long term scenarios for R&D priority setting,
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An Electricity Utility View on R&D Priority Setting:

lessons learned and priorities for the future

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Outline

EDF and R&D key figures

A Long Term Scenario on Global Resources Availability

- **Energy Demand Assumptions**
- **Supply :**
  - Fossil Fuels Resources Assumptions
  - Non-fossil Energy Supply
  - Electricity Mix
- **Global Energy Balance**

From a LT Scenario to R&D Priorities

- **EDF's R&D : Portfolio of Challenges**
- **Long Term Challenges :**
  - Power Generation and Optimisation
  - Customers
  - Global Environment

EDF Group

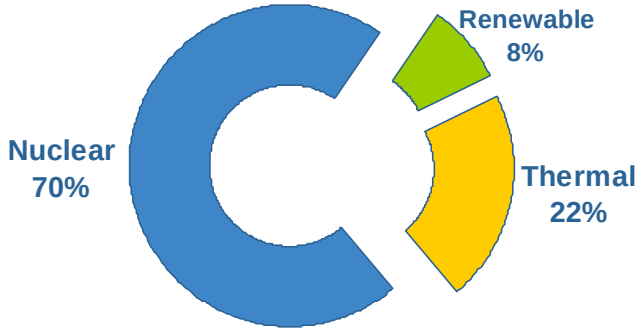
Installed power

Customers worldwide

((28 million in France)

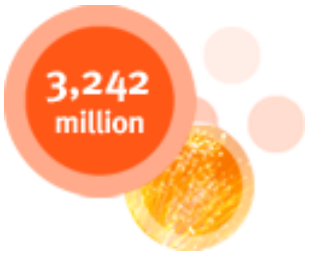
Worldwide workforce

Production worldwide



Revenue in euros

Net income in euros



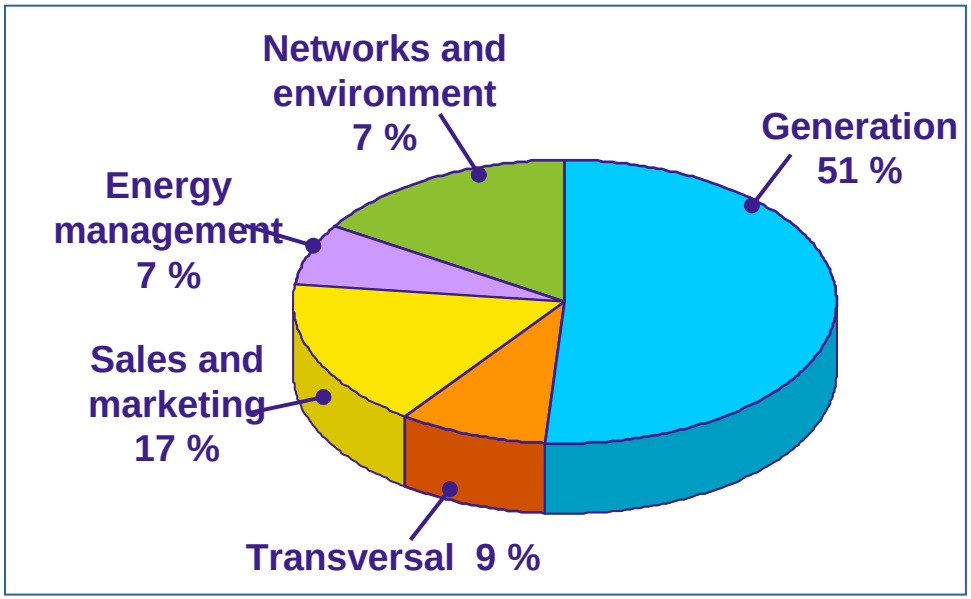
EDF Group is :

- the major player on France's electricity market and a major player on European electricity an gas market
- the world leader for Nuclear power
- Europe's first player for Renewables

EDF R&D: Key figures

- **4 locations : 3 around Paris, 1 in Germany**
- **2,000 individuals**
- **300 PhDs and 200 doctoral students**
- **Partnerships :**
  - CNRS, CEA, Universities
  - EPRI, Thermal Power Research Institute (China), Karlsruhe University, Boconi, Politecnico de Milano…
- **Joint laboratories with : EnBW, Edison, EDF Energy…**

