Topics in Fusion Socio-Economics

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UCSD

Scientific Context

- Multi-disciplinary Industrial Ecology
- Formal Systems Engineering begins with “requirements specification”

Fission as Precursor

- Ref. S. Levy, *et al.,* ``Technology Goals
- For Generation IV Nuclear Energy Systems," *Trans. ANS,* 85, (Nov. 2001) 58.
- http://gen-iv.ne.doe.gov/pdf/GENIVGoalsGRNS.pdf

Long-Term Planning

- Naturally a governmental function
- *e.g.,* energy/climate interaction
- Incorporates considerations of
  - intergenerational equity
  - sustainability
  - benefit/cost/risk analysis
- ref. C. Starr, ``The Ultimate Uncertainty—Intergenerational Planning,'' *Risk Analysis* 20, 6 (2000) 793.

ARIES Systems Code (ASC)

- Contributes to fusion design studies
- Integrates physics/engineering/costing
- Update in progress
- Benchmarking activity is timely

  IEA Task 7

US Sources of Cost Projections

- Nuclear Energy Cost Data Base (NECDB) → J. Delene → ASC
- EPRI Technical Assessment Guide (TAG)
- USDOE Energy Information Administration (EIA)

  -Annual Energy Outlook, AEO20xx (20 year rolling horizon)

International Cost Comparison

- Inhibited by differences in assumptions
- Ref. NEA/IEA, ``Projected Costs of Generating Electricity" (Update 1998).
- Ref. IAEA, ``Economic Evaluations of Bids for Nuclear Power Plants 1999 Edition," Technical Report Series No. 396 (2000).

Cost Comparison

- Reconcile different Cost Breakdown Structures
- Compare line by line as needed
- Direct + Indirect --> Internal Cost
- Financial rules yield levelized, life-cycle COE projection
- Consider External Cost/Benefit

Financial Underpinnings

- Traditional (pre-deregulation) financing
- Government as ‘partner’
- Merchant plant
- Government as credit-worthy customer

  to reduce risk (proposed for fission Gen-IV) of capital-intensive projects

Consistent Cost Projections Enable Energy Modeling

- Energy scenarios ask "What if…?"
- Project future energy-source mix
- Project market penetration of new technologies, *e.g.,* fusion
- Decision-making under uncertainty
- Portfolio analysis

IEA Task 7

- Ref. I. Cook, *et al.*, ``Prospects for Economic Fusion Electricity,'' ISFNT6
- Discussion of Task 7 later

Major Long-Term Energy Planning Uncertainties

- Technological
- Economic
- Environmental health
- Social/public acceptance

Source: EPRI, ref. C. Starr, NN, (Feb. 2002) 31.

Technological Uncertainties

- Unexpected go-no-go technical issues
- R&D scope greatly underestimated
- Unexpected siting requirements
- Low-level effluent public risk perception
- Unsettled effluent management criteria
- Major earthquake functional survival
- Sabotage/terrorist attack resistance
- National security implications

Source: EPRI

Economic Uncertainties

- Cost of money
- Much delayed financing
- Delay of critical support technology
- Imposition of CO_2 sequestration
- Cooling restrictions: air *vs* water
- Unexpected regulatory requirements
- Unexpected critical resource restrictions
- Unexpected alternative competition

Source: EPRI

Environmental Health Uncertainties

- Unexpected air/water/land pollution limitations
- Uncertain global climate-related restrictions
- Vague land and sea use restrictions
- Public radiation exposure perceptions
- Unexpected ecological concerns

Source: EPRI

Social/Public Acceptance Uncertainties

- Unexpected changes in social value priorities
- Unexpected changes in living patterns such as rapid increase in longevity
- Unexpected changes in demographics
- Unexpected public transportation shifts
- Major shifts in city planning
- Public phobias/fear of technology
- Weapons proliferation concerns
- Energy-related national security issues

Source: EPRI

Summary

- Much interesting work to be done, pending much tedious work in progress.
- This activity contributes to ``The Case For Fusion'' such that care must be taken to avoid confusion between analysis and advocacy.