EFDA EUROPEAN FUSION DEVELOPMENT AGREEMENT

Overview of EU Socio-Economic Studies

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Power Plant Studies and Related Advanced Technologies

US/Japan Workshop, with EU Participation

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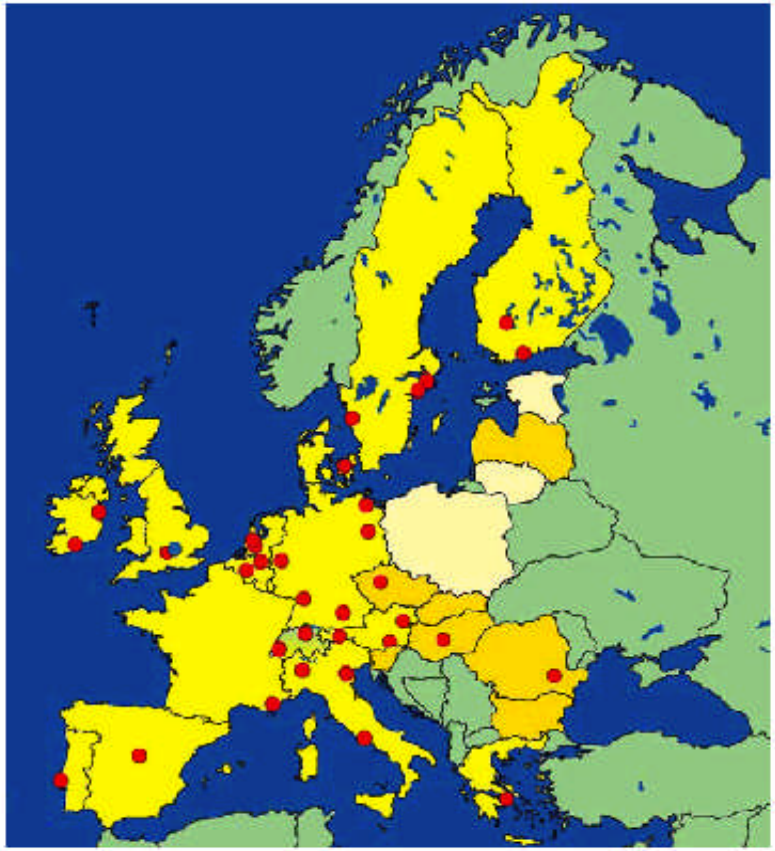
European Fusion R&D Community



EURATOM-Associations:

- conduct individually coordinated research (partly on own facilities)
- form, together with the Comission, EFDA

Background

When available, fusion power plants may provide electricity, which is the most important part of the global energy system, worth >1 T$.

How to transform this future perspective into decisions to allocate yearly 1 B$ or more to fusion R&D in the next fifty years?

To achieve this goal, in 1997 EFDA and EURATOM associates decided to invest about 1 M$ yearly.

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1.1 Fusion as Megascience: social patterns

Tendance to be described in superlatives by proponents

Unclear boundaries between factual and rhetorical arguments

(E.g. with the intention to achieve public acceptance and legitimate large and long term costs, proponents of fusion have in the past described the development of fusion power as equivalent to the discovery of fire.)

The effect is to create enormously high expectations, and

In case of delay, breakdowns or other setbacks, the public is prone to see these problems as total failures.

1.2 The dilemma of megascience proponents

'For scientist the situation is difficult to handle: it is necessary to gain public and political acceptance, yet creating unrealistic expectations and offering promises that have little chance of being fulfilled under the stipulated budget, can rapidly overthrow this support.

The former public enthusiasm over the scientific project might than fade away, and the common feeling of witnessing an important historic process changes into a feeling witnessing and financing a costly fiasco. As a result the willingness to maintain the financial support is reduced or even relinquished' (W.D. Kay, 1994)

Dependence or autonomy for researchers?

1.3 In the early years of fusion science …

… the researchers laid it down that a viable fusion reactor would be constructed within the near future (20-50 years). Slowly it became apparent that this promise would not be fulfilled; the researchers had run into serious difficulties on several fields, and the fusion power problem appeared to be more complicated than first assumed. The consequence was a delay which hurt the cause of fusion research.

Promising to much is a danger, responsibility is important when selling the research to other actors of the society, because: *'The externalised cost of overselling science is no different from the cost of pollution: we leave it to the next generation of scientists to clean up the mess when we create expectations that may not be realized'* (K. Patel, 1994). Today fusion researchers have to work hard to restore the public trust in their field.

1.4 The decision making process

… for a long term, large scale project is a complex arrangement. Its presence in the political decision making process is complicating the situation for the political actors. The decision to support a development of such a project cannot be based on an assumption of instant or close benefits. Rather, the presumed gain will not be observed until many years. The political actors have little incentives to allocate large resources to long term projects.

What may prevent them from investing all money and political prestige in short or medium term projects? A larger budget? Hopes for long term solution? Rely on many options to solve a big and otherwise unsolvable problem? Or what? … Eventually this complex decision making process requires to researchers responsiveness to changes in the scientific, technical and financial situation.

