FR13- Young Generation Event

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YG activities at FR13

- Wednesday afternoon working groups of 25 participants with 6 themes :
  - Sustainability ,Innovation ,Simulation, Safety, Economics,Public Acceptance
  - Content and scenario were worked out
  - Spokespersons were selected
- Wednesday night Social event in Paris sponsored by CEA
- Thursday afternoon Young Generation Event panel

Scenario

"Mr Earth has unresolved sustainability problems.
A team of young experts try to find a solution "

- Scene 1 : Dr Sustainability presents the case
- Scene 2 : Dr Innovation comes with a panel of solutions
- Scene 3 : Dr Simulation bounces and explain how he can fulfill Dr Innovation's scheme and the limitations
- Scene 4 : Dr Safety presents his perspective on the solution
- Scene 5: Dr Economics presents his position on proposed scenario
- Scene 6 : Dr Public Acceptance present the associated communication scheme

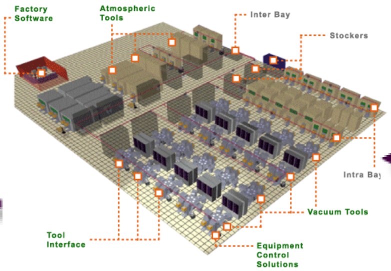
Sustainability

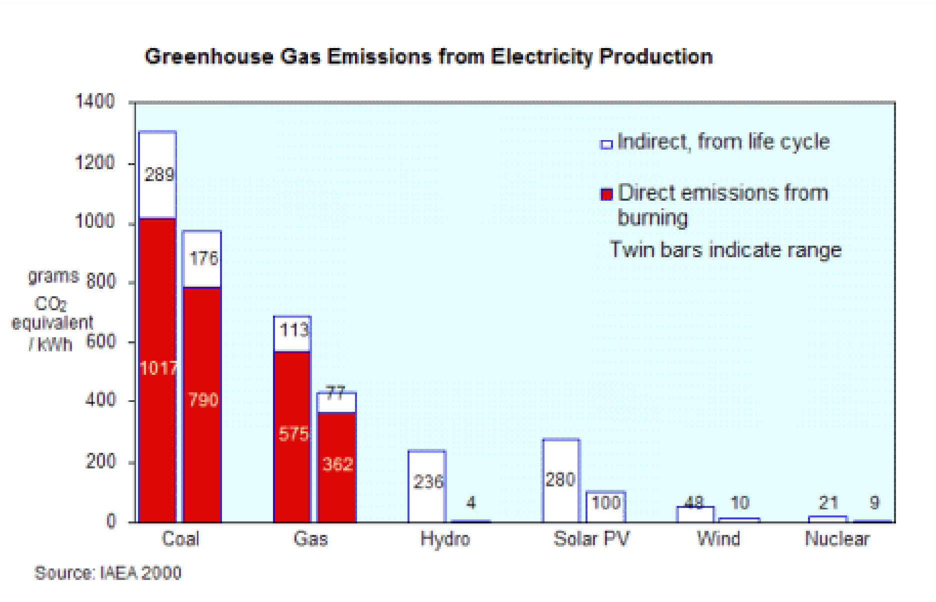
Sustainability (Su)

- Definition 1: Reaching todays needs without compromising the needs of the future.
- Definition 2: Maintaining the happiness of the society.

- Sustainability and Energy :
  - Earth's Energy Outlook
  - CO_2 Green House effect
  - Resources
  - Wastes

Life Cycle Anaysis (LCA)





Global

Global Problem --> local concerns and solutions

- Solutions are connected to changes in society:
  - Public outlook on environmental stewardship differs between societies
  - Necessary vs Unecessary Use
- How far in the future is sustainability an issue? 100 years, 1000 years, 10,000 years?

Wastes and Resources

- Inherited Waste
- There is no such thing as Zero Waste
- Every Industry, Every Electricity Source produces waste
- Waste processing (even recycling) produces waste

- Inherited Resources
- Access to electricity
- Water resources and Energy
- Access to Energy

Decision Making

- Public Acceptance
- Economics
- Environmental
- Risk Factor

- Young Generation Impact?

Sustainability (Su)

- Sustainable Energy for the Future – is our Responsibility
- Life Cycle Analysis – is a way how to quantify the emissions in order to reduce them
- Global Solution – needs to be applied step by step
- Wastes and Resources - must be minimized and conserved, resp.

- Can we make our current lifestyle sustainable?

Innovation

Innovation for Sustainable, Safe and Economical Electricity

Context

- Fast Reactors turn out to be promising solutions as regard sustainability
  - better use of fissile material resources
  - potential for minor actinides transmutation

- Great innovations required to cope with the expectations for future reactors, notably in the field of :
  - Sustainability
  - Safety
  - Economics

Innovation needed in safety

→ Provide clear, simple and convincing demonstration

- Suppress risks or intrinsically limit them
  - e.g. “low void effect core”
- Reinforce severe accident prevention
  - e.g. favorable natural behavior, grace periods
- Consideration of severe accident in the frame of the defense in depth
- Lessons from reactor accident (e.g. FKS) to be addressed
- All aspects to be taken into account at design stage
  - environmental impact, human and organizational factors, non proliferation, malevolence…

Innovation needed in economics

→ Provide simplified and optimized designs

- Anticipation of operation constraints to increase availability
  - E.g. favor repair and inspection capabilities
- Extend reactor lifetime
- Cost management at design stages :
  - on the whole plant lifecycle
  - on the whole fuel cycle
  - with consideration of the market conditions (number of units…)