2005 budget: € 377 million



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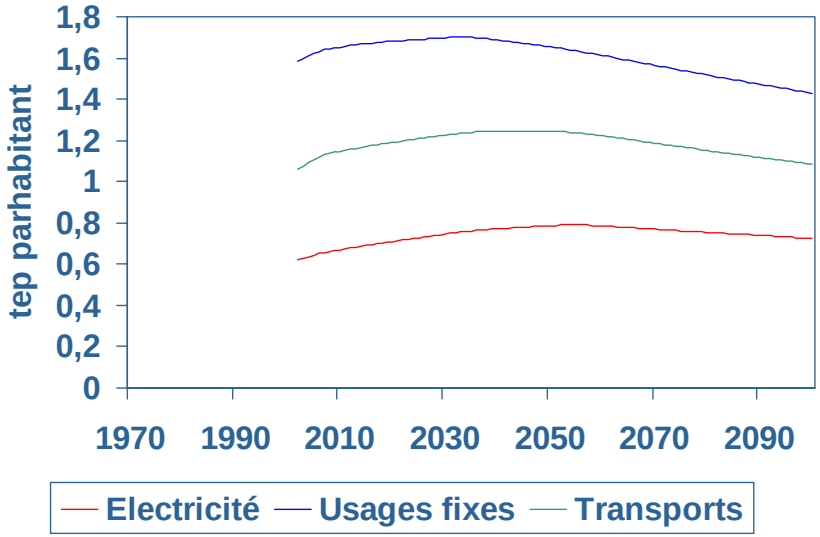
A Long Term Scenario on Resources Availability

Energy Demand Assumptions – Per Capita Energy Demand by Region and end-uses

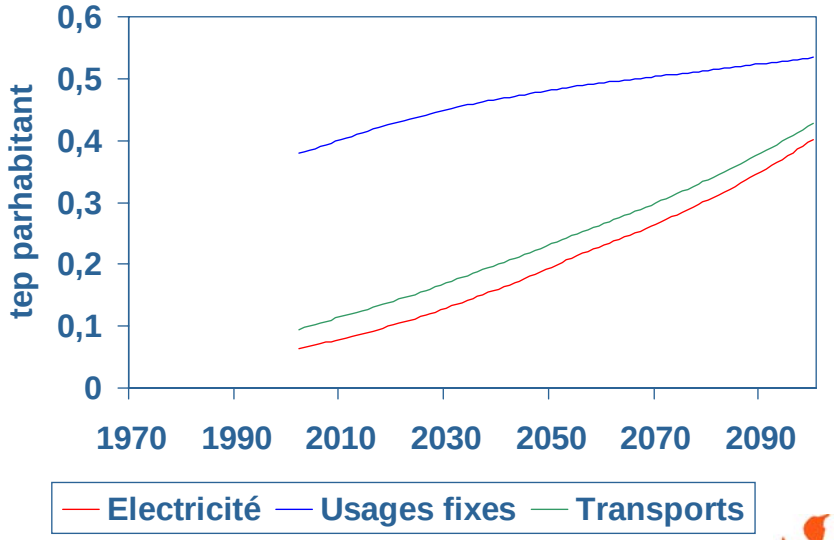
In industrialised countries, per capita final energy demand is supposed to flatten after 2020 and slightly decrease thereafter

Per capita final energy demand in developing countries will continue to grow over the projection period, especially for Transport and Electricity

