

"Factor 4": Managing the transition for the French economy by 2050

Facteur 4: comment organiser la transition de l'économie française d'ici 2050

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CAPTURE AND GEOLOGICAL STORAGE OF CO2 SYMPOSIUM
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1. Recap on urgent, long-term environmental concerns at a global level



After Kyoto

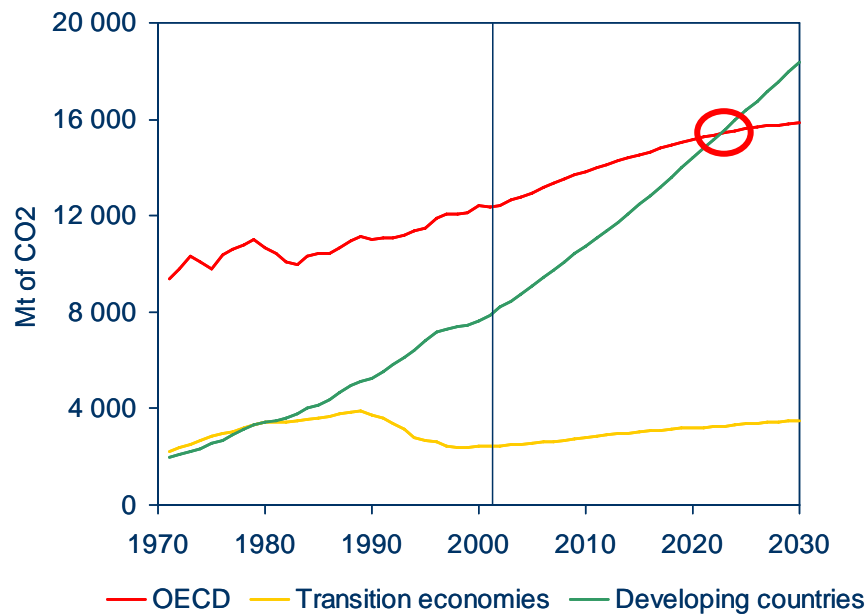
- Kyoto offers only a very partial response: in 2012, -2.8% in relation to 1990 for those parties which ratified it
- According to the IEA (WEO 2006) trend estimates, in a BAU scenario, energy-related CO₂ emissions worldwide between today and 2030 will increase 55% over the 2004 level
 - Developing Countries will account for 75% of this 55% increase
 - see following graph
- **Halving** annual worldwide emissions of GHG's **by 2050**
 - ❑ According to IPCC and EU, leads to +2°C only
 - ❑ Does not obviate the need for efforts after 2050
 - ❑ Can be split into two convergence objectives (see following graph):
 - Objective 1: 0.33 tC/inhab [1.2 tCO₂/inhab.]
 - Objective 2: 18 gC/US\$ 2000 ppp of GDP [66 gCO₂/US\$ of GDP]



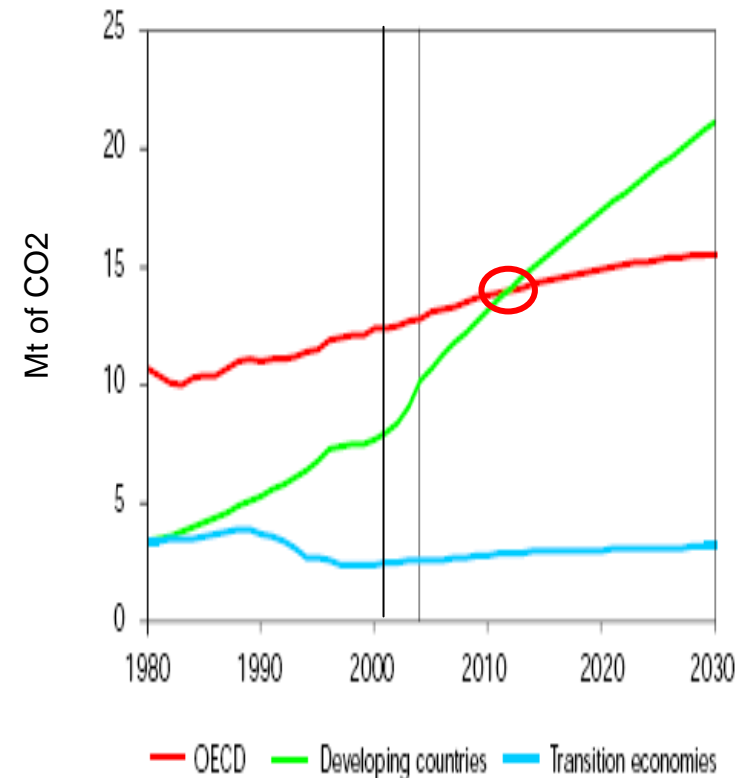
World CO2 emissions could rise 55% in 2030 in BAU scenario

- CO2 emissions which are getting worse in the developing countries according to the IEA's BAU scenarios

