

# **NERAC MEETING PRESENTATION**

September 30, 2002

# **THE GEN IV ROADMAP PROGRAM**

**Professor Neil Todreas**

# Presentation Schedule

- |                 |                                    |   |  |
|-----------------|------------------------------------|---|--|
| <b>(30 Min)</b> | <b>Dave Wade</b>                   | - | <b>Dose Comparisons of once-thru and closed fuel cycles.</b> |
| <b>(30 Min)</b> | <b>Ralph Bennett</b>               | - | <b>Roadmap Overview</b>                                      |
| <b>(15 Min)</b> | <b>Neil Todreas</b>                | - | <b>GRNS Perspectives and Recommendations</b>                 |
| <b>(75 Min)</b> | <b>Neil Todreas /<br/>Sal Levy</b> | - | <b>NERAC DISCUSSION</b>                                      |

# Generation IV Roadmap NERAC Subcommittee (GRNS)

**Bobby Abrams\***  
Duke Engineering

**Douglas Chapin**  
MPR Associates

**B. John Garrick**  
Independent Consultant

**Dan Kammen**  
University of California-  
Berkeley

**Salomon Levy \*\***  
Levy & Associates

**Ted Marston**  
Electrical Power Research  
Institute

**Bill Naughton**  
Exelon

**Neil Todreas \*\***  
Massachusetts Institute of  
Technology

\* Resigned, July 2002

\*\* Co-chair

## GRNS Recruited Working Group Co-Chairs

**Jack Devine**

**TWG-1 Water Cooled**

**Phil Hildebrandt**

**TWG-2 Gas Cooled**

**Steve Rosen**

**TWG-3 Metal Cooled**

**Bill Rasin**

**Evaluation Methodology Group (EMG)**

## NERAC Members on Roadmap Team

**Mike Corradini**

**Co-Chair, Economics Crosscut Group;  
Member, TWG-1 Water Cooled**

**Andy Klein**

**Co-Chair, Energy Products Crosscut Group  
Member, TWG-4 Non Classical**

**John Taylor**

**Near Term Deployment Committee**

## Roadmap Highlights

- A) **The GEN IV Roadmap is an international consensus identification of (a) the potential nuclear energy systems which could be developed for GEN IV and (b) their needed viability and performance phase R+D needs.**
  
- B) **The GEN IV Roadmap includes all identified R+D needs for each system but does not adopt the fundamental premise that the success of GEN IV system development depends heavily on continued success of currently operating nuclear power plants and the near term deployment of new units. Hence, the potential flow of R+D results from the NTD units to GEN IV systems (and the inverse) is not an integral element of the roadmap strategy. The U.S. Advanced Fuel Cycle Initiative also is not explicitly recognized in the Roadmap.**

## Roadmap Highlights (cont.)

Hence,

C) **The GEN IV Roadmap is not a U.S. GEN IV R+D program.**

D) **Closed cycle R+D is a central component of the Roadmap**

– **Not uranium resource driven**

**but**

– **waste management driven introducing the following challenges:**

- **Achievement of economic, very low processing losses (of actinides), proliferation acceptable separation strategies.**
- **Achievement of competitive capital costs for needed fast spectrum reactors.**

## Roadmap Highlights (cont.)

- E) The proposed R+D scope, schedules and costs are highly uncertain and almost certainly optimistic. Infrastructure and demonstration facility needs are not yet identified.**
  
- F) Communication of the nature, basis, and substance of the Roadmap recommendations needs to be communicated to relevant stakeholders.**

**However,**

- G) The GEN IV Roadmap provides an acceptable basis for the DOE to work with the GIF and other interested countries to develop collaborative research activities on Generation IV nuclear systems, addressing observations and guidance provided by the NERAC.**