1.5 Why socio-economic studies for fusion?

What makes fusion successful or unsuccessful? Not only research, demonstration, competitiveness, safety, …

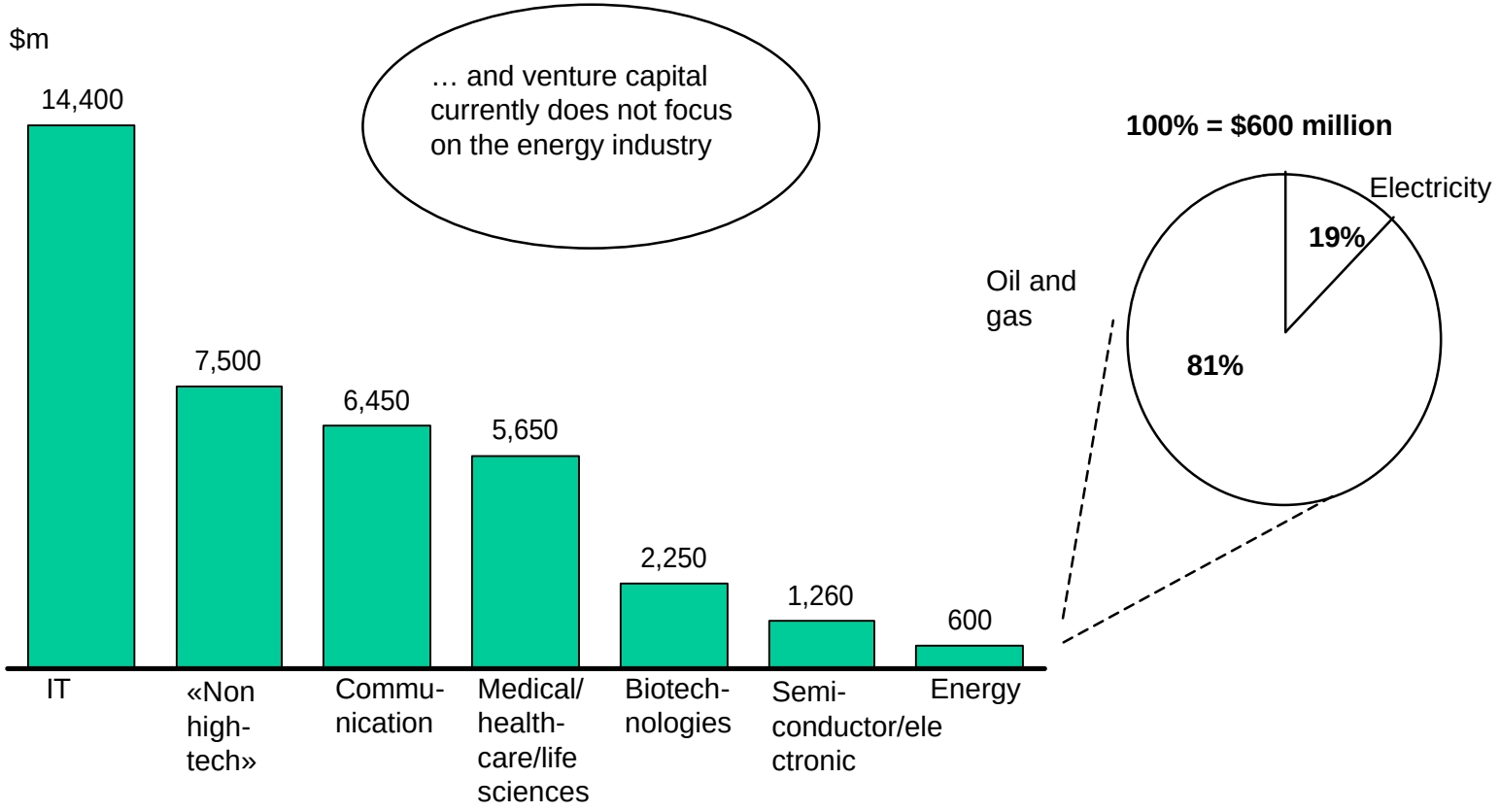
What makes fusion research successful or not? Not only the knowledge of the object, the subjects, the luck, …

Fusion R&D is unique, as to internal scientific and technical challenges, but externally it faces known and common problems.

The public support is necessary and is the starting point to legitimise positive attitudes from different actors and a successful outcomes at the end of the complex decision making process.

…to receive public acceptance, financial support

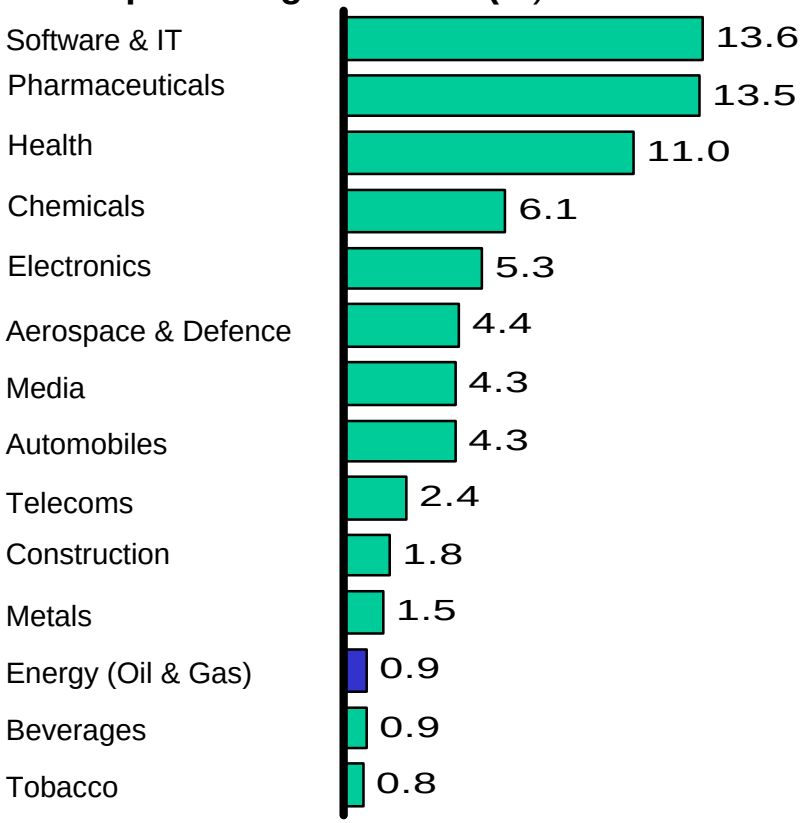
Venture capital investments by sector, 1998 (ZETS)



*Venture Economics accounts for roughly 70% of all the deal flow, Source: NVCA

International Industry R&D (ZETS, WDC, March 2002)

R&D spend as percentage of Sales (%)



The level of R&D investment is comparable to industries with limited innovation aspirations

* Survey of top 300 international companies. Data provided are sector weighted averages. Source: UK DTI R&D Scoreboard 1999

2 What socio-economic studies for fusion?

Questions on the social process and methodologies:

- Will experimental fusion devices and series production power plants be socially acceptable?

