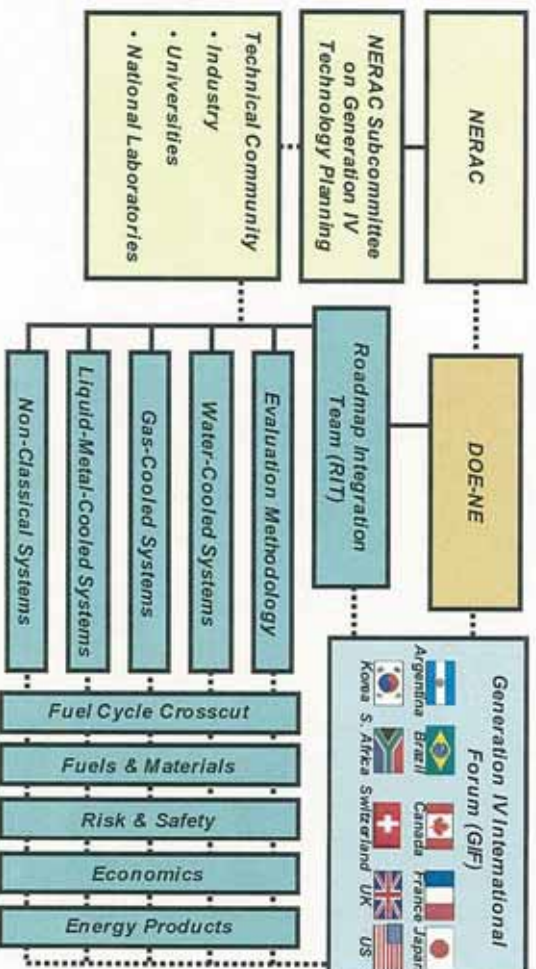


The Generation IV Roadmap Project

As the Generation IV goals were being finalized, preparations were made to develop the Generation IV technology roadmap. The organization of the roadmap is shown in the figure at the right. The Roadmap Integration Team (RIT) is the executive group. Groups of international experts were organized to undertake identification and evaluation of candidate systems, and to define R&D to support them.



In a first step, an Evaluation Methodology Group was formed to develop a process to systematically evaluate the potential of proposed Generation IV nuclear energy systems to meet the Generation IV goals. A discussion of the Evaluation Methodology Group's evaluation methodology is included in this report. At the same time, a solicitation was issued worldwide, requesting that concept proponents submit information on nuclear energy systems that they believe could meet some or all of the Generation IV goals. Nearly 100 concepts and ideas were received from researchers in a dozen countries.

Technical Working Groups (TWGs) were formed—covering nuclear energy systems employing water-cooled, gas-cooled, liquid-metal-cooled, and nonclassical reactor concepts—to review the proposed systems and evaluate their potential using the tools developed by the Evaluation Methodology Group. Because of the large number of system concepts submitted, the TWGs collected their concepts into sets of concepts with similar attributes. The TWGs conducted an initial screening, termed *screening for potential*, to eliminate those concepts or concept sets that did not have reasonable potential for advancing the goals, or were too distant or technically infeasible.

Following the screening for potential, the TWGs conducted a *final screening* to assess quantitatively the potential of each concept or concept set to meet the Generation IV goals. The efforts of the TWGs are

briefly presented in this technical roadmap report. The TWG Reports are included in their entirety on the Roadmap CD-ROM, along with the reports of the other groups.

A Fuel Cycle Crosscut Group (FCCG) was also formed at a very early stage to explore the impact of the choice of fuel cycle on major elements of sustainability—especially waste management and fuel utilization. Their members were equally drawn from the working groups, allowing them to compare their insights and findings directly. Later, other Crosscut Groups were formed covering economics, risk and safety, fuels and materials, and energy products. The Crosscut Groups reviewed the TWG reports for consistency in the technical evaluations and subject treatment, and continued to make recommendations regarding the scope and priority for crosscutting R&D in their subject areas. Finally, the TWGs and Crosscut Groups worked together to report on the R&D needs and priorities of the most promising concepts.

The international experts that contributed to this roadmap represented all ten GIF countries, the Organisation for Economic Cooperation and Development Nuclear Energy Agency, the European Commission, and the International Atomic Energy Agency.

Evaluation and Selection Methodology

The selection of the systems to be developed as Generation IV was accomplished in the following steps:

1. Definition and evaluation of candidate systems
2. Review of evaluations and discussion of desired missions (national priorities) for the systems
3. Final review of evaluations and performance to missions
4. Final decision on selections to Generation IV and identification of near-term deployable designs.

The first step was the collective work of the roadmap participants and the NERAC Subcommittee on Generation IV Technology Planning over a one-year period. It was concluded with a broad consistency review across the candidate concepts, and reviewed by the Subcommittee in early April 2002. The latter three steps continued to be advised by the Subcommittee but were increasingly taken up by the GIF members in a series of meetings in the first half of 2002, culminating in the selection of six Generation IV systems by the GIF. The entire process is summarized below, beginning with a detailed explanation of the evaluation methodology in the first step.

The use of a common evaluation methodology is a central feature of the roadmap project, providing a consistent basis for evaluating the potential of many concepts to meet the Generation IV goals. The methodology was developed by the Evaluation Methodology Group at an early stage in the project. The basic approach is to formulate a number of factors that indicate performance relative to the goals, called criteria, and then to evaluate concept performance against these criteria using specific measures, called metrics.

Two evaluation stages were employed, screening for potential and final screening. The screening for potential evaluation was designed to eliminate concepts that lacked sufficient potential, based on the TWG's judgment of their performance against the evaluation criteria. The final screening evaluation was performed for concepts that passed the screening for potential and was designed to support selection of a small number of Generation IV concepts. This final screening employed a more detailed and quantitative set of evaluation criteria than the screening for potential. Numerical scales were employed for a number of the criteria, and weights were

assigned to the criteria associated with each goal. The scales were established relative to a representative advanced light water reactor baseline. To complete the selection process, the GIF members considered the evaluations and eventually selected six to become the basis for Generation IV. They also considered a number of plant designs that had good potential for deployment in the near term, and selected 16 such designs for recognition as International Near-Term Deployment (INTD). Both lists are presented in the next chapter.

The following figure presents the four goal areas, with the eight goals arranged under them, and the 15 criteria and their 24 metrics assigned to the various goals. The criteria and metrics are grouped to indicate which goals they were assigned to. For example, under the sustainability goal area there are two goals. The first goal, "SU1 Resource Utilization," is evaluated using a single focused criterion named, "SU1-1 Fuel Utilization." The second goal, "SU2 Waste Minimization and Management" is evaluated using two criteria. It is very important to note that the criteria are only a sampling of many factors that could have been evaluated—they were not selected to be exhaustive but for their ability to discriminate between concepts on important attributes.

For each criterion, the TWGs evaluated each concept and specified a probability distribution for its performance potential to reflect both the expected performance and performance uncertainty. The Crosscut Groups and the Roadmap Integration Team reviewed these evaluations and recommended changes to make them consistent. For a goal evaluated with several criteria, the goal evaluation was combined using criteria weights suggested by the Evaluation Methodology Group. Comparisons of Generation IV candidates were mostly done at the goal level.

A central feature of the roadmap is that the eight goals of Generation IV are all equally important. That is, a promising concept should ideally advance each, and not create a weakness in one goal to gain strength in another. On the other hand, promising concepts will usually advance one or more of the goals or goal areas more than others. This will be apparent in the six systems recommended below for Generation IV. It should be emphasized that while these numerical evaluation results were a primary input to system selection, additional factors and judgment were also considered in the selection process, as described below.