## GRNS Recommendation for a NE Long Range Program

- **The Issue:** NE is working on a US NTD and GENIV program. The linkage between those two needs to be emphasized. However, the selected GEN IV systems do not embody truly advanced features of the type relative to the goals envisioned desirable at the outset of the Roadmapping effort (Oct 1999).
- **Why the Issue Exist:** First there is no recent DOE history of funding for truly innovative reactor systems. Hence there was little for the GEN IV Roadmap experts to draw upon. Further even though the Roadmap looked out to 2030 given the criteria and competition with other coolant concepts, the Roadmap process inevitably focused upon whole concepts which could reference a reasonably developed technical basis.
- **Principals of the Corrective Action:** A new program with a time horizon beyond the selected GEN IV concepts needs to be defined. The program should identify approaches, having considerable promise, and should focus work on the major feasibility questions.
- **Suggested Program Elements:** Allocate a fixed position – say 25% - of future NERI budgets to advanced (truly) nuclear energy concepts. That will focus available real money on the goal. Run a yearly, summer advanced concept camp for students dedicated to creating novel approaches. This camp properly directed by both faculty and researchers for laboratories and relevant industrial units could both generate ideas and create the excitement which could jumpstart the recruitment of students to our field. The approximate cost of a month long program for 20 students is in the order of \$250 – 300K.

## NERAC ACTIONS RECOMMENDED BY GRNS

- **The NERAC endorse:**
  - 1) **The GEN IV Roadmap as an acceptable basis for the DOE to work with the GIF and other interested countries to develop collaborative research activities on Generation IV nuclear systems, subject to DOE addressing the observations and guidance provided by the NERAC.**
  - 2) **The observations of the GRNS on the Roadmap.**
  - 3) **The establishment of a student advanced concept summer camp.**
  
- **The NERAC establish:**
  - 4) **A subcommittee (to succeed the GRNS) composed principally of NERAC members to review the strategy and implementing programs of the US GEN IV Program, when it is established and on a subsequent ongoing, periodic basis. (This NERAC subcommittee could be formed in conjunction with the AFCI committee or it's function could be added to the AFCI committee's charter).**
  - 5) **A technically expert group of reviewers independent from DOE contractors and participants to advise this NERAC subcommittee and the DOE of the appropriateness and progress of the US GEN IV program.**

## GRNS Observations

	GRNS Viewpoint	DOE Action Needed	Recommendation to NERAC
<b>Context</b>	<p>#2 – NTD/AFCI being pursued</p> <p>#3 – GRNS did not review AFCI</p> <p>#6 – GIF formation noteworthy</p>	<p>#1 – NTD support</p> <p>#4 – Integration of programs</p> <p>#5 – Communication to stakeholders</p>	
<b>Content</b>	<p>#7 – Number of concepts needs pruning</p> <p>#8 – Demonstrations scope needs definition</p> <p>#9 – R+D definition – uncertain and optimistic</p>		
<b>Execution</b>	<p>#10 – US program R+D definition just beginning</p>	<p>#13 – Examine who in government should fund some programs</p>	<p>#11 – Roadmap an acceptable basis for US program definition</p> <p>#12 – Future review structure needed</p>

## GRNS Observations on Roadmap Context - 9/20/02

- 1) **The development of advanced nuclear energy systems in the U.S. will depend greatly on the continued success of currently operating light water nuclear power plants and the ordering of new installations in the short term. DOE needs to give those immediate objectives the highest priority and any additional support they require to assure their success.**
  
- 2) **DOE is pursuing two initiatives to encourage a greater use of nuclear energy systems. The initiatives have been reviewed by NERAC Subcommittee on Generation IV Technology Planning (GRNS) and they are:**
  - **A Near Term Development (NTD) Roadmap which is in the process of being implemented and which was approved by NERAC. NTD identifies six nuclear plant designs with the potential for commercial deployment in the U.S. by 2010. All will operate on the existing once-through fuel cycle. DOE, through its “Nuclear Power 2010 Initiative” has taken action to implement the NTD Roadmap, in cooperation with U.S. industry.**
  
  - **A Technology Roadmap for Generation IV Nuclear Energy Systems which is described in a report distributed to NERAC and which is to serve as the framework to start to negotiate joint Research and Development (R&D) programs among the ten countries which have come together to form the Generation IV International Forum (GIF). The objective for Generation IV advanced nuclear energy systems is to have them available for international deployment before the year 2030.**

## **GRNS Observations on Roadmap Context - 9/20/02** **(cont.)**

- 3) **DOE is getting ready to launch an Advanced Fuel Cycle Initiative which will be discussed with NERAC on September 30,2002. The purpose of this initiative is to develop highly effective and economical means to deal with nuclear waste management. GRNS did not participate in its formulation.**
  
