From EFDA to DEMO

Chris Ibbott
European Commission

DG Research and Innovation
Directorate K – Energy
Unit K6-001

Outline

- European Energy Roadmap 2050
- ITER – What, Why and When
- Electricity from Fusion – the long term goal
- Horizon 2020 – an important transition
- Conclusions

- **European Energy Roadmap to 2050**
- ITER – What, Why and When
- Electricity from Fusion – the long term goal
- Horizon 2020 – an important transition
- Conclusions

Policy initiatives

The realisation of fusion as a viable energy source is part of the long term EU vision of 2050 spelt out in the Strategic Energy Technology Plan (SET-Plan).

The European Commission has elaborated the "Innovation Union" flagship initiative, outlining a strategic approach to innovation, focusing on societal challenges such as energy security.

One of the priorities is to extend Europe's leadership in selected energy technologies, including fusion.
In June this year, President Barroso proposed to allocate 80b€ to research and innovation during 2014-2020, a significant increase over the 54b€ allocated for 2007-2013.

Near term Strategy to 2020

Main strategy focused on initiatives that are industry-led and aim to strengthen industrial participation in energy research and to accelerate the use of low-carbon energy technologies. Six technologies form the near term Initiatives: wind, solar, carbon capture and storage, bio-energy, nuclear fission and electricity grids.

Success in delivering on these will be driven by Innovation: in relation to this meetings agenda the Commission is pushing for a common European patent.

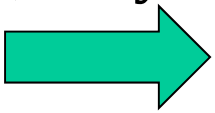
Note that fusion is only considered in the longer term.

In the longer term – to 2050

It is expected that 65% of passenger and light duty vehicles will run on electricity

All energy scenarios predict that electricity will play a greater role increasing by 36 to 39% on current levels

An Energy Roadmap to address this and provide a safe, secure, sustainable and affordable energy portfolio is being developed.

One certain fact, any de-carbonisation policy requires more electricity  **Fusion Power Plants**

- European Energy Roadmap 2050
- **ITER – What, Why and When**
- Electricity from Fusion – the long term goal
- Horizon 2020 – an important transition
- Conclusions

What is ITER?

Very simply, ITER is one of the most important and significant energy experiments in the world.

Why? Because ITER

- Is the worlds first power plant sized nuclear fusion experiment
- will demonstrate generation of significant amount of fusion power and control of high temperature plasmas
- will demonstrate crucial tritium production technology
- will advance many fusion power plant technologies such as steady state heating, remote handling, etc, etc, etc, etc
- ……

When?

- **As fast as possible! *(BUT more haste, less speed)***
- **~2000 experienced engineers and scientist plus many more in industry around the world are working to provide us with ITER**
- **Many thousand other engineers and scientist are working to ensure ITER operation will be a success**
- **Present planning puts ITER first plasma ~2019**
- **more importantly tritium breeding experiments are forecast for ~2027-30**

ITER **must** be a success

- European Energy Roadmap 2050
- ITER – What, Why and When
- **Electricity from Fusion – the long term goal**
- Horizon 2020 – an important transition
- Conclusions

- **The ultimate goal of the EU fusion Research programme is to develop the knowledge base required to build the first Fusion Power Plant.**
- **This ultimate goal has been unchanged for 3 decades. Although the EU fusion programme has been primarily a research programme, the "energy orientation" must become predominant in the future**
- **With the Energy Roadmap 2050 Fusion should demonstrate large scale electricity generation during the 2040's**
- **To meet this date the programme should be ready to construct DEMO by 2030 to 2035 – present ITER tritium operation planning fits well with this timeline.**
- **This implies a detailed engineering design for DEMO by 2030 at the earliest, giving 16 years for the conceptual and detailed engineering activities starting from the beginning of the Horizon 2020 programme.**

DEMO?

Significant work is still required to develop and to qualify the components and processes required to build the first Fusion Power Plant. Detailed gap-analyses have been carried out in 2009-2010, at least in the EU and in the US, with similar conclusions

A number of choices will have to be made before freezing the design of the next major facility(ies) after ITER, such as material test facilities, as well as:

- **Reference plasma scenario ⇒ Current Drive requirements, power handling (divertor)**
- **Coolant for in-vessel components ⇒ breeding blanket concept**
- **Maintenance scheme ⇒ plant architecture**
- **Structural and functional materials**

The validation of some of these choices will only be achieved in ITER, and the construction of DEMO will only start after this validation.

- European Energy Roadmap2050
- ITER – What, Why and When
- Electricity from Fusion – the long term goal
- **Horizon 2020 – an important transition**
- Conclusions

Several exercises have been performed:

- **Independent review of the possible JET contributions in the future**
- **Comments and recommendations from Industry (FIIF)**
- **Outline of a "strategic orientation" of the EU fusion programme**
- **Definition of possible (resource loaded) roadmaps till 2020**
- **Independent review of the "strategic orientation"**

A Commission proposal for the Euratom Horizon 2020 Research and Innovation programme has been prepared and it is expected that the Commission will adopt the proposal on the 30th of Nov.

Keep in mind that the discussion is still in progress.

The main activities can be summarised as:

Secure the success of future ITER operation

Technical

Further develop operational scenarios to ensure rapid and efficient start-up of ITER, which will require the operation of existing facilities; the main facility in Europe foreseen to achieve this objective is JET.

Develop predictive modelling tools.

Financial

Protect our investment by minimising the chances of unexpected technical problems.

People

Training of the "ITER generation", i.e. prepare (i) a cadre of experienced machine operators and scientists to exploit ITER and (ii) experienced engineers to finalise the DEMO design.

Secure the success of future ITER operation (cont'd)

Although this objective is self-evident, it is not certain that the activities in progress are optimised in this respect:

In Europe, we decided in 2005 to focus JET operation on points of direct relevance for ITER. A major 15 months shutdown was completed in April 2011 to install an "ITER-like wall" and to implement a series of upgrades (increased NBI power, high-frequency pellet injector, improved plasma control and diagnostics). A 2MW plasma was achieved in this new configuration already and gas inventory studies are under way.

Operating ITER, however, will require efficient collaboration between all ITER partners, and setting up an experienced team to do so will take years. This objective still has to be addressed.

Lay the foundations for fusion power plants (FPP)

The whole research and development programme is re-orientating itself to meet this objective with significant resources being allocated to:

- **Develop long pulse / steady state scenarios.**
- **Develop a scheme for heat and particle exhaust.**
- **Explore the potential of alternative configurations to ITER**
- **Qualify materials.**

Pre-conceptual design activities have started:
EFDA now has a department dedicated to Power Plant Physics & Technology (Head of Department – Dr Gianfranco Federici)
Main purpose of this work: to define and to steer FPP-relevant R&D.
Answer the questions: what exactly is FPP, and when do we need to start its construction? Industry (FIIF) has also expressed a wish to be part of the FPP activities at the earliest possible stage.

This phase is preparing for a proposed aggressive conceptual design activity under EFDA in the Horizon 2020 programme

Provide a basis for developing a competitive fusion industry

This touches on the heart of this conference

IPR is essential for a competitive industry.

Fusion is an innovative programme with three main elements:

- **the construction of ITER**
- **the design of DEMO**
- **the supporting research activities of the fusion laboratories**

Like other large research programmes such as CERN, ESA, DoE, fusion research in Europe has a responsibility to provide industrial access to our knowledge. We must maximise our technology transfer and provide quantitative added value to industry and society.

In the future we will be judged on our success.

- European Energy Roadmap 2050
- ITER – What, Why and When
- Electricity from Fusion – the long term goal
- Horizon 2020 – an important transition
- **Conclusions**

The EU is currently developing a new fusion roadmap.

Its focus is to define the framework programme 2014-2020 aiming at:

- **Regaining credibility for fusion.**
- **Ensuring the success of ITER i.e. ITER construction within scope, schedule and cost;**
- **Integrate industry in the DEMO design programme at all levels**
- **Implement a DEMO component development and validation programme**
- **Creating a competitive fusion industry and maximising added value from the programme**

Work in progress

Thank you for your attention