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PARLIAMENTARY OFFICE FOR EVALUATION OF SCIENTIFIC AND TECHNOLOGICAL CHOICES

SUSTAINABLE DEVELOPMENT

CLIMATE CHANGE, ENERGY TRANSITION: OVERTAKING THE CRISIS

Summary of the report by Senators Pierre LAFFITTE and Claude SAUNIER

Principal conclusions and proposals

I – The world energy model is on red alert.

A – IT IS SPEEDING UP A CLIMATE CHANGE, THE CONSEQUENCES OF WHICH ARE BEING VERY UNDERESTIMATED.

1. The climate change is speeding up.

The Intergovernment Group of Experts on Climate Change (GIEC) situates climatic warming within the upper part of the range of previous estimates (+1°C to +5.8°C in 2100).

As a result, there is a risk of:

- **climate runaway** (disturbance of forest photosynthesis in the event of an increase in temperature, faster release of the CO_2 contained in permafrost),
- **incipient, in-depth climatic imbalance** (melting of ice in Greenland, accentuated disturbance of the Gulf Stream).

These risks are minimal but their **effects will be with us by the next generation.**

2. By the next generation (towards 2025-2030), the consequences of this change are very underestimated.

- **The physical consequences of this change exceed natural catastrophes alone.**

Phenomena such as glacier shrinkage, the movement of flora a few degrees northward, hydric stress around the edge of the Mediterranean, the arrival of invasive species or the creation of milieus fostering the propagation of viruses **will change our way of life.**

- **The economic consequences will become more acute.**

The cost of climate change in 2005 amounted to around **1% of the world GDP** (200 billion dollars of this amount in the United States).

A German study based on low climatic assumptions predicted that, in **2050, the cost would represent 2,000 billion dollars for the United States (i.e. 6% of the current world GDP!).** However, the higher assumption, which is very likely, is more than double these forecasts.

B – IT IS OVEREXPLOITING ENERGY RESOURCES THAT ARE BECOMING DEPLETED.

1) In principle, the last energy reserves are expected to run out in over a hundred years' time - in 130 years for oil and natural gas and in over two hundred years' time for coal, **on the basis of current consumption levels.**

2) **However, demand will increase by 2050 and reduce availability.**

Everything is pointing towards this:

- **Demography:** There will be 2.6 billion more people in 2050.

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- **Growth in the globalised economy:**

- US growth is being maintained whereas an American consumes twice as much oil as a European and eight times more than a Chinese;

- the growth of China (9% pa), very costly in greenhouse gas emission, is likely to continue at a very fast pace. It is driven by a very high savings ratio and high demographic reserves.
At a growth rate of **8.5%,** China's GDP would be multiplied by **11.5 in 30 years' time** and by **60 in 50 years.**
Even at a growth rate of **5.5%,** the GDP would be multiplied by **5 in 30 years' time.**

- Growth of the Indian Union is aligned to that of China, with a 10-year time lag.
Greenhouse gas emission will be multiplied by the same figures.

- The **economic rules of globalisation** (short-term financial logic contrasting with the long-term pace of sustainable development, with the world division of work based on long-distance transport) **sustain this demand for fossil energy.**

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II – The long-term durability of this model will create serious economic and social threats.

A – THE CERTAINTY OF A VERY EXTENSIVE OIL SHOCK.

1. The tank and the tap

The problem of the oil peak is not a tank size issue but a tap flow rate problem.

Irrespective of the size of the assumed reserves – over a century at the present rate of consumption – **their exploitation is becoming increasingly difficult whereas demand is rising sharply.**

Over the past five years, world growth in the demand for oil has risen from 1% to 2.4%.

This increase in demand is destined to speed up: there are now **750 million private vehicles with 1,200 million forecast for 2020** and **1,400 million for 2030.**

2. Oil at USD 150 or more in the future

In around fifteen years' time, the clash between the decreasing supply and sharp increase in demand will lead to a far-reaching oil shock.

This shock will be intensified by elements specific to the market:

- the **continuous quotation of prices (from the well to the pump, oil is subject to 90 different financial transactions)** will result in extensive speculative anticipation,
- **political risk may amplify these phenomena.**

As a result of these phenomena, the price of oil may be driven up to USD 150 a barrel or more in fifteen or so years' time.

3. The immediately foreseeable consequences

Recent studies have shown that the transition of oil prices from USD 30 a barrel to USD 60 corresponds to a 0.5-point erosion of the GDP.

Oil at a price of USD 150 would lead to a decline of over 2% in the GDP, which would crush any growth in the Euro zone.

Moreover, the growing cost of climatic change will reduce the available margins of national budgets.

A – THE SCENARIOS ENVISAGEABLE BY 2020-2030.

Under the dual impact of climate change and far-reaching oil shock of the future, the earth will undergo changes on a par with those experienced **during both the industrial revolutions that shook the previous two centuries.**

However, the future is still an open book. Two main alternative scenarios can still be envisaged:

1. Continuation of the present trend: "Business as usual" or the worst-case scenario.

Consequences :

a) A rise in national and international tension.

(1) Internally, for each State

The 2% erosion of the GDP represented by oil at USD 150 will add to the rising cost of climate change, possibly over 4% of the GDP; this will take away any financial ability for States to react, in a context where the inequality of individuals and production sectors facing the oil shock **will modify social cohesion.**

(2) On an international scale

Tension will rise:

- **between States struggling to combat the greenhouse effect and those that wish to disregard reality,**
- for the securisation of access to oil resources **that could culminate in armed conflict.**

b) Questioning about the financial tie-up of the system

The rise in the price of oil from USD 30 to USD 150 a barrel would result – with comparable energy consumption structures - in a 2-point percentage decrease in the GDP of consumer countries.

For a world GDP in the region of 50,000 billion dollars in 2030, **there would be a difference in the demand by consumer countries of 1,000 billion USD.**

By 2020-2030 there will, therefore be a major risk of the shrinkage of the world economy.

2. Successful energy transition

The energy transition issue at stake is to anticipate the changes that will occur by the next generation in order to strongly reduce greenhouse effect gas and prepare for the future oil shock.

Success of this transition must be based on twofold proactive political measures:

a) On a national scale

Only the authorities can take on a **project of this type, on the scale of the post-war reconstruction effort** since three types of inertia need to be overcome over a period of time:

• **Inertia of the speed achieved**
Both in terms of transport and residential use of energy, neither public nor private equipment is ready for energy transition.

• **Inertia of the scientific and technological progress achieved**
It takes time to change the energy model. The deployment of alternative systems to oil, gas and coal for use in everyday life requires **periods in the region of two decades.**

• **And inertia of mentalities.**

b) On an international scale

The success of transition presupposes the reintegration of the United States into the Kyoto cycle **and on the basis of a strict commitment, that of the two major emerging countries – China and India.**

Failing this, the rules of international trade will need to be modified, which are based on 19th century concepts, in order to reintegrate threatening the external diseconomy represented by CO_2 emission.

III – The contribution made by science and technology to energy transition are essential but will not resolve everything.

A – ENERGY TRANSITION DATA

Two simple facts should be borne in mind:

- to stabilise the CO_2 content of the atmosphere at 550 ppm, the emission of this gas must be halved,
- the **current trend to consume the earth's primary energy** will, taking an average assumption, result in it being doubled in 2030 (from 10 to 20 MGtep).

However, **this is based on a consumption of 88%** (oil 37%, coal 27%, gas 24%) **of fossil energy which gives off CO_2 whereas alternative solutions exist:**

The basic data for energy transition is clear: fossil energy must be replaced by energy that does not give off greenhouse effect gas, in three sectors in particular, and the CO_2 emitted by power stations and heavy industry captured and stored:

- the production of electricity: responsible for **40% of CO_2 emission worldwide,**
- transport: responsible for **24% of CO_2 emission worldwide,**
- and the residential/commercial sector, responsible for **17% of CO_2 emission worldwide.**

B – DIVERSIFIED SCIENTIFIC OFFERING

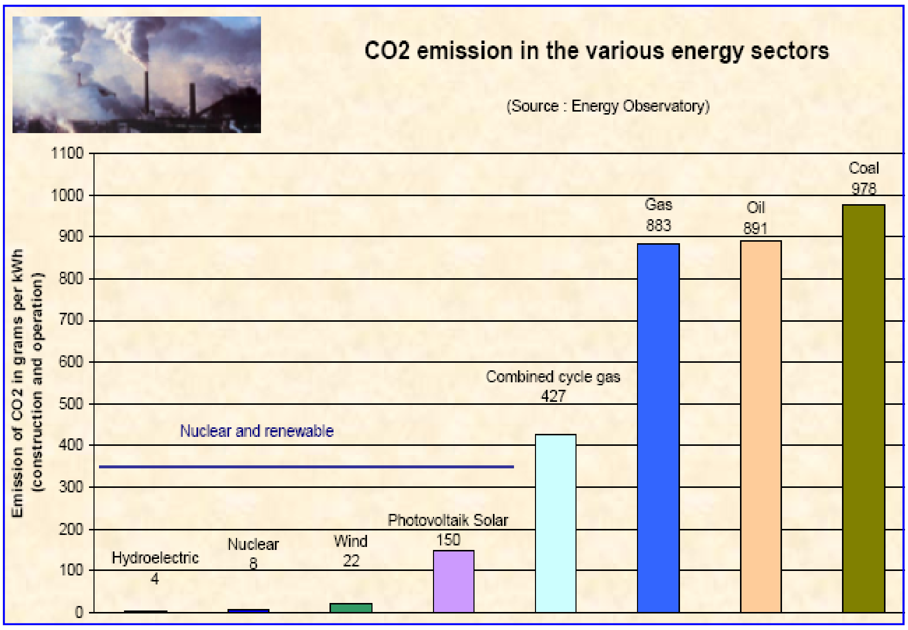
1. The production of electricity

There is not only one solution in this area – and a complex energy mix based on three main elements should be implemented:

a) Proposals to reduce CO_2 emission in power stations

The technology known as "CO_2 capture and storage" must therefore be implemented:

- but its deployment is long and costly (several hundreds of millions of euros for each of the 2,000 power stations worldwide),
- and storage without risk of carbon in deep geological layers has not yet been established to ensure acceptance by society.



b) The elctronuclear sector

It should be one of other elements involved in energy transition.

Research needs to be intensified to set up Generation IV reactors in 2030-2040. Multiplying the use of uranium by 50 to 80, they will provide energy reserves for several thousand years, with a very low **CO_2 emission rate.**

c) Renewable energy

(1) A contrasting outlook

The proportion of "new" renewable energy in world consumption is still very marginal (0.04% for wind energy and 0.01% for solar). Renewable forms of energy are abundant, present everywhere with extremely vast potential.

However, they are:

- **diffuse** and therefore supply low levels of power. For example, to produce 1 GW for one year, the following are required:
  1 nuclear reactor or **12 Serre-Ponçon type dams** or **1,500 x 2 MW wind masts spread over 150 sq.km. or 70 to 100 sq.km. of solar panels,**

- and **intermittent** according to the rainfall, day and night alternation or wind conditions (need for storage).

(2) A vital element in the energy mix

The temptation exists to relegate the use of renewable forms of energy to zones isolated from major electricity production and distribution systems (which nonetheless concerns a third of human beings).

This is a mistake:

- to reduce the 40% CO_2 emission attributable to the production of electricity, **all the sources not emitting greenhouse effect gas should be brought into play;**
- **the technological efficiency of these sectors is making constant progress:** for example, we anticipate factor 3 gains in costs for photovoltaic energy by 2015;
- **progress may be made in the storage of energy in batteries and permit a solution to be found to the intermittence of renewable energy.**

Renewable energy should, therefore, **play an important role in the success of energy transition,** in the electricity production sector.

2. Residential/commercial sector

a) Reinforced action

This sector accounts for 33% of the emission of CO_2 in France.

Thanks to thermal regulations introduced from 1973 onwards, the consumption by new buildings per sq.m. has decreased by 60% in the past thirty years.

However:

- **The "thermal" condition of buildings in use varies considerably. In 2050, 28 million residential units will have been built before 2000 and only 15 million after 2000.**
- The **surface area of all buildings in use** is increasing due to the separation of couples living together and an increase in the size of accommodation (20 sq.m. per person in 1960, 35 sq.m. anticipated in 2050).
- **New needs are appearing** such as:
  - air conditioning,
  - and specific types of electricity consumption (domestic appliances, audio-visual and computer products) that have doubled in thirty years.

b) Scientific and technological responses

On the basis of existing forms of technology, the potential savings in this sector can be estimated from 30% to 40% since there are numerous technological proposals already available:

- use of biomass (wood) for heating, the greenhouse effect gas emission of which is zero;
- mass recourse to solar energy for heating (hot water) and photovoltaic solar energy (to produce electricity);
- use of depth and surface heat pump techniques;
- implementation of **bioclimatic architecture** (thickness of walls, glazed surfaces facing south, etc.) and **insulation developed with new or phase-change materials.**

3. Transport

a) Irrepressible growth in needs

We are living on the trends of the past half-century (decrease in the cost of transport and increased number of mobility offerings).

At present, transport is responsible for 24% of the earth's CO_2 emission.

And, according to the data provided by the IEA, the proportion represented by transport in world oil consumption is increasing steadily: 33% in 1971, 48% in 2002 and 51% in 2010.

In the longer term, this growth is expected to be maintained. As a result, the annual number of billions of car passengers per km is called upon to increase by 50% by 2030 and double by 2050.

Moreover, air transport is increasing at an annual rate of 5% and maritime transport by 6%.

b) Technological responses

There are numerous responses of this type but they can only be deployed within different timeframes.

(1) Diverting part of road transport to rail

A start should be made with this solution but, like "piggybacking", it is very costly and long to implement and limited since, **even if the capacity of public transport in France were doubled, car traffic would only be reduced by 8%.**

(2) The reduction of the consumption of individual vehicles

Techniques to improve the efficiency of automobile motorisation are currently making faster progress **but their introduction into vehicles on the roads takes a long time** (15 years for half the total vehicles on the road, 25 years for almost all of them).

(3) Hybridisation is a first response

- It is an incremental technique, the output of which has already doubled in five years;
- it is a technique that provides an answer to high consumption in city use where it saves 25%;
- it is a central technique that can be combined with all the technological improvements (biofuel hybrid, new motorisation hybrid, electrical hybrid, hydrogen hybrid).

(4) Biofuel

This **replacement sector constitutes an essential intermediary solution.**

However, from the current 1% to the 35% of use of biofuels envisaged by the European Commission, there is a certain difference.

First generation biofuels (esters, ethanol) have advantageous yields in **terms of energy efficiency (1.9 from the field to the tank for ethanol and 25 for esters)** and offer reduced levels of CO_2 emission, for which estimates are divergent but are at least 60% for ethanol used directly and 70% to 80% for esters.

Their estimated **profitability threshold** also varies but is situated between USD 80-90 a barrel for esters and USD 90-150 for ethanol.

This sector will not reach maturity until 2015 with the advent of second-generation biofuel (lignocellulosic forms in particular, which have a higher yield and do not compete unduly with other uses in agriculture).

(5) Alternative sectors

Two alternative sectors should be considered:

• Electric cars

This sector – developed as an experiment in captive EDF (electricity board) or La Poste (post office) fleets – is close to market maturity.

Its gradual introduction is linked to:
- an **improvement in the efficiency of batteries;**
- recharging in urban areas **may be resolved** by the **deployment of a network** of standard replacement batteries.

• Hydrogen

The hydrogen sector may have a future but will not be deployed for another generation.

In fact:

- **the difficulties of massive production of hydrogen without the emission of CO^2 could only be resolved by the capture/ storage of carbon in traditional power stations or the deployment of Generation IV nuclear reactors from 2030 on;**

- **the costs for ex nihilo deployment of a complete distribution network are very high** (in the region of **15 billion USD in the United States);**

- and the cost of onboard fuel cells should be **divided by a factor of 50 to 100 if they are to be introduced onto the market.**

C – AN OPPORTUNITY TO BE SEIZED

Changing or even strongly modifying the orientation of energy architecture means changing the economic world.

Energy transition is an obligation but is also an opportunity to be seized.

The introduction of forms of energy to replace those currently in use will initially be a very costly process. **However, it will create hundreds of thousands of sustainable jobs, as demonstrated by the example of Germany.**

It is a "new frontier" that is being offered for our future development.

MAIN PROPOSALS

***I – Integrate climate change into globalisation mechanisms*, by:**

- *creating a worldwide carbon tax to establish fair competition between countries;*
- *reinserting climate obligations into WTO regulations.*

***II – Create a specific form of taxation to finance energy transition (5 billion euros),* by:**

- *increasing tax on petrol and fuels by 1% for 10 years except for the tax on domestic fuel;*
- *re-establishing road tax in the form of a carbon tax, also applicable to two-wheelers;*
- *introducing a special tax for the use of motorways by heavy goods vehicles.*

***III – Make energy transition a national priority,* by:**

- *coordinating the action of the State by a High Council and Commissioner for energy transition;*
- *appointing project managers for the development of each fossil fuel replacement sector;*
- *indicating the deadlines for a plan for energy transition by 2030;*
- *developing the awareness of society and providing concrete information to users.*

***IV – Develop greater insight into the effects of climate change,* by:**

- *creating a unified computation platform at worldwide level;*
- *initiating studies of the actual cost of climate change.*

***V – Make Europe a distinct player in energy transition,* by:**

- *introducing a European tax on kerosene and high-tonnage maritime transport;*
- *creating a carbon certification system based on compliance with Kyoto provisions;*
- *setting up European piggybacking routes;*
- *increasing experimentation in the hydrogen sector.*

***VI – Take specific action in the area of transport,* by:**

- *using standardisation;*
- *subsidising the purchase of low-CO_2 emission vehicles;*
- *encouraging social experimentation modifying the orientation of the use of cars.*

***VII – Reinforce action in the residential/ commercial sector,* by:**

- *planning regulations for thermal systems in the long term;*
- *using these regulations for more sustainable town planning;*
- *clarifying the awarding of new energy certificates;*
- *activating the demand for renovation of housing by loans and tax incentives;*
- *reinforcing specific electricity consumption standards.*

VIII – Heavily involve local and regional authorities by varying the "Reallocation of Operating Funds" and "Global Equipment Grant" according to their efforts to combat the greenhouse effect.

IX – Prepare for the post-2030 period by activating support to future sectors *(nanotechnology, Generation IV reactors and hydrogen, etc.).*

This report can be viewed in full on the Internet site of the Senate: www.senat.fr/opecst/rapports.html
and National Assembly: www.assemblee-nationale.fr/documents/index-oecst.asp

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