Challenges in Innovation for Fast Reactors

- Availability of fundings to support innovation on long durations
- Conciliate safety objectives (not negociable) and reactors’ economic competitivity
- Resistance to change
- Licensing of innovative features
- Attracting new talents
- Public acceptance

Assets for innovation

- International collaboration and sharing of R&D efforts
- Some available experience feedback
- Time available to explore new ideas and progressively validate most interesting ones
- Innovative projects mixing newcomers and experienced engineers
- Recent scientific progress in other fields and industries (e.g. materials, simulation, I&C,…)

Simulation

Simulation (Si)

- Ultimate goal: abundant, cheap and environmentally friendly energy
- Role of simulation

  → accurate prediction of systems' performance

  – Reduce costs
  – Improve safety
  – Help defining policy choices
    - Reactor technologies
    - Fuel cycle strategies

Simulation

- Matching methods to rapidly developing (and changing) computing infrastructure/architecture
- Combining different disciplines (multi-physics)
- Reduce reliance on experiments
  - Can we, some day, live without them?
- Increasing specialization (division of labor)
  - Efficient interfaces and integration
  - Not trivial to see the big picture
  - “Code as a black box” problem
- Making sense of the results
  - Codes generate gigantic amounts of data

Simulations as policy making aid

- Energy policy decisions need to be made <u>now</u>
  - The effects will be spread over many decades
  - Today’s reactors “live” 60y or more
- Severe uncertainty in input data
  - No way of predicting future economic growth, natural disasters, climate, crises, wars, etc.
- How simulations can help making “wise” technology and fuel cycle choices?

Concluding remarks

- Experiments will always be needed
  - Crucial to maintain knowledge/expertise
- "Brute force" (MC, DNS, MD) simulations
  - Will become increasingly important
  - Always need for innovative modeling approaches
  - Always keep in mind the big picture
  - Guided by Sensitivity & Uncertainty (Cost/Benefit)
- Interfacing between engineering and policy decisions

Safety

Safety Insights

- Safety is the key for nuclear power acceptance, but philosophy and money often stand in the way
- Humility is required when facing safety issues
  - The next generation cannot rely solely on the last generation's proof of safety

Competing Safety Philosophies

- The goal for everyone is the same: **Convince people that nuclear energy can be safe enough, yet conflicts remain:**
  - Deterministic/Probabilistic
  - GenIII/GenIV,
  - Gas/Salt/Sodium
  - Frequentist/Bayesian
- Don’t systematicly oppose safety approaches, safety level of reactors
  - **There are only good convincing safety demonstrations and bad ones**.

Safety Concerns Cross Borders
Safety Knowledge Should as Well.

- **Humility** is required when **facing safety issues**:
  - we don’t know everything,
  - **need of experiments** (to confirm the progress in simulation)
  - a **worldwide continuous progress** in safety studies.
- In fact safety is a general issue: one nuclear accident anywhere has a wordlwide impact on every nuclear country.
- The world can’t accept lowcost safety, nor can it fund redundent expensive tests around the world

Zero Risk Does Not Exist

- YG is defined as less than 35 years
  - In 35 years 3 major nuclear accidents happened
- What is acceptable for the last generation may be unacceptable for the next one
- Spread safety culture and understanding can only happen through education and **involvement** of young nuclear professionals

Safety Summary

- Competing Safety Philosophies
- Safety Concerns Cross Borders, Safety Knowledge Should as Well.
- Zero Risk Does Not Exist

Economics

Fast Reactors : a long term economical option

- Electricity : part of public infrastructure that needs public financial support
- needs to be affordable and security of supply has to be ensured
- Short term and long term solutions
- Nuclear is competitive because of the physical reasons (great energy density compared all other technologies known) on the long term
- Fast Reactors are the only long-term option:
  - for full actinides usage, solving the long-term waste problem,
  - and for uranium/thorium resource problems

Short term support for first movers

- Subsidy for construction
- Guarantuee of operation on lifetime of the plant
- Insurance
- Price Guarantee

-> On long term perspective, nuclear plants should be able to support themselves without any government funding

Obstacles to economical rationality

- Irrational safety regulation could politically make it uncompetitive
- irrational measures related to health impact

  -> identify what is really dangerous

  -> research helps reducing fears of the people

  -> public acceptance

  -> long term governmental support

Long term outlook and recommendations

- Financing research :
  - Improve on all levels, including economics
  - main stream and game changing concepts
  - keep connection with basic science

- Convey the competitiveness of nuclear
  - Linked to physics
  - Value of goods depends on public perception

Public acceptance

Keep in mind

- Communicate simple messages
- Plain language
- Tailor message to audience (children, people in vicinity, public in general…)
- Listen to the public

- Discussion groups, media, citizen consultation

A simple concept

- Communicate on :
  - nuclear basics
  - differences for FR compared to prev. Generations
  - waste issue improvement
  - uranium supply security
  - Energy demand will always rise

Improvements easy to communicate

- Waste
- Overall efficiency of plant
- Resource utilization
- Side benefits (H-production)
- Breed and/or burn

What are the issues ?

- Risk can only be minimized
  - Avoid communicating with probabilities
  - Explain solution for worst case scenario
  - Inherent and passive safety systems in place
- Economics
- First of a kind technology
  - Proof of principle is given

IT’S NOT RUNNING BY ITSELF – FUEL IT!