According to IEA, World Energy Outlook 2004

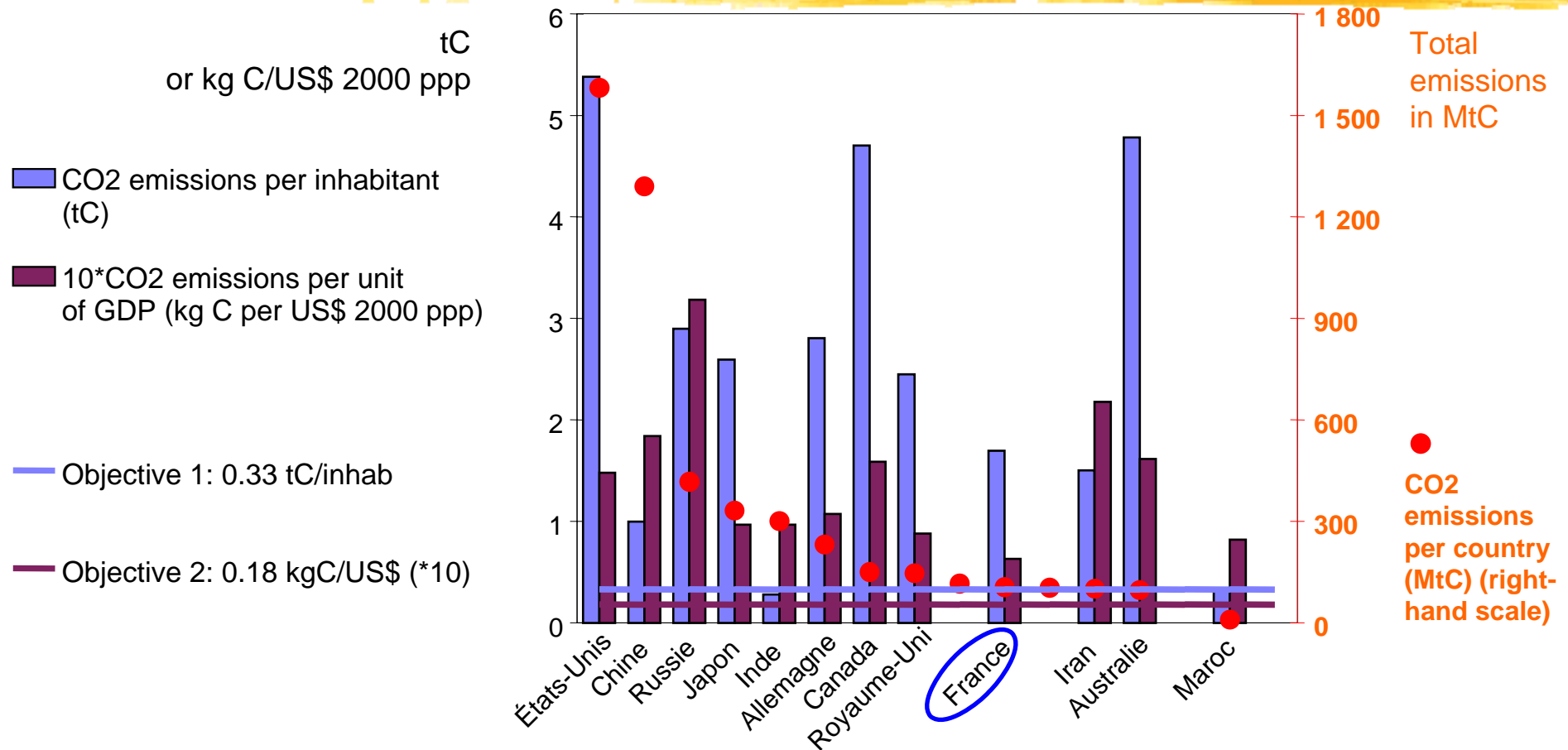


According to IEA, World Energy Outlook 2006





CO2 emissions for a few countries: What fair burden sharing?



- “Obvious” formula: $(\text{CO2/inhab.}) = (\text{GDP/inhab.}) \times (\text{CO2/GDP})$ where GDP/inhab. is to rise
- Transition or developing countries: despite low (CO2/inhab.), (CO2/GDP) may be very high => **development challenge**, see China, India, etc.



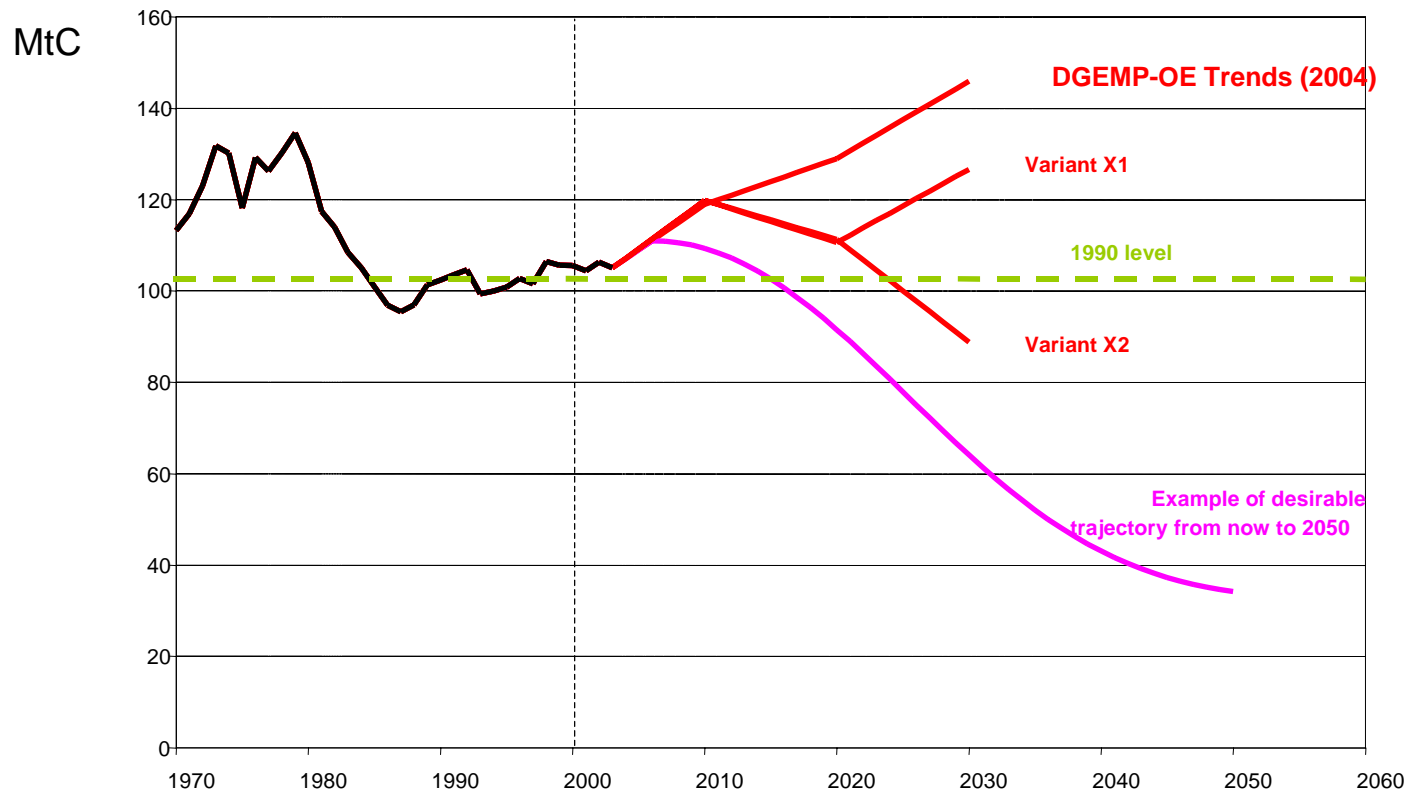
Origin of "Factor 4" for France

- Convergence of emissions per head: division by 6 of total emissions for France
 - 0.33 tC/inhab. in 2050 as against 1.7 at present (assuming population stability)
- Convergence of emissions per unit of GDP: division by 1.3 of total emissions for France
 - 0.018 in 2050 as against 0.063 at present (if +2.3% GDP growth per annum)
- Government choice + French Energy Law of 13/7/2005: division by 4 of CO₂ emissions by 2050