- 4) **All three initiatives above need to be integrated to avoid overlaps and to define and modify their technological interrelationships as a function of time and progress.**
  
- 5) **Due to the significance of the Generation IV Technological Roadmap plans, a concerted effort needs to be made to communicate with other stakeholders including Congress, the Administration, the NRC, ACRS, environmental groups, anti-nuclear groups and the general public about the nature, basis and substance behind the Roadmap recommendations to solicit support for the agreed upon R&D effort. The process should provide for a process that allows for changes in the Roadmap based on this dialogue.**
  
- 6) **DOE is to be commended for its efforts to reach an international consensus on the formulation of a GEN IV Roadmap. The bringing together of a diverse group of over 100 international experts with different backgrounds and experience from ten different countries is particularly noteworthy.**

## **GRNS Observations on Roadmap Content - 09/22/02**

- 7) **Six systems were selected to Generation IV by the GIF: Gas Cooled Fast Reactor System (GFR), the Lead-Cooled Fast Reactor System (LFR), the Molten Salt Reactor (MSR), the Sodium-Cooled Fast Reactor (SFR); the Supercritical Water-Cooled Reactor System (SCWR) and the Very-High-Temperature Reactor System (VHTR). The Roadmap describes R&D programs required by all six concepts to reach the viability and performance stages.**

**This is too many concepts to be effectively pursued in the US GEN IV R&D program. GRNS has provided preliminary advice to DOE on such a strategy and, for example, has recommended no participation on the Molten Salt Reactor, focus only on the key viability issues of the Supercritical Water-Cooled thermal spectrum Reactor and very targeted participation beyond fuel cycle work on both the Sodium-Cooled fast Reactor (i.e. capital cost reduction) and the Lead-Cooled Fast Reactor (i.e. corrosion control and polonium management).**

- 8) **The Roadmap R&D for the six concepts is limited to the viability and performance phases and did not include their demonstration. Developing specific demonstration needs to be accomplished for selected concepts in order to achieve the industrial participation required to assure actual use of the Generation IV systems. The US roadmap effort needs to recognize that the demonstration scope will require significant DOE investment and support.**

## GRNS Observations on Roadmap Content - 09/22/02 (cont.)

- 9) **The proposed R&D scope, schedules, and costs are not detailed enough to pass judgment on their merits. The GRNS notes that these are not the result of a detailed planning process and are highly uncertain and almost certainly highly optimistic. Further because of the long term nature of the proposed R&D, it is very difficult to anticipate the downstream R&D which will be needed based on the results of early R&D efforts. Necessary specific facilities are not identified and their schedules, capital and operating costs, and locations are not provided. The forthcoming discussions among GIF members need to address such details in order to be able to prioritize and schedule the Roadmap R&D appropriately and support DOE budgeting and planning activities.**

# GRNS Observations on Execution of the Roadmap

09/22/02

- 10) The hard task of determining the R&D tasks and their schedules, the degree of participation by each country and the agreed means to measure progress and make appropriate changes is just beginning. The success of the Roadmap will be very dependent upon the organization, selection, and conduct of the R&D projects.
- 11) NERAC should endorse the GEN IV Roadmap for use by DOE to develop joint R&D programs with GIF members and other interested countries. When agreement is reached on most joint R&D programs and a definitive U.S. strategy is developed with respect to Generation IV systems, NERAC should review the strategy and the implementing programs. NERAC should continue to periodically review the progress and resultant adjustments of the GEN IV R&D and the complementary NTD and AFCI R&D programs on an ongoing basis.
- 12) The currently scheduled evaluation of the progress on the Roadmap by GIF experts once a year is inadequate. Quarterly reviews of the U.S. program and progress may be more appropriate and they should involve reviewers independent from DOE contractors and participants.
- 13) There are R&D programs included in the Gen IV Roadmap, which are likely better funded by other organizations. For example, it is proposed to develop a non nuclear-coupled thermo chemical hydrogen closed loop experiment. This process is best evaluated by the government organization involved with the production of hydrogen. Similarly, there are programs to improve the handling, storage of spent fuel, which right now are the responsibilities of the power generators and the Yucca Mountain Project. DOE should review the Gen IV roadmap and make appropriate revisions.