… and on the content of the messages:

- What will be the environmental impact of fusion power production, and how do the associated "external" costs compare with those of other energy supply technologies?
- What are the expected direct costs of base load electricity production by nuclear fusion?
- Can fusion acquire a substantial share of the global electricity market within the 21st century?

3.1 Fusion and Public opinion

Theoretical questions:

- Is there a social dimension for fusion?
- What is the public perception of risk?

Experimental questions on fusion and public opinion:

- What do researchers think on fusion R&D process?
- What communication to/from outside? How?
- If a fusion experimental facility has to be built, to what extent and how is it possible to modify the attitudes of the local community?
- How to initiate and carry on a dialogue with the local public to introduce the construction of ITER?

3.2 Communication on fusion: 6 focus groups in Germany

A team of sociologists from the university of Stuttgard

- selected the 6 groups: managers, very young people, science journalists, environmentalists, cultural elite, science teachers
- gathered 6-8 people per group for a 3 hours session structured in:
  - initial briefings on: global energy projections (IIASA, WEC), other energy sources, 'what is fusion', statements on fusion by an IPP scientist and an environmentalist from Oko-Institut
  - group discussions (videotaped)
  - final discussion on 'Fusion as an energy option – yes or no' (with moderator)

3.3 Communication on fusion:

some experimental evidences from focus groups in Germany

Categories discussed, ranked by importance:

1. Cost/benefit ratio of fusion research: who pays? enough money? Solar is the preferred option for the future
2. Lifestyle: more energy conservation/efficiency or new energy supply sources? Is this an incentive to consumption?
3. Risk discussed far less: all groups realized that fusion is less hazardous than fission (main risk is nuclear waste)
4. Credibility of experts was a minor discussion topic
5. Fusion as an energy option: no from science teachers and environmentalists, cultural elite (less), ni from science journalists, yes from managers and young (less)

3.4 How to modify the public opinion locally:

European Awareness Scenario Workshops in Italy

EASW aims at increasing the conscious participation of local communities to their choices on science and technology? How?

- 1-2 days, 5-6 moderators, 30-50 participants: resident citizens, politicians, entrepreneurs, technology experts
- the community is asked to develop guidelines and scenarios for a general development strategy: what balance between low and high tech? between collective and individual solutions?
- each group reports the proposals in a general sessions; 4 separate groups, reshuffled from the original 4, discuss and rank the proposals; final votes are in a new general session.

3.5 How to modify the public opinion locally:

experimental evidence from an EASW in Italy

- The population expressed a strong need for participation in local decision making.
- Development strategies have to be based upon composite visions.
- The support of local actors is necessary to establish a local network and develop the trust necessary to start an awareness process.
- The participants perceived the importance of their participation, worked hard and at the end were ready to become ‘partners’ in the public awareness process.

What has changed? At the end of the process the local community was supporting the project, and in fact asking to host it.

4.1 External Costs of Fusion

How does fusion compare with other power plants or concepts on non direct cost related issues, such as environmental damage or adverse impacts upon health?

The ExternE methodology, previously developed for the European Commission, has been used for evaluating in a standard way the external costs of electricity generation by different fuel cycles.

It is a bottom up methodology, with a site specific approach, i.e. it considers the effects of an additional power plant and fuel cycle in a specific location (in this exercise Lauffen in Germany).

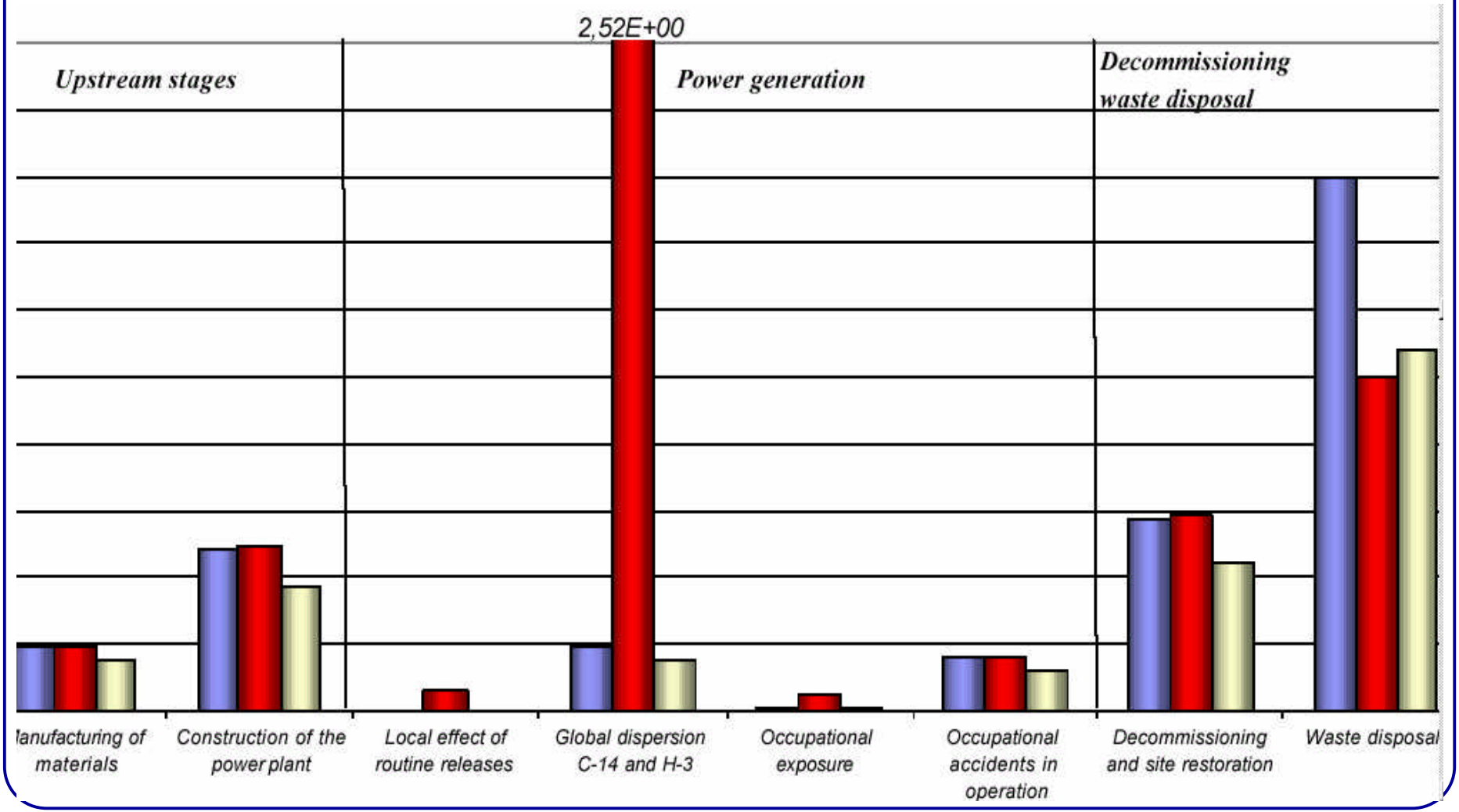
Quantification of the impacts is achieved through the damage function or impact pathway approach.

4.2 External Costs of Fusion

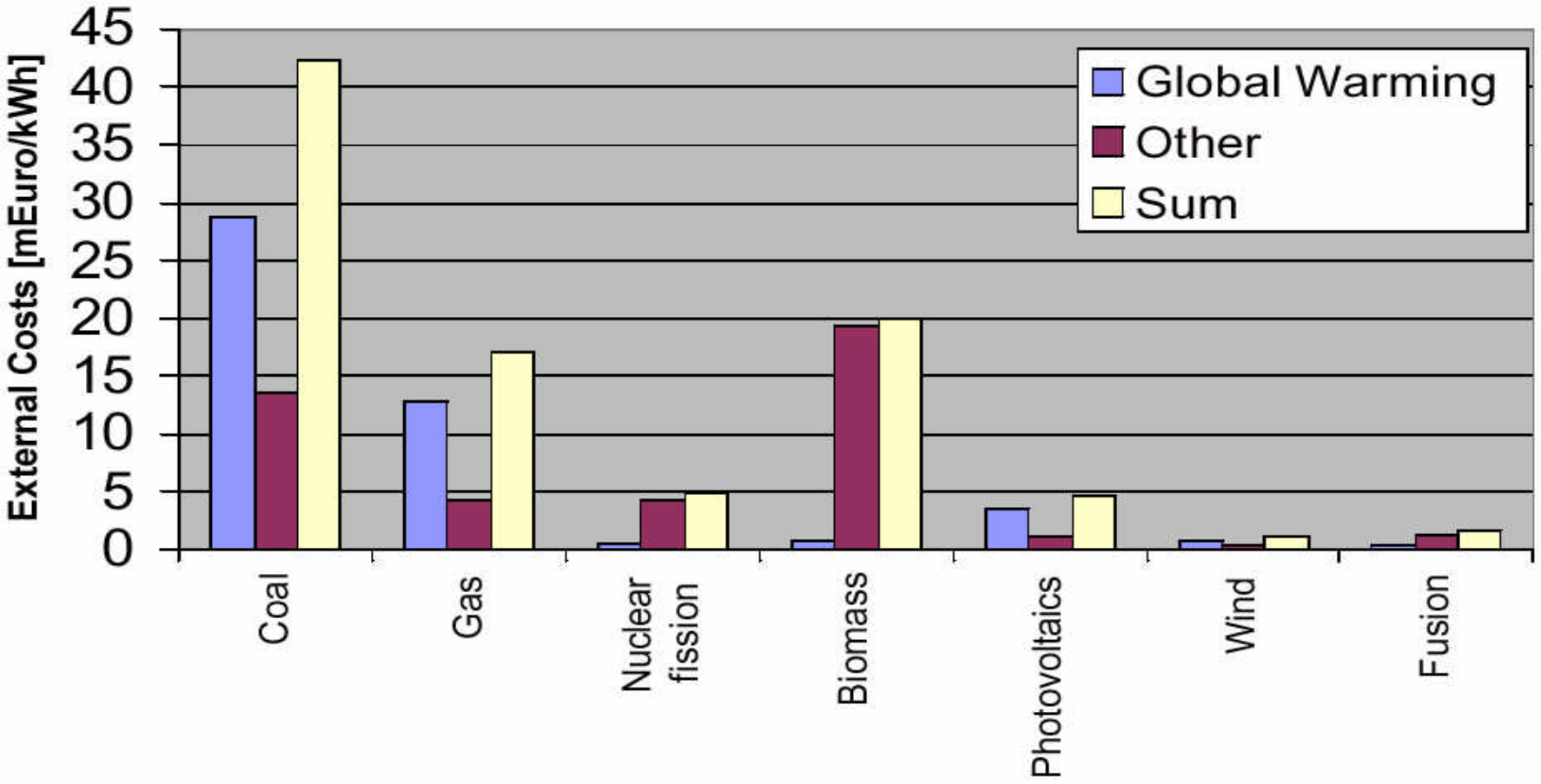
The ExternE methodology proceeds through the following stages:

- Site and technology characterization *(It assesses the entire life, fuel cycle and closure of a power station: material manufacturing, construction, operation of the plant, dismantling, site restoration and disposal of wastes)*
- Identification of fuel chain burdens and impacts *(hazardous chemical or radioactive emissions, road accidents, occupational accidents, accidents at the plant exposing the public to risks and occupational exposure to hazards)*
- Prioritisation and quantification of impacts
- Economic evaluation *(quantification of the individuals willingness to pay for environmental benefits)*
- Assessment of uncertainties

4.3 External Costs of Fusion *(CIEMAT, Spain)*



4.4 External Costs of Fusion (CIEMAT, Spain)



5.1 Direct Cost of Fusion: findings (UKAEA)

The projected direct cost of fusion base load electricity is in the range 70-130 m$'96/kWh.

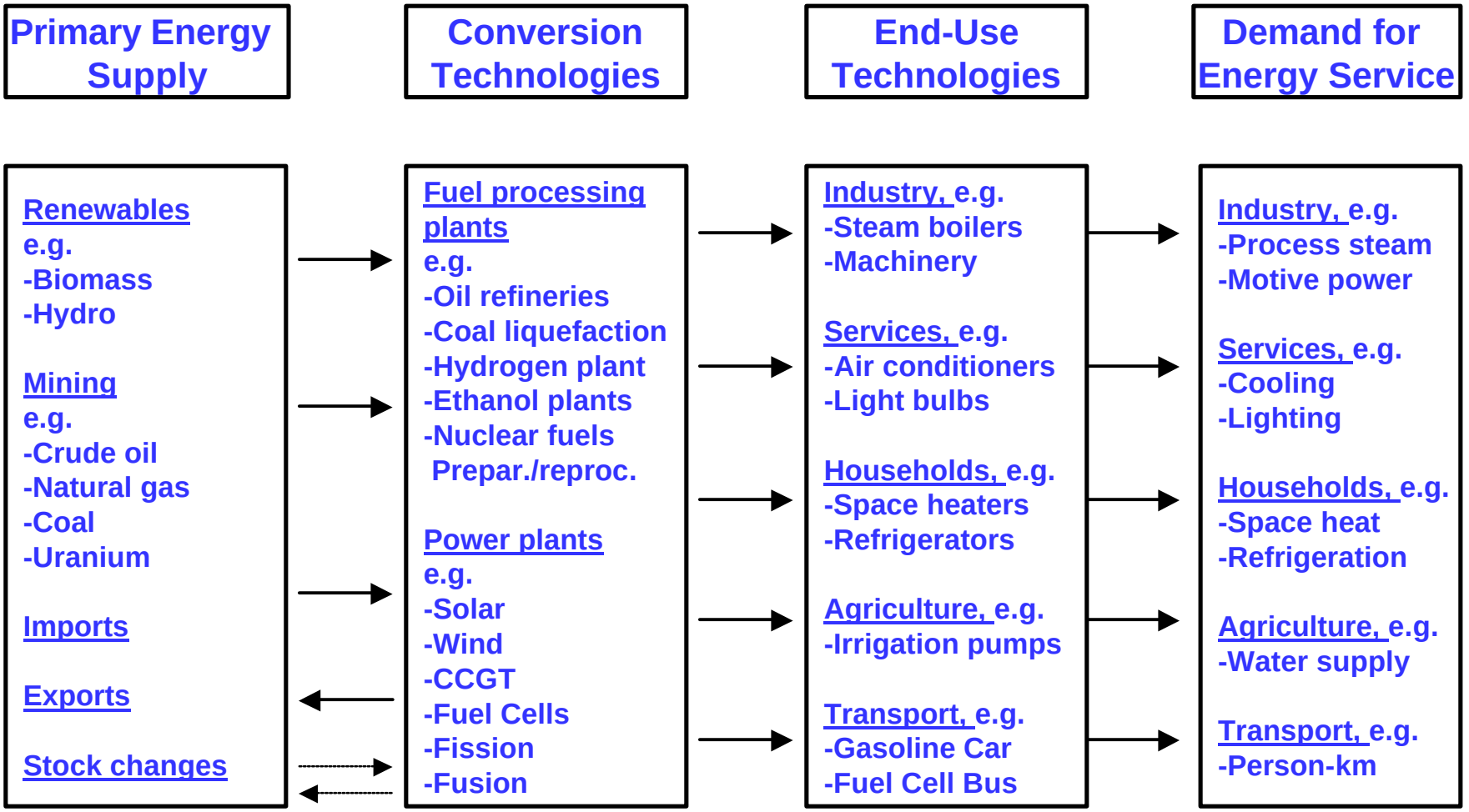
Further to superconducting technology, series production and discount rates, the important factors in improving the economics of fusion are:

- *Availability*
- *The thermodynamic efficiency*
- *Normalized pressure*
- *Unit size*
- *Limiting plasma density*

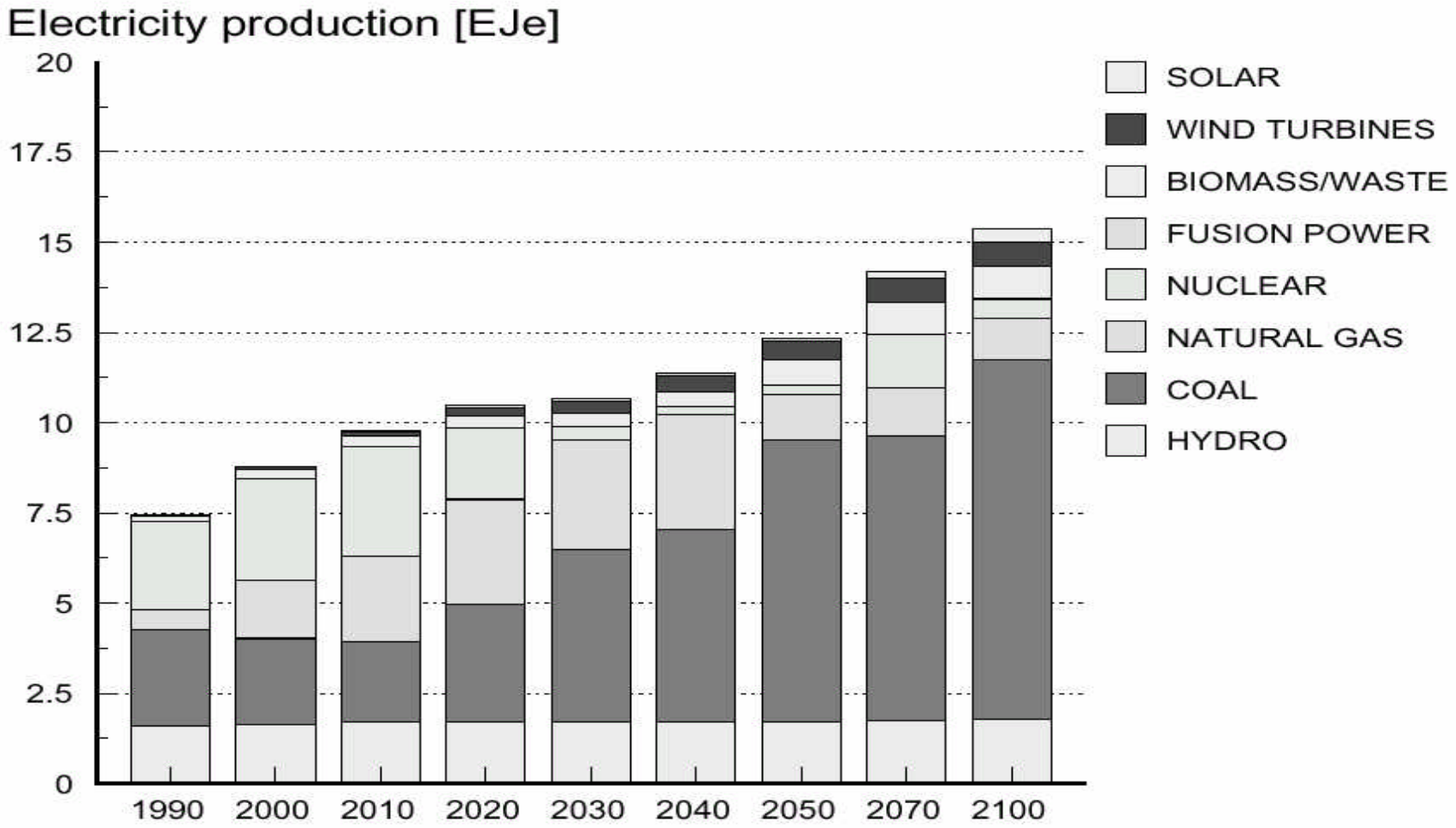
5.2 Direct Cost of Fusion: ongoing activities (UKAEA)

- Improvement of existing studies, make the implications more transparent, clarify trade-off / complementarity of advances in physics and technologies.
- What are the main decision criteria to build a competitive toroidal tokamak?
- How does a toroidal tokamak power plant compare with stellarator fusion concepts and advanced nuclear fission concepts from the environment, public / worker safety, proliferation point of views?
- What are the costs and benefits of designing a variable electric output fusion power plant?
- Improvement of system codes and benchmark inter-comparison

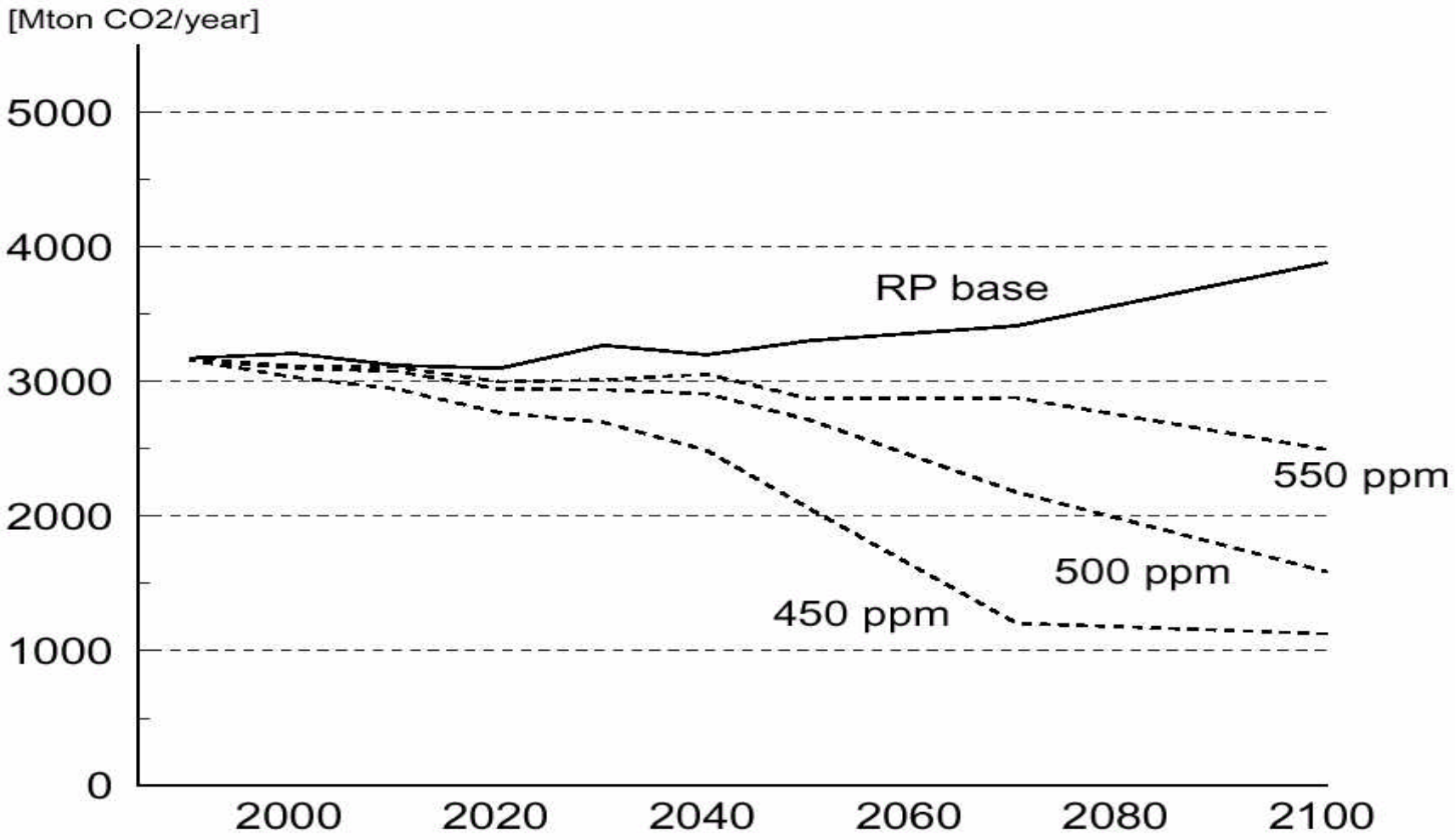
6.1 Fusion as Part of Energy Systems: RES (IEA)



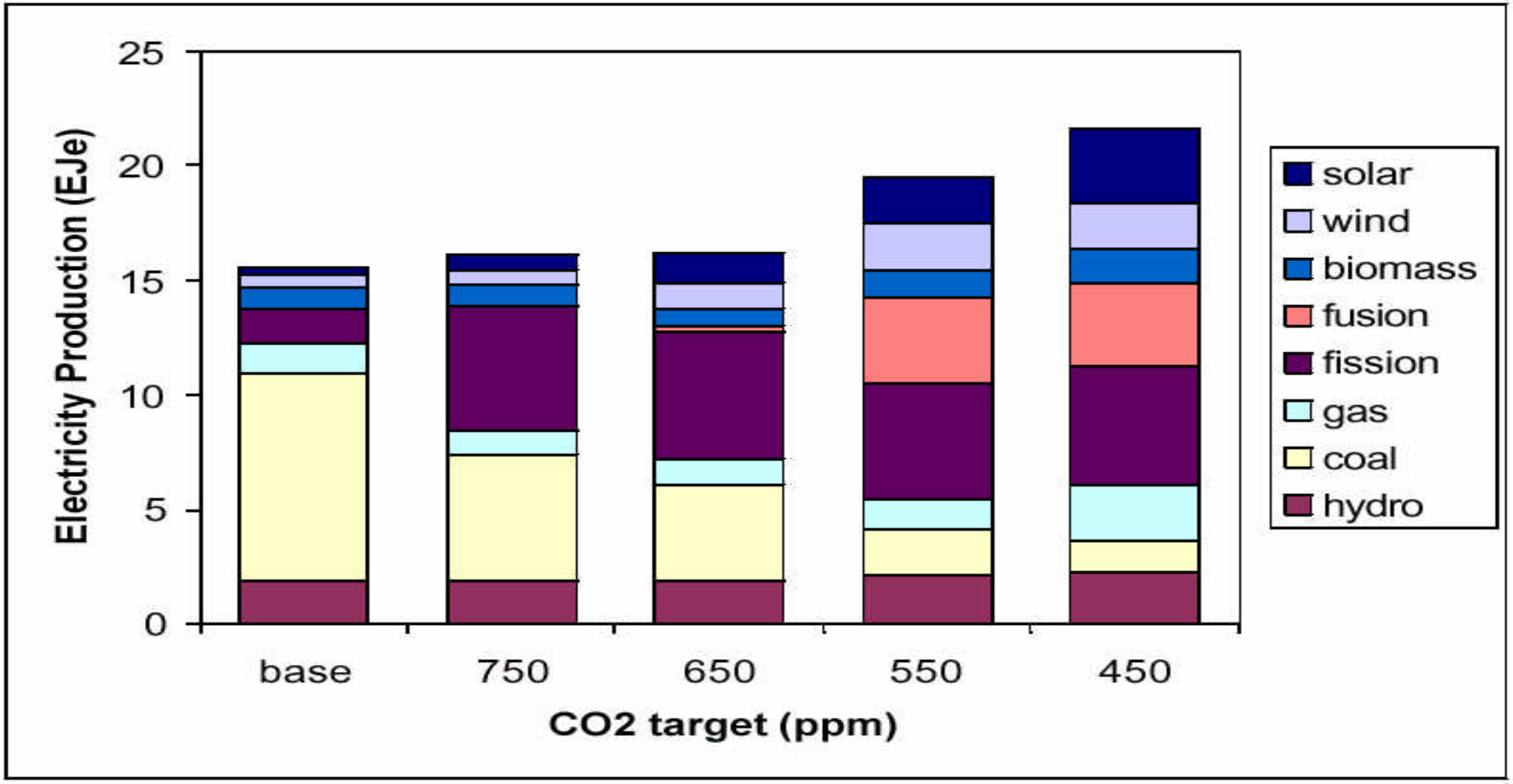
6.2 WEU, power gen.by source–year: *base case,ECN*



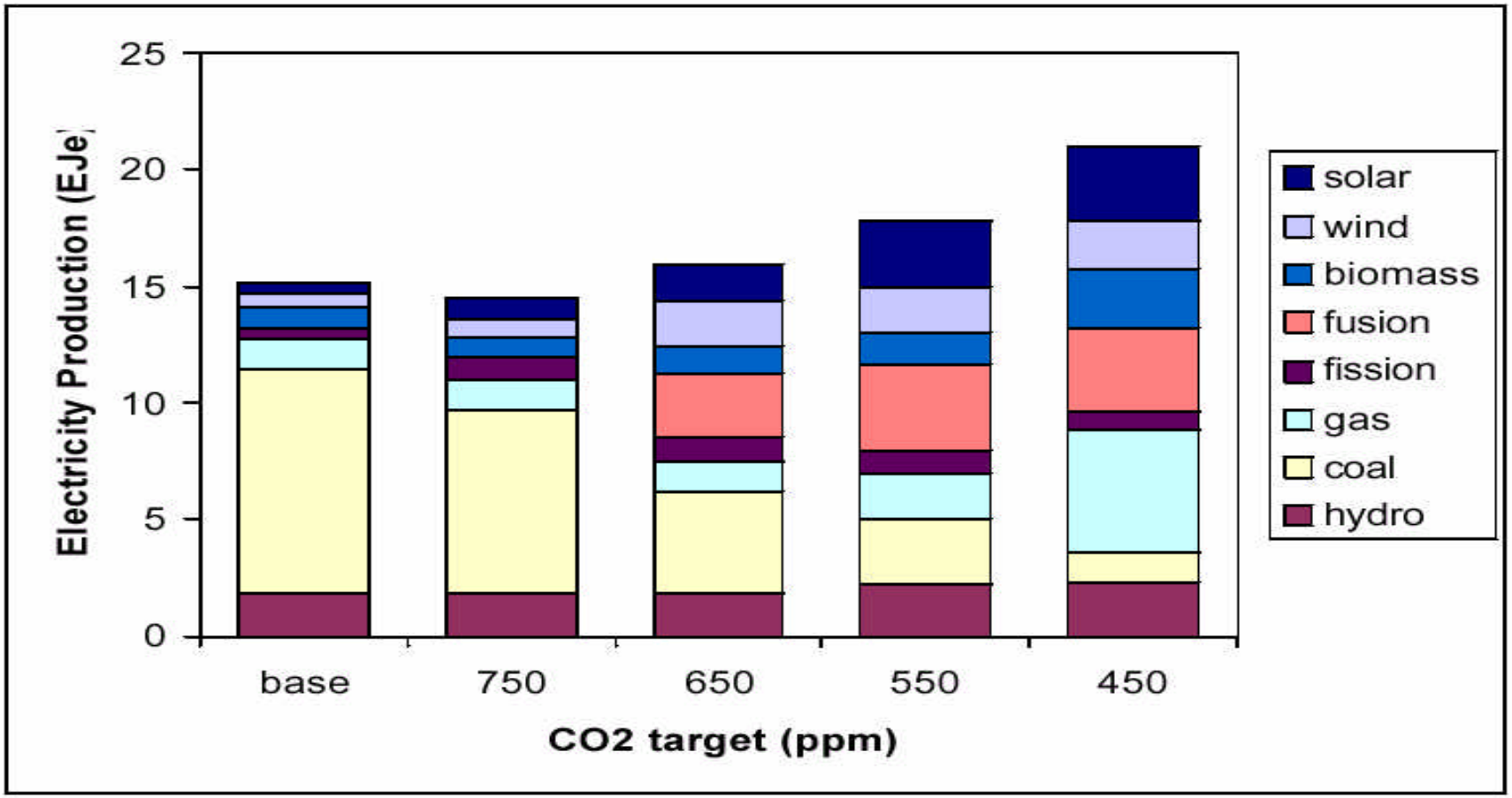
6.3 Western EU, time profile, CO2 emission *(ECN)*



6.4 Western EU, 2100, large role of fission (ECN)



6.5 Western EU, 2100, fission constrained (ECN)



6.6 Fusion as Part of the Energy System: tasks

What is the value / benefit of fusion power plants?

- with the traditional CBA carried out on long term scenarios with partial equilibrium technical-economic programming models for
  - + *a developed region (Western Europe)?*
  - + *a developing region (India)?*
  - + *the world?*
- are there other economic evaluation criteria, under which the value of fusion is higher?

What is the technical limit of use of fusion power plants? Mainly versus intermittent sources!

7.1 Approach

The fusion R&D community

- opens a dialogue with decision makers and the public, with their language,
- exposes its goals, if not its programs, to a sort of “peer review” from experts in different fields and external to the program,
- accepts the comparison with competing options on technical, economical, environmental and social aspects,
- accepts, at least implicitly, to respond or even to adapt its programs to indications coming from outside.

7.2 Basic rules

In order to produce fair comparison it has been decided to

- assess the competing options
- accept the same criteria
- produce comparable results
- use the same methods *(the best available or better ones developed on purpose)*
- rely on independent researchers

8.1 Ongoing activities and goals

- Assess, through multi-regional partial equilibrium technical economic models, potential and benefits of new energy options (2004):
  - *including fusion power plants for the fusion R&D community,*
  - *in alliances with external groups with similar goals,*
  - *in cooperation with the international effort on CC mitigation;*
- extend the assessment of direct and external costs to new plant system models (2002);
- contribute to
  - *EU ITER Site Studies on communication and awareness, local level,*
  - *IEA FPCC ESE and related Cooperative Programs,*
  - *Public Information Actions (see below).*

8.2 Provisional workplan to 2004

"The socio-economic studies will be continued beyond the on-going SERF3, focusing on the extension of European regional models to global multi-regional ones for the study of energy supply scenarios.

The assessment through such global multi-regional energy technology scenarios should demonstrate that the potential benefits of fusion power plants in the second half of the century far outweigh the investment in R&D required to make it available during the first half.

Some fieldwork on fusion in the public opinion and on suitable techniques for communication will continue as well.

The results from these studies will provide the requested information to the political level for future decisions on the orientation of the fusion program."

9. Public Information Actions, *F.Casci, CSU Garching*

EFDA web site: www.efda.org

- Exhibitions
- Fusion Expo
- CD – Rom
- EFDA Newsletter
- Information Fusion
- Fusion in Newspapers / Magazines
- Film on Fusion
- EFDA Reports
- Brochures