France's CO2 emissions

- Trend-based vs. alternative scenarios from the Energy Observatory
- For the same rise in energy savings, variants X1 and X2 correspond to two different offering structures
- Desirable scenario in pink



Plethora of energy outlook exercises



- International Energy Agency: every two years → WEO 2004, WEO 2006
- European Commission (DG TREN, DG Research): at least once/year
- French CAS (Prime Minister's Centre for Strategic Analysis)
 - "Long Term Energy" Group (1982-1983)
 - "Energy 2010" Group (Michel Pecqueur, 1990-1991)
 - "Energy 2010-2020" Group (Pierre Boisson, 1996-1998)
 - "Energy Commission" (Jean Syrota, 2006-2007)
- DOE – Energy Information Administration (USA): every year
- DTI (UK)
- DGEMP (general directorate for energy and raw materials): 1987, 2000, 2004 + 2005, attempted forecast for 2050
- Major companies (Shell, Total, etc.)
- Many experts/consultants: P. Radanne, P.R. Bauquis, J. Laherrère, Enerdata, LEPII, ..., Dr. Jacquard (Canada), Fraunhofer Institute (Germany), etc.
- World Energy Council: 1998, 2007
- etc.

Energy outlook at the DGEMP

(General Directorate for energy and raw materials)



- Recurring exercise to produce a “Business as usual (BAU)” reference scenario to 2030, in particular for the IEA
- Continuation of the CAS “Boisson” group, two BAU exercises:
 - DGEMP-OE(2000)
 - DGEMP-OE(2004)
- Preparation of the draft “Energy steering law” (mid-2004) voted 13 July 2005
- Interministerial “consensus” in line with this BAU approach
 - Presentation to the MINEFI-DGEMP international seminar on 30 June 2004 on the energy outlook in France and Europe
 - More than 300 participants, mainly from outside the French Ministries (proceedings available on www.industrie.gouv.fr/energie)
- Continuation through:
 - 2050 “factor 4” scenario (Enerdata + LEPiI) published in 2005
 - Think tank for other scenarios
 - “Factor 4” group (see later)



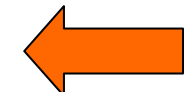
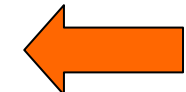
Study reports available on the Internet: www.industrie.gouv.fr/energie

La prospective énergétique

notamment du poids significatif que peuvent alors commencer à prendre les technologies de rupture.

- **un scénario dit "facteur 4"**, conçu au contraire pour réaliser l'objectif d'une **division par quatre des émissions de CO₂ d'ici le milieu du XXI^{ème} siècle**. L'exercice avait cependant davantage comme objectif d'évaluer à cette occasion les dispositifs de modélisation disponibles, qui ne s'étaient guère aventurés au-delà de 2030 jusqu'à présent, que de fournir des scénarios aboutis pour 2050. Les résultats présentés dans le rapport final doivent être vu comme une image parmi d'autres des nombreux futurs possibles. En revanche, le retour d'expérience sur la problématique méthodologique permettra d'engager les travaux ultérieurs s cet horizon sur des bases mieux établies.

- [Le scénario énergétique tendanciel à l'horizon 2030 pour la France](#). Document présentant la synthèse des résultats comparés aux scénarios disponibles réalisés par la Commissariat général du Plan en 1998, la DGEMP-Observatoire de l'énergie en 2000, la Commission européenne (DGTREN) en 2003. DGEMP, juin 2004. Format pdf, 110 ko.
 [english version](#).
- [L'étude pour une prospective énergétique concernant la France, 2030-2050](#). Cette étude réalisée par Enerdata et le LEPII, pour l'Observatoire de l'énergie, vise deux objectifs : produire un scénario tendanciel de référence à l'échéance 2030, selon une démarche exploratoire classique et produire un scénario "division par quatre de nos émissions de CO2 à l'horizon 2050" selon une démarche plutôt téléologique. Février 2005.





Quantified objectives of the Energy Law of 13 July 2005

- Article 2:
 - division by 4 of GHG emissions by 2050 (-3% per year)
- Article 3:
 - Raise the annual energy intensity reduction rate from the current level of -0.8% per year to -2% by 2015 and -2.5% by 2030
- Article 4:
 - 10% of our energy needs from renewable energy sources by 2010
 - 21% threshold in 2010 for production of electricity from renewable sources (directive 2001/77 of 27/9/2001)
 - By 2010, 50% rise in heat production from renewable sources
 - 2% by the end of 2005 and 5.75% by 2010 for incorporation of biofuels
 - etc.
- Annex:
 - For new buildings, 40% improvement by 2020 in the minimum overall energy performance thresholds
 - 120g CO₂/km by 2012 for average individual emissions from new vehicles
 - etc.



Origin and roles of the “Factor 4” Group

- 23 March 2005: Government seminar on sustainable development
- 27 May 2005: Nomination of Christian de Boissieu by the French Government
- 13 July 2005: Energy Law, art. 2: “division by four or five”
- 8 August 2005: Terms of Reference of the Group by Ministers François Loos and Nelly Olin, extract:

“We hope that (...) this Group can compile a compendium of the main results and issues that you have identified, with a view to proposing a smooth and successful transition by French society, in economic, ecological and social terms, towards the objective of division by four [of French greenhouse gas emissions by the year 2050]”.



