Generation IV Roadmap Overview

NERAC Meeting: Washington, D.C.
April 15, 2002

Definition – Generation IV

Generation IV is:

"…the next generation of nuclear energy systems that can be licensed, constructed, and operated in a manner that will provide a competitively priced and reliable supply of energy to the country where such systems are deployed, while addressing nuclear safety, waste, proliferation and public perception concerns."

Objective – Gen IV Technology Roadmap

The Technology Roadmap:

