

# FUSION POWER

## A STRATEGIC CHOICE FOR THE FUTURE ENERGY PROVISION

Why is so much time lost for decision making?

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# Overall Energy Situation

Problematic situation; “squaring the circle?”

In the long run, major *perturbations* expected:

- considerable increase of world energy demand
- finiteness oil and gas; geopolitically ‘unstable’ regions  
→ higher prices...
- enhanced greenhouse effect (coal only with CO<sub>2</sub> sequest)
- energy efficiency & renewable sufficient?
- drive towards decentralized power; base load work horses
- revival of nuclear fission?
- hydrogen economy not really ‘solution’; energy *carrier*

# Need for Energy Research

Major challenge on long term scale:

- Energy is vital for society
- Sustainable energy provision not evident
  - Security of supply
  - Clean
  - Affordable
- Major uncertainties for context & technological solutions

→ Need much more energy R&D and urgently to deliver in  
time

# Need for Fusion Research

Because of uncertainties and challenges

- *Cannot afford to fail*
- *There is no silver bullet*
- *Need portfolio of energy-technology research*

→ *Irresponsible to stop or delay development of potentially successful source: **nuclear fusion***

# Views on Fusion Research

- Scientific progress fusion research remarkable
- ITER process 'bumpy' but good technical design
- Reactor orientation biggest promise for success
- Alternative-concepts & materials R&D needed
- Independent experts and industry supportive
- Utilities not interested because liberalization
- Fusion stands good chance for commercial electricity generation

# Realistic Time Frame for Fusion

- Middle of next century reasonable time table for *commercial fusion*

- ITER construction	8 - 10 y
- first ITER experimental campaign	10 y
- design DEMO	6 - 10 y
- DEMO construction	8 - 10 y
- test & measuring phase DEMO	10 y
- construction PROTO / FOAK reactor	10 y
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	50 - 60 y

- *Fast track* combines DEMO and 'old' PROTO;  
but still need for a FOAK!

# ITER History

- 1985 summit Geneva USA & USSR
- 1988-1990 ITER CDA; two divertors,  $R < 6\text{m}$
- 1992-2001 ITER EDA:
  - Stage 1: Rebut; bottom divertor,  $R > 8\text{m}$
  - Stage 2: Aymar-1 till 1998;  $\approx$  Rebut design, Cost 6 G €
  - Stage 3: Aymar-2 till 2001; ITER FEAT, Cost 3 G €
- 2001-2002 ITER CTA; support negotiations
- 2003-... ITER TA; idem

US leaves ITER in 1998-1999

2001-... ongoing 'Negotiations' on ITER site

# ITER-EDA Parameters

$P_{\text{fus}} (\text{nom})$	1500 MW <sub>th</sub>
$P_{\text{design}}$	2500 MW <sub>th</sub>
Burning duration	1000 s
$R_{\text{maj}}$	8 m
I	20 MA
Cost construction	~ 6000 MEuro



# ITER FEAT Parameters

- Long pulse duration  $\sim 300\text{-}500\text{s}$  with  $Q > \sim 10$
- Demonstrate current drive with  $Q \sim 5$
- Aim for ignition
- $P_{\text{fus}} = 500 \text{ MW}$  i.s.o.  $1500 \text{ MW}$
- $R \cong 6\text{m}$  i.s.o.  $8 \text{ m}$
- $I \sim 13 \text{ MA}$  i.s.o.  $20 \text{ MA}$
- Modular and evolutive construction

# ITER-site negotiations

- < 2003, only three partners: EU, JP, RF
- Originally 4 sites: CAN, FR, ES, JP
- CAN drops out; EU selects Cadarache
- 2003: US returns, CH and S Kor join negotiations
- End of 2003: **deadlock**
  - EU, CH and RF favor Cadarache
  - JP, US and SK prefer Rokasho-mura
- Early 2004 'technical' evaluation 9 topics
- Middle 2004 EU proposal 'Broader Approach'  
Winning site pays 50% ITER + 50% IFMIF

# Reflections and Observations on Negotiations

- < 2003, three partners expressed 'willingness' to build machine: 50%, 35%, 15%
- < 2003, EU never thought JP wanted to host ITER; JP negotiations 'misinterpreted'
- Does international politics play a role (US↔FR)?
- Did Europe make the 'wrong' choice?
- Does US science politics (lin accel) play a role?
- US approach 'strange':  
only 10% in ITER and dropping of FIRE?

# Way out of these negotiations?

- Ph. Busquin announces 'breakthrough'  
cfr 'Broader Approach'
- JP has not changed position...
- Way out?
  - 'dissolve' present ITER club;
  - one candidate host to propose to build alone;
  - invites other partners (also worldwide) to join new club
- But no need for two ITERs !
- Non-ITER site to host IFMIF + complementary fusion experiment

# Conclusions

- Major energy-related challenges & uncertainties  
energy is a **strategic** issue !
- Much more energy R&D needed
- Fusion development so far very successful  
→ *fusion to be part of energy R&D portfolio*
- Current funding of fusion R&D too low!
- Pharmacist's scale approach unsuccessful
- Stalemate ITER siting shame for fusion development
- Break gridlock and get ITER built 'somewhere'!