A “political” Group chaired by an economist (31 people)

● Ministries

- Agriculture and Fisheries
- Transports and Public Works
- MINEFI (DGTPE + DGEMP)
- Interministerial Delegate for Sustainable Development
- Interministerial Delegate for Bio-energies

● Companies

- MEDEF
- EPE (Entreprises pour l'Environnement – environment enterprises)
- Areva
- EDF
- GDF
- Total
- CCFA (committee of French automobile manufacturers)
- APCA (permanent association of chambers of agriculture)

● Organisations

- Académie des technologies
- AIE
- Ademe
- Caisse des Dépôts et Consignation
- Météo-France

● Trade Unions and other associations

- CFDT
- CLCV (consumption, housing and living conditions confederation)
- FNAUT (national federation of transport users associations)

● Universities

- CNRS-EHESS/CIREO
- IDDRI (Institute for sustainable development and international relations)

● Elected officials

- Association of eco-mayors
- A deputy and a senator

● Ecological associations

- Greenpeace France
- Réseau Action Climat
- WWF (World Wildlife Fund)

● Chairman: Christian de Boissieu

● 2 rapporteurs

- Jean-Claude Gazeau (MEDD-MIES)
- Richard Lavergne (MINEFI)



2. A 2050 “Factor 4” scenario for France [DGEMP-OE(2005)]

The DGEMP-OE(2005) "Factor 4" energy scenario in 2050



- “Exploratory” scenario, “back-casting” with the POLES (worldwide exercise) and VLEEM models
 - continuation of the macro-economic assumptions of the trend-based scenario whenever possible
 - “internalised” oil price: less than 30 \$/bl in 2050!
 - Breakthrough technologies, necessary but not yet identified: “VLE technologies” (very low emissions), particularly in building
 - CO2 capture and sequestration to produce electricity: as of 2020 but little used in France
 - About 5 Mtoe/year of hydrogen consumed in 2050 by transports

Factor 4: transition from final energy to primary energy

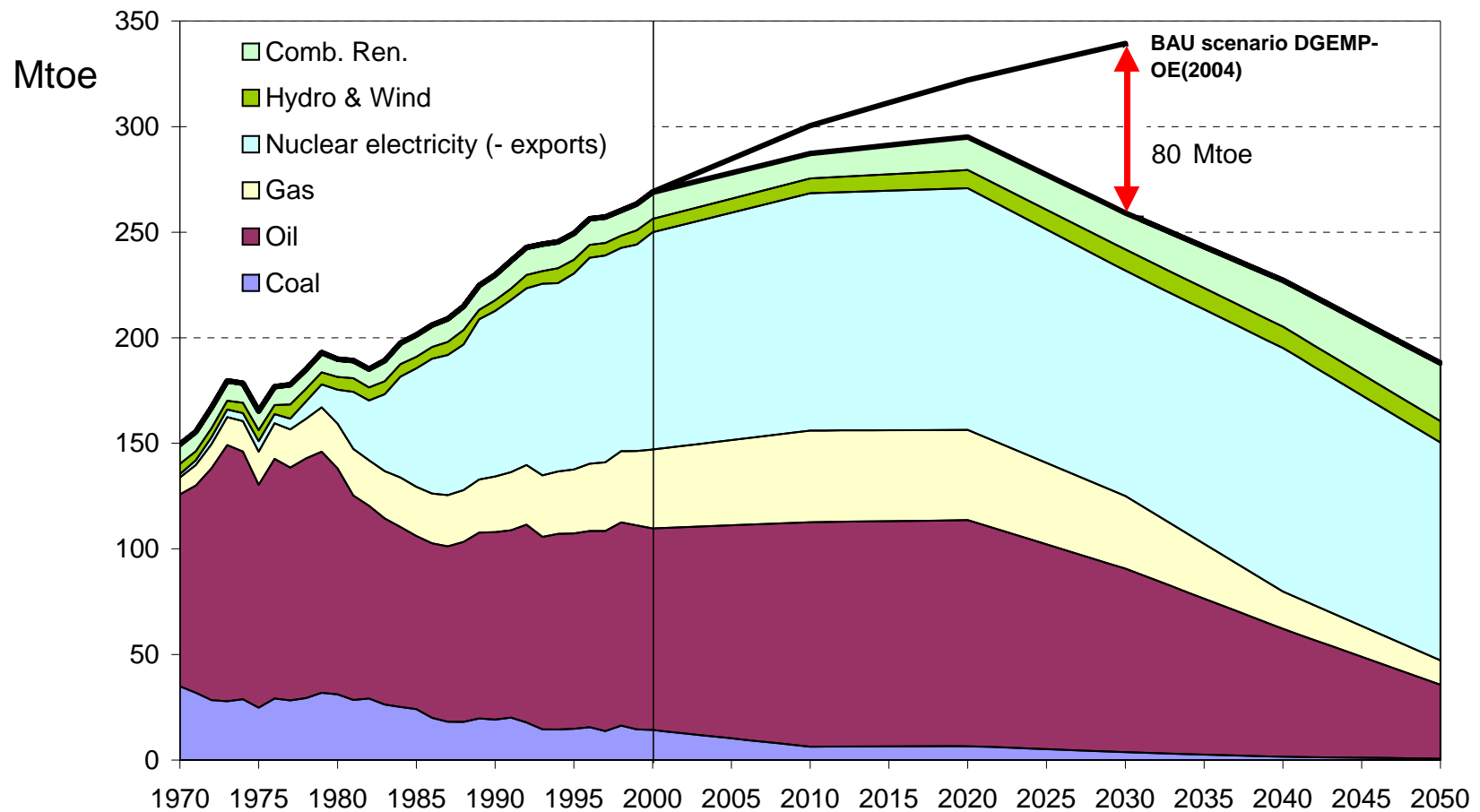


- Energy balance (supply – demand) built using the model, by:
 - ❑ Equalising the marginal costs of emissions reduction
 - ❑ Minimising this cost, enabling the “factor 4” to be achieved
- All emitting activities (final consumption and energy branch) are given the same “carbon value” (~ 300 to 400 euros/tCO₂)
- The model arbitrates between:
 - ❑ Reducing energy consumption
 - ❑ Dissemination of new technologies
 - ❑ Modification of the energy mix structure
- Two global projections:
 - ❑ BAU + no emissions constraint => “peak-oil” at around 2040 for non-conventional, then ramp-up of extra-heavy oils, tar sands and CTL
 - ❑ emissions constraint in 2050 => drop in oil consumption, no “peak-oil” before 2050. Price between 20 and 30 \$/bl at end of period

Primary energy consumption from 1970 to 2050

(DGEMP-OE(2005) "Factor 4") (1/2)

- Nuclear virtually stable in volume, share is up (55%, against 38%)
- Fossil fuels down sharply, both share and volume