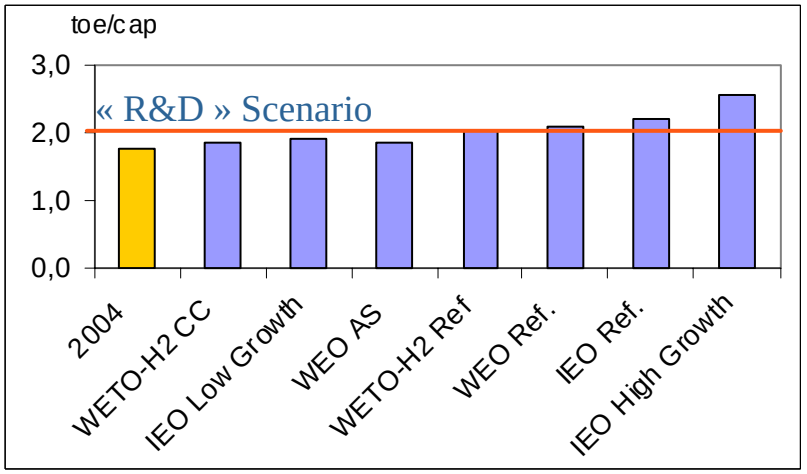
OECD and Russia



Devloping Countries

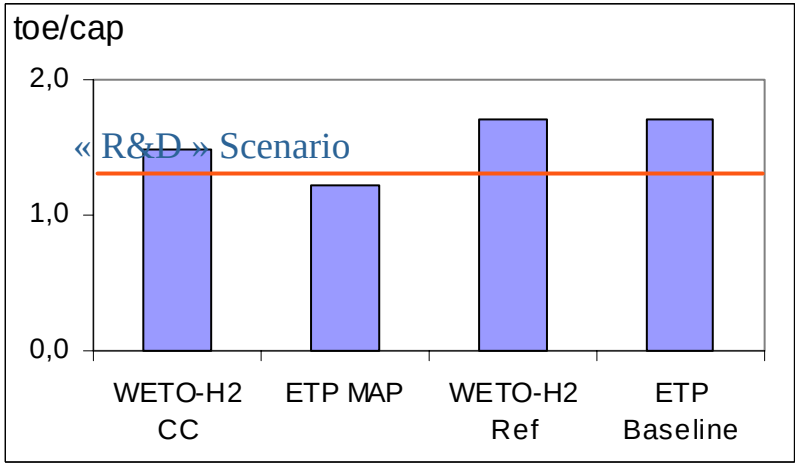


Per Capita Primary Energy Demand - Comparison



In 2030, energy demand per capita in this scenario is in the range of most other projections

...and among the lowest in 2050

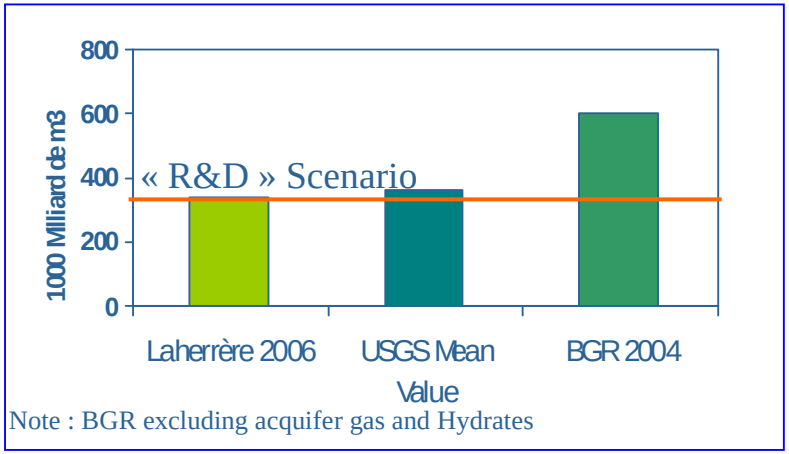


Global energy demand will reach 15 Gtoe in 2030 and 17 Gtoe in 2050

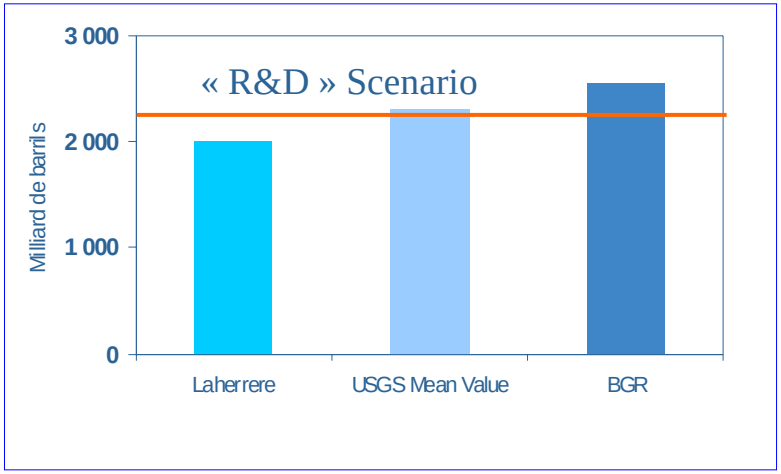
Fossil Fuel Resources Assumptions (1/2) – Remaining Ultimate Recoverable Resources

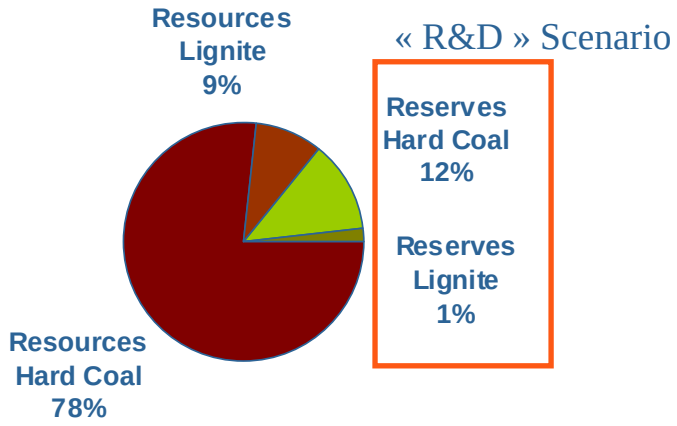
Oil Remaining Ultimate Recoverable resources were put at 2200 billion barrels

This scenario assumes a total of 380 trillion m3 of gas to be recovered



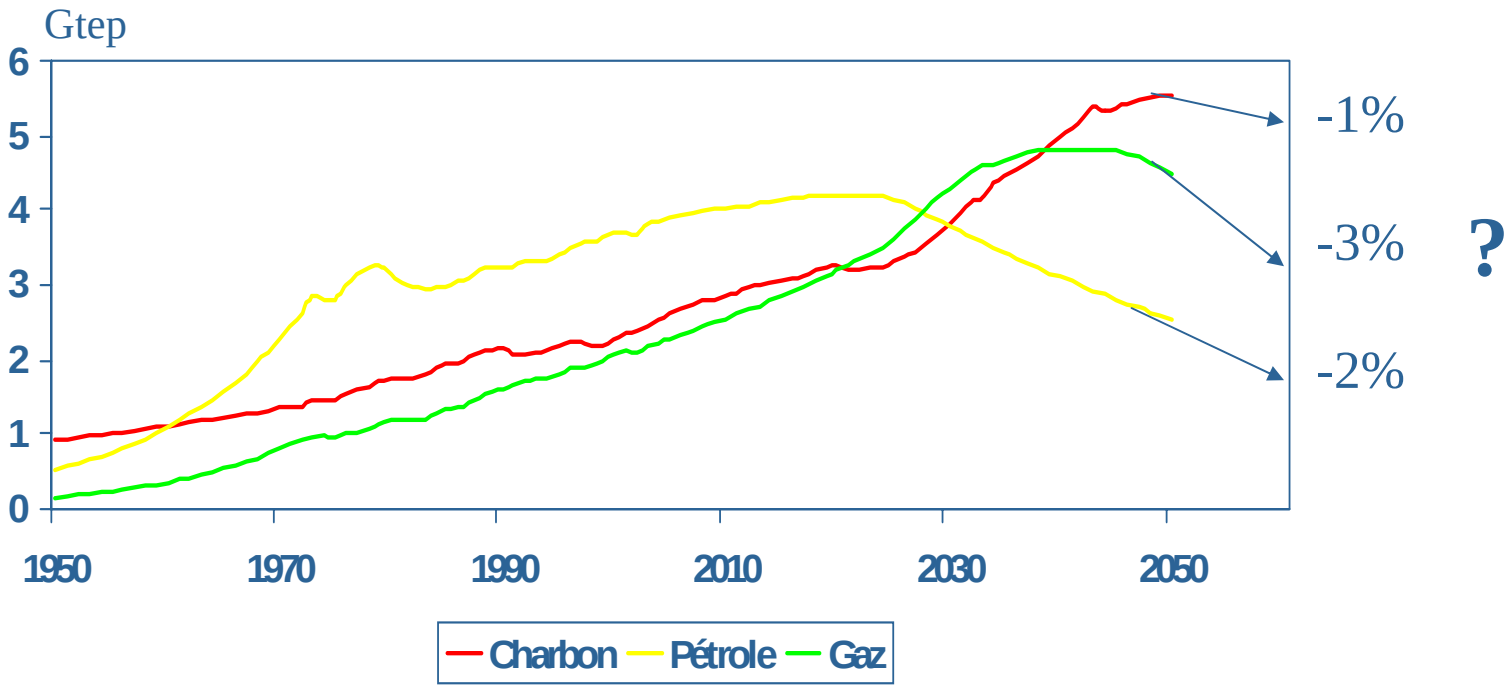
Note : BGR excluding acquifer gas and Hydrates





- ✓ Coal reserves are abundant (633 billions tce)
- ✓ Huge resources, according to BGR, 3963 billions tce. How reliable is this number ?

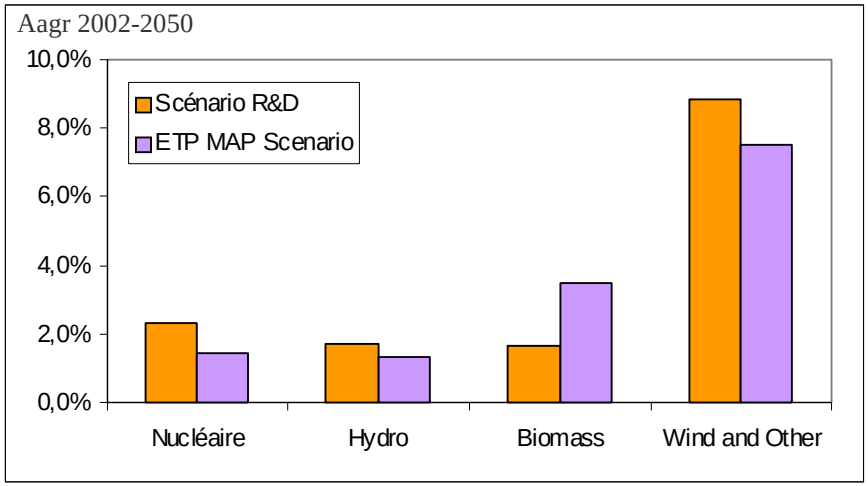
Fossil Fuels Resources Assumptions (2/2) – Fossil Fuel Decline Rates



- **The date of peak depends mainly on :**
  - Demand growth
  - Global resources level and the capacity to mobilise it
  - **and also** the rate of production decline : faster it is, later could be the peak
- **This has implications for the global balance**

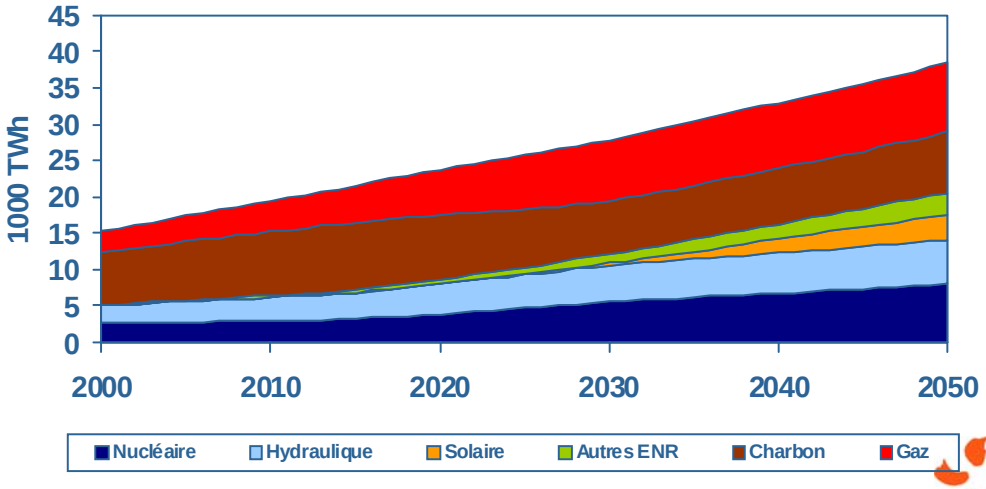
Non-Fossil Fuels Supply

This scenario assumes a very rapid increase of renewable and nuclear productions



A large Contribution of non-fossil fuels in the power mix in 2050 :

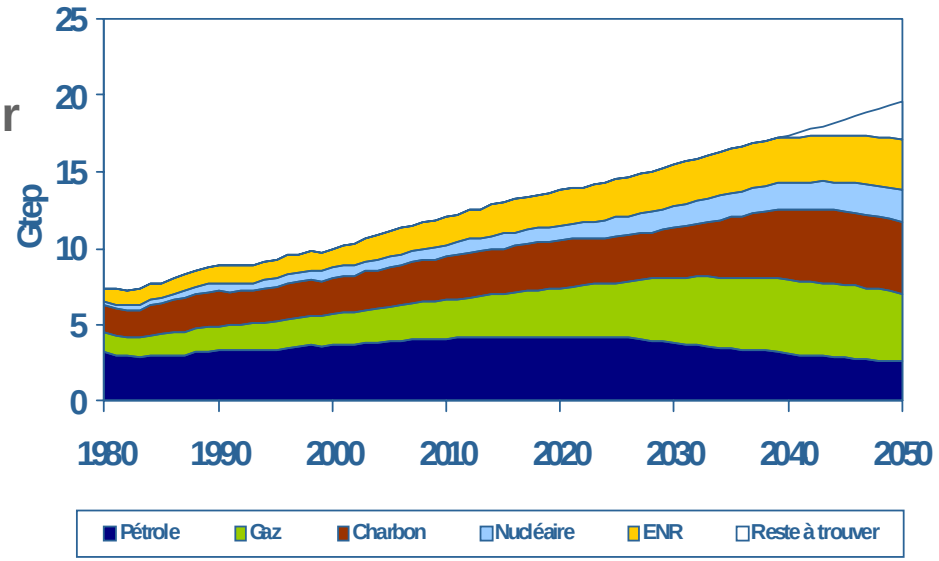
- **more than a third of total electricity production from renewables**
- **21% for Nuclear**



Supply and Demand Imbalance

Under this scenario assumptions

- Supply disruption could occur as early as 2040
- This would have dramatic consequences : economic, social and political crisis…



- Especially if we are not prepare to the required transition to a low-carbon world

From a LT Scenario to R&D Priorities

Lessons from this scenario :

- Under “reasonable” assumptions concerning energy resources, this scenario illustrates that it could be difficult to meet energy demand by 2050
- A supply disruption could occur as early as 2040
- More optimistic assumptions on fossil fuel resources would postpone this risk for a few years, but
- A transition to a low-carbon world would be needed : to fight climate change effects and to prepare the second half of the century

R&D policy implications from now on

- **Limiting energy demand growth**
- **Increasing efforts on Renewables and Nuclear**

2

From a LT Scenario to R&D Priorities

EDF's Portfolio of Challenges

Our Environment

- **Anticipating the new energy landscape**
- **Water : anticipating the climate constraints on a shared resource**
- Improving the characterisation of the environmental impacts of our facilities

Our Optimisation :

- Generation optimisation into the market : methods and tools
- **Finding new flexibilities between consumption, generation and storage**
- Simulate and decide

Customers

- **Home and building : developing technologies and services for energy efficiency**
- **Improving efficiency and new electricity end uses in Industry**
- **Preparing the Distribution Market**

Generation

- Enabling 60 year lifespan to our nuclear power plants
- Integrating new technologies to operate more efficiently
- **Innovating in renewable energies and storage**

Customers - Long Term Challenges

Home and building : developing technologies and services for energy efficiency

- Energy efficiency : development of new technologies (thermal insulation, heat pumps, thermal solar, PV panels)
- Managing customer demand and reduce peak consumption : remote services, storage in buildings,

Improving efficiency and new electricity end uses in Industry

- Developing electrical end uses and processes
- Developing generic solutions for small and midium sized entreprises
- Developing generic tools for remote energy diagnostics and consumption monitoring

Preparing the Distribution Market

- Integration of distributed energy sources and storage capacity
- Potential development of plug-in hybrid electric vehicles

Power Generation and Optimisation- Long Term Challenges

Innovating in renewable energies and storage

- Technology monitoring and experimenting
- Renewables : PV, Thermal Solar, Ocean energy and hydro turbines
- Storage : CAES, NaS batteries, inertial storage

Creating new flexibility between consumption, generation and storage :

- Insure a better coverage of intermittent energy sources
- How to flatten the load curve by price incentives, ICT, local heat or electricity storage, combined use of gas and electricity
- Evaluate the economic benefits of peak demand reduction through DSM and storage peak demand reduction

Our Environment - Long Term Challenges

Water : anticipating the climate constraints on a shared resource

- Forecasting water availability over different time horizons
- Evaluate potential technological breakthroughs in the water sector
- Impacts of new and future regulations

Anticipating the new energy landscape

- Overview of existing studies on the energy future
- Impacts of new and future regulations on energy markets
- Macro-energy Scenarios building :
  - identifying key drivers
  - Assessment of risks and uncertainties
  - quantification
- Implications
  - Analyse global implications
  - Propose alternative solutions
  - Implication for EDF and Recommendations