Primary energy consumption from 1980 to 2050 (DGEMP-OE(2005) "Factor 4") (2/2)



in Mtoe	1980	2000	2030	2050	TCAM 2050/2000
Coal	31	14	4	1	-5.9%
Oil	107	96	87	35	-2.0%
Gas	21	37	34	12	-2.3%
Nuclear (excluding net exports)	16	103	107	103	-
Ren. (elec. and thermal)	14	19	27	38	+1.4%
Total primary	190	269	259	188	-0.7%

TCAM: average annual growth rate

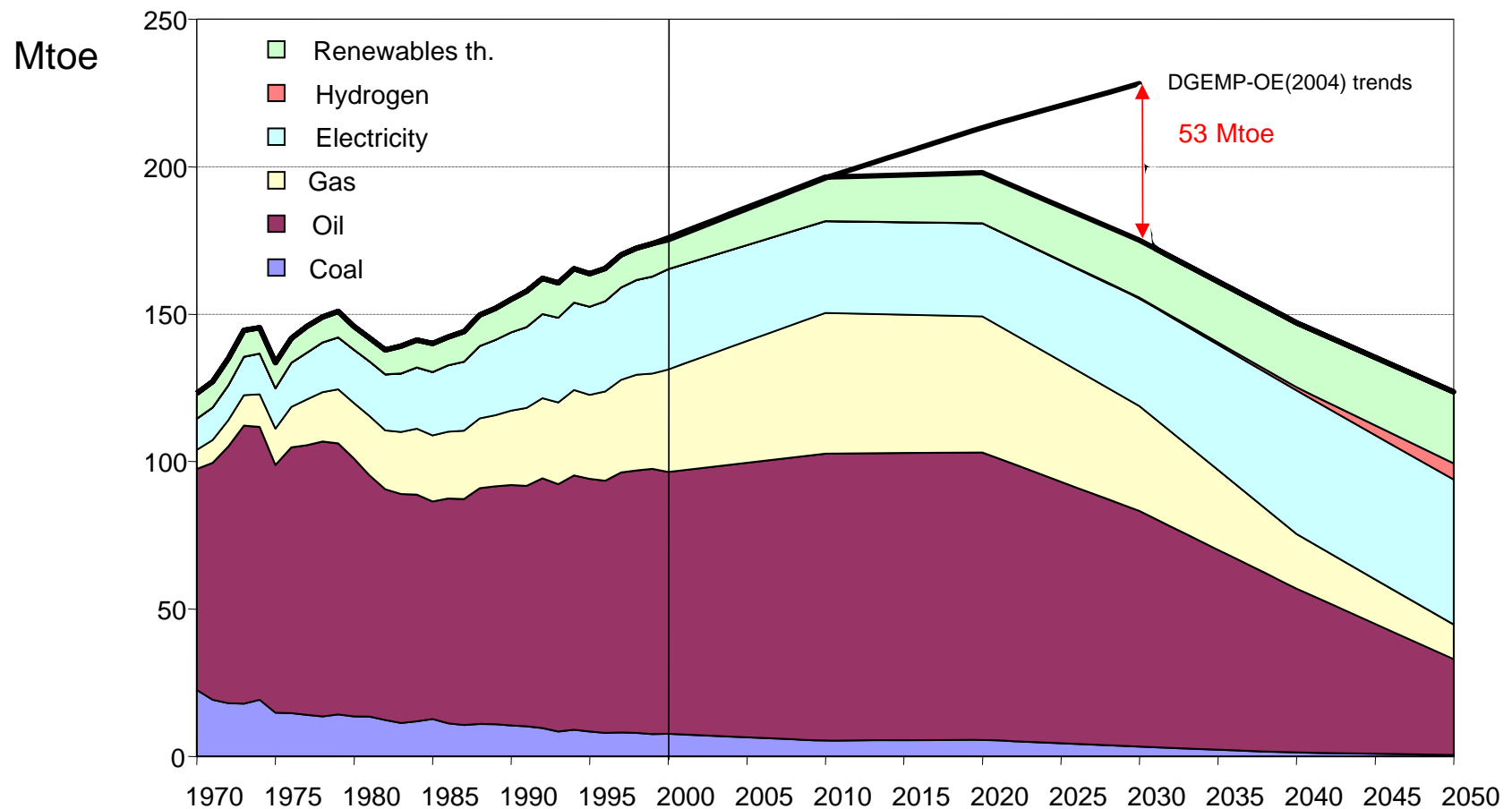
as %	1980	2000	2030	2050	Trend 2050/2000
Coal	16	5	1	-	-5 pt
Oil	56	36	34	19	-17 pt
Gas	11	14	13	6	-8 pt
Nuclear (excluding net exports)	9	38	41	55	+17 pt
Ren. (elec. and thermal)	8	7	11	20	+13 pt
Total primary	100	100	100	100	



Final energy consumption (1/3)

until 2050: by product ("factor 4")

- The final mix would be 62% elec. + H2 + NRE (against 27% in 2005)
- 20 Mtoe unidentified reductions ("VLE")

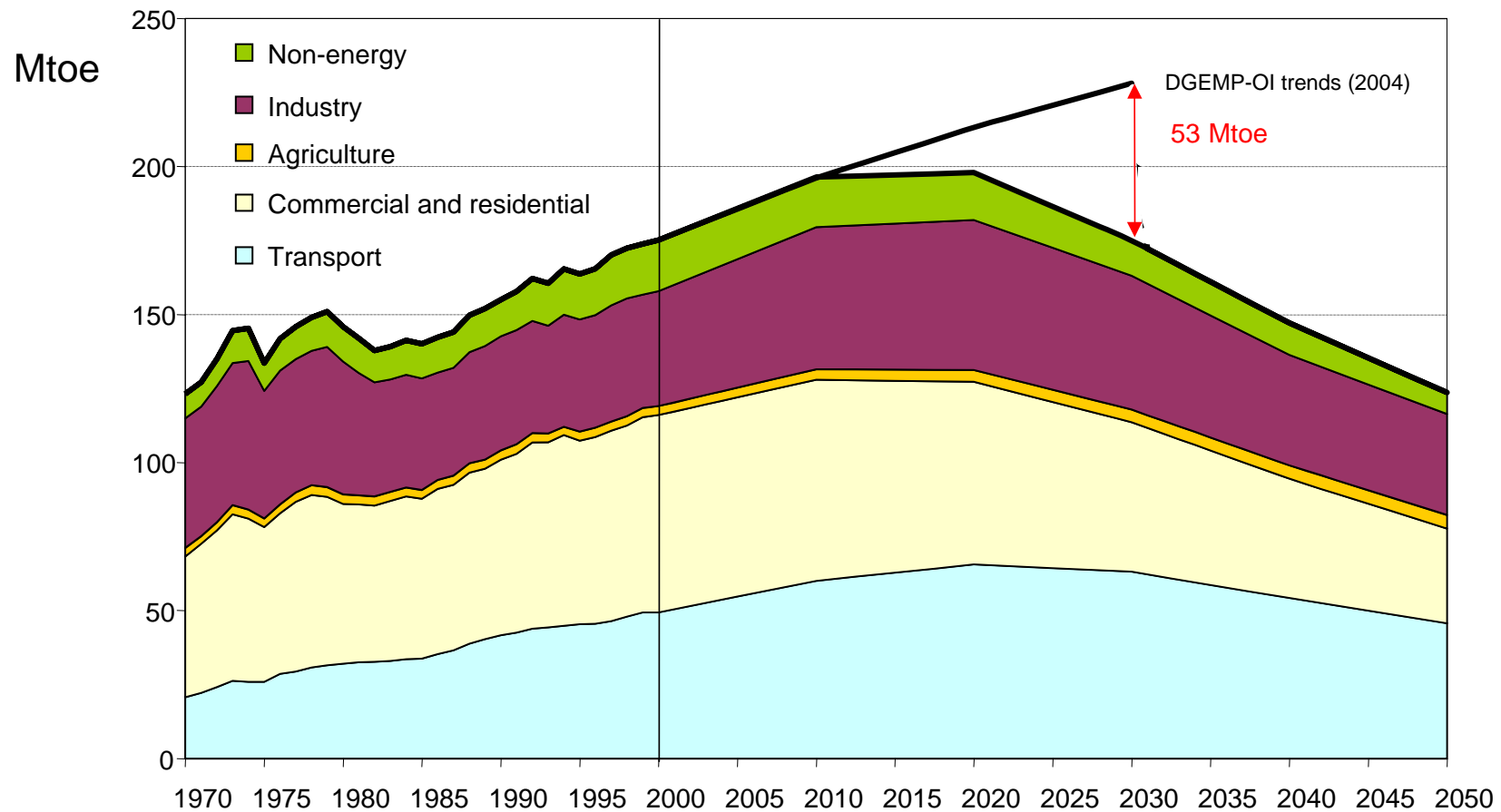




Final energy consumption (2/3)

until 2050: per sector ("Factor 4")

- Significant drop in transports and residential/commercial
- -2% per year in each sector as of 2030





Final energy consumption (3/3) until 2050: per sector ("factor 4")

- General drop in final consumption (except agriculture)

in Mtoe	1980	2000	2030	2050	TCAM 2050/2000
Industry (energy uses)	45	39	45	34	-0.3%
Agriculture	3	3	4	5	+0.8%
Residential & commercial	54	67	51	32	-1.5%
Transports	32	49	63	46	-0.2%
Total energy	134	159	163	116	-0.6%

TCAM: average annual growth rate

- Rise in final electricity consumption (except residential/commercial)

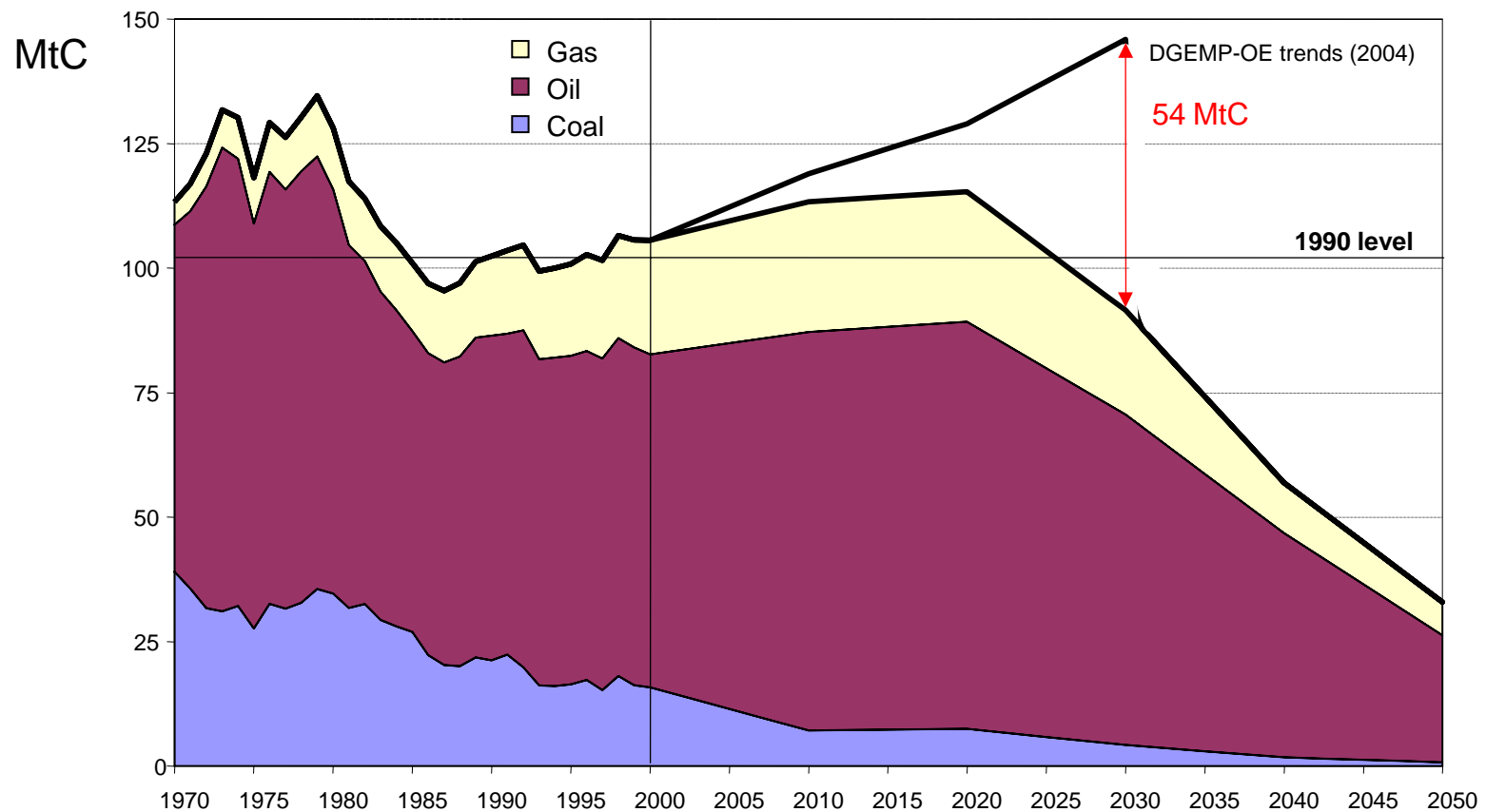
in TWh	1980	2000	2030	2050	TCAM 2050/2000
Industry	95	139	163	193	+0.7%
Agriculture	2	3	4	5	+1.1%
Residential & commercial	107	244	207	226	-0.1%
Transports	7	10	48	147	+5.4%
Total final elec.	211	395	422	570	+0.7%

TCAM: average annual growth rate



CO2 emissions due to energy by 2050 (DGEMP-OE(2005) – “Factor 4”)

- “CO2 stabilisation at 450 ppm” worldwide and “factor 4” in the industrialised countries => Peak Oil/Gas does not happen!
- CO2 emissions due to fuel combustion in France:





Conclusion of the scenarios: "Factor 4" is possible for France

- More energy efficiency and de-carbonisation of the energy mix

Average annual growth rates	CO2 =	Pop.	(GDP/Pop)	(Primary/ Final energy).	(Final energy/GDP)	(CO2/Primary energy)
Recent past (1990-2005)	+0.2%	+0.5%	+1.4%	+0.4%	-1.1%	-1.0%
Mid-term BAU (2000-2030) DGEMP-OE(2004)	+1.1% =	+0.3%	+2.0%	-0.1%	-1.4%	+0.3%
F4 (2000-2050) DGEMP-OE(2005)	-3.0% =	+0.3%	+2.0% ?	-	-1.6%	-3.7%

Energy efficiency, behaviour, techno. breakthroughs, etc.

Renewables, nuclear, CCS, H2 (?), techno. breakthroughs, etc....

National target, i.e. "division by 4"

Primary energy/Final energy is a technical coefficient
CCS = CO2 Capture & Storage

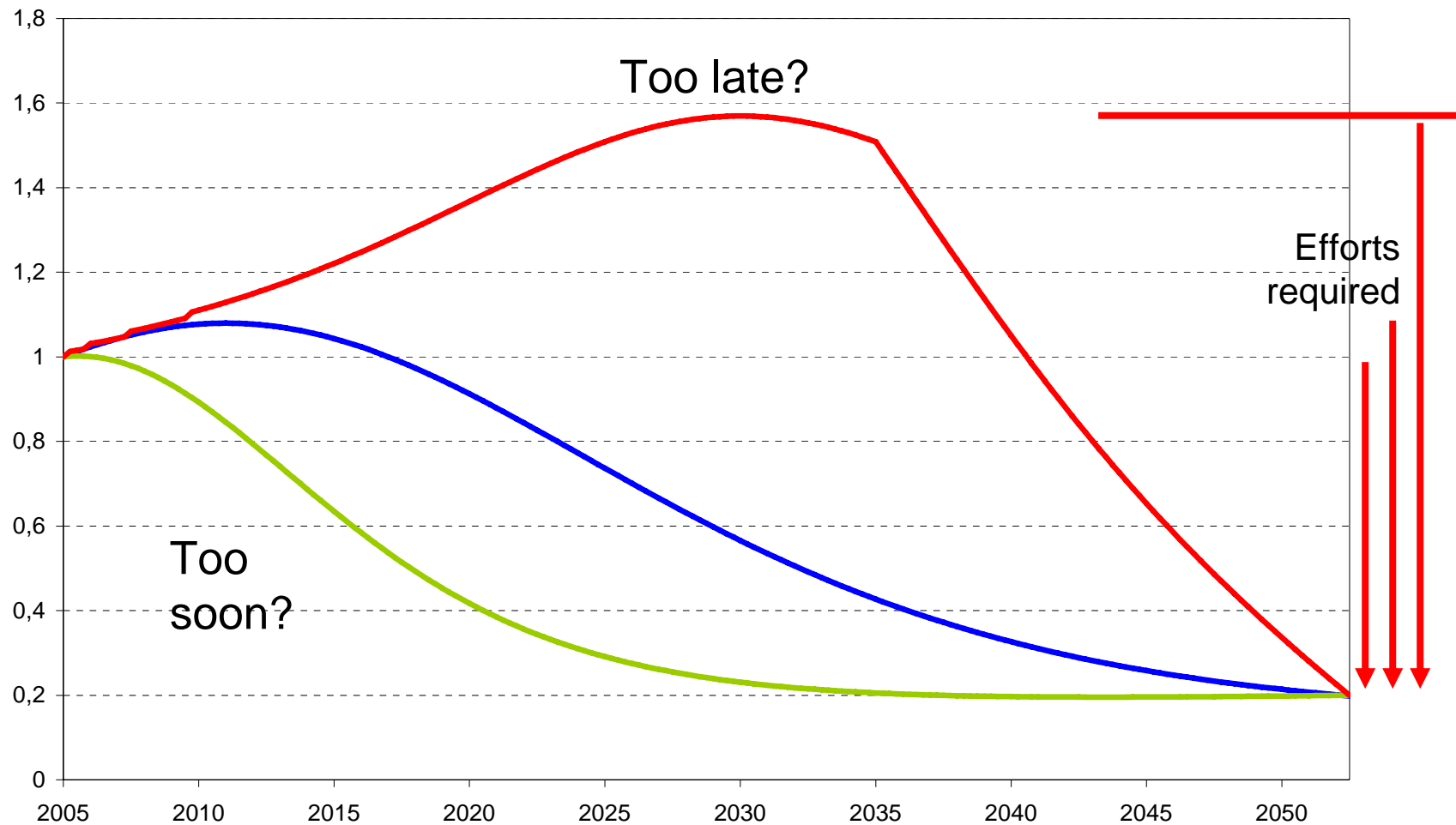


3. Main conclusions of the "Factor 4" Group



How to make the transition to F4?

- GHG emissions, base 1 index in 2005





A few fundamentals for a reasonable “Factor 4” future

● Arbitrate between several complementary approaches:

- Move towards a less carbon-based energy mix
- Dissemination of efficient and/or new technologies
- Changing attitudes (citizens, businesses)

} => Energy efficiency

● Global constraints:

□ peak-oil/peak-gas

- If no emission constraint => “peak-oil” in about 2040 for the non-conventional, then ramp-up of extra-heavy oils, tar sands, oil shale and CTL
- If emission constraint in 2050 => drop in oil consumption, no “peak-oil” before 2050, price between 20 and 30 \$/bl at end of period

□ International division of labour (wealth, industry, etc.)

□ Avoid “free riders”



First lessons

- Investing in energy efficiency and renewable energies = “no regrets” precaution for the future
 - +/- close to profit-making (thermal already OK)
 - Positive externalities: creation of local jobs, competitiveness, etc.
- All energy options must remain open: fossil, nuclear, renewables, efficiency
 - Each option has its advantages and drawbacks
 - Hydrocarbons will hit peak-oil / peak-gas and have two handicaps that will only get worse:
 - concentration of reserves
 - CO2 emissions (unless CCS used)
 - One must prepare for the transition by 2050
 - => what is essential, what is unacceptable and the needs for technological innovations



Essential, unacceptable and need for technological innovation

- 4 essential policies to be implemented and to keep in mind:
 - ❑ Boost energy efficiency in all sectors
 - ❑ Save electricity during “peak load” consumption
 - ❑ Effect structural change in transport attitudes
 - ❑ Develop supply in the CO2 free energies: nuclear and renewable energies
- 4 unacceptable options:
 - ❑ Postpone implementing infrastructures that are compatible with the huge energy savings required, in particular in the building and transport sectors
 - ❑ Consume fossil fuels at large scale for thermal purposes
 - ❑ Consume fossil fuels large scale to produce electricity
 - ❑ Maintain the oil predominance in the transport sector
- 3 needs for technological innovation (“breakthroughs?”):
 - ❑ VLE (Very Low Emissions) technologies in all sectors
 - ❑ Storage of electricity and/or development of uses of hydrogen
 - ❑ CO2 capture and storage (CCS)
- **No precise road map** proposed by the Group, but a list of “no regret” policies & measures that may be modulated

28 recommendations, that may be transposed in any country

● 3 categories:

□ Strategy

- visibility, objective for 2020-2025 time-frame, “National Pact”

□ Overall consistency of public policies

- COFACE, World Bank, European plan

□ General mobilisation of sectors and stakeholders

- Sectoral policies: building, general infrastructures, agriculture, renewables (especially biomass), nuclear, energy efficiency
- Raise awareness and encourage stakeholders: example to be given by the Government, public buying, industry/agriculture outlook, training
- Support for R&D
- Local authorities
- Tax measures (although neutral), generalised use of the price signal
- Regulations: consumer goods, existing buildings, vehicles



Recommendations

● Strategic recommendations (4)

- ❑ Gradual, realistic objectives that are made known well in advance
- ❑ Complete with a 2020 or 2025 objective ("Beyond Kyoto")
 - e.g. -20% to -25% emissions in relation to today
- ❑ Prepare and implement a "Factor 4 National Pact"
- ❑ At EU and international levels, encourage and support initiatives to provide a predictable, long-term institutional framework



Recommendations (cont.)

- Recommendations concerning overall consistency of public policies (2)
 - Ensure that the public finance stakeholders are consistent with French policy to combat GHGs
 - E.g. COFACE, World Bank
 - In order to promote a European strategy designed to achieve the Factor 4 objectives internationally, propose a long-term investment plan to the EU member states, enabling them to make an immediate commitment to “beyond 2012”



Recommendations (cont.)

- Recommendations on the general mobilisation of stakeholders and sectors (22)
 - Mobilisation of sectoral policies (7)
 - Plan for existing buildings (e.g. “bank product”)
 - Infrastructure selection criteria (CAS)
 - Use all available energy resources to minimise the “carbon” part of the energy mix (in addition to the essential efforts needed in favour of energy savings)
 - Encourage investments in energy production facilities and energy transport infrastructures
 - Promote large-scale use of “biomass” in place of fossil fuels (energy, materials, etc.)
 - Promote carbon storage through agriculture and forestry
 - Opt for rational management of renewables, with decisions to be made between the various uses of domestic production and any imported share



Recommendations (cont.)

- Awareness and encouragement of stakeholders (6)
 - Ensure that the State sets a good example
 - Increase the amount of useful information available for combating climate change
 - Raise the awareness of all buyers (including public buyers) and individual consumers
 - Carry out a forward-looking analysis of how to adapt French industry and agriculture in order to maintain their competitiveness
 - In the various professional sectors, bring to the forefront a generation educated in the issues of climate change and the answers needed
 - Clarify public perception of the risk and the strategy adopted



Recommendations (cont.)

- Support for R&D (3)
 - Through various instruments, promote the emergence of GHG reduction technologies
 - Ensure scheduled and coordinated large-scale investment in the “New Energy Technologies”
 - Promote the dissemination of new economic incentives enabling financing of innovative projects: “carbon finance”
- Participation by local authorities (1)
 - Establish local strategies through Territorial Climate Plans
- Tax measures (3)
 - Develop taxation or subsidisation of goods based on their level of GHG emissions (although “fiscally neutral”)
 - In terms of energy consumption, set up a system of tax incentives based on carbon content
 - Extend the “price signal” to diffuse sectors, through “CO2 domestic projects”



Recommendations (cont.)

- Regulations to be set up (2)
 - Generalise the standards and regulations concerning the minimum required energy performance of consumer goods and existing buildings
 - Take action concerning vehicle engines (clear commitment with flexibility through carbon credits system)



Conclusions

- Difficult but feasible and it is urgent!
- Conclusions similar to those of the UK's "Stern Report", but more focused on policies and measures than cost assessment
- In line with the European "Triple 20%" draft strategy
- New tools, watch out for risks!
 - see Enron bankruptcy, Amaranth fund debacle, CO2 market crash
- Initial measures already taken or envisaged in France, see "Grenelle de l'environnement"
 - National environment pact
 - Sustainable development "savings book" (CODEVI)
 - External carbon tax
 - etc.
- Almost 45 years of hard-working to come, but the first 15 are critical
- Two useful web-sites:
 - www.industrie.gouv.fr/energie/facteur4.htm
 - www.legrenelle-environnement.fr

THANK YOU FOR YOUR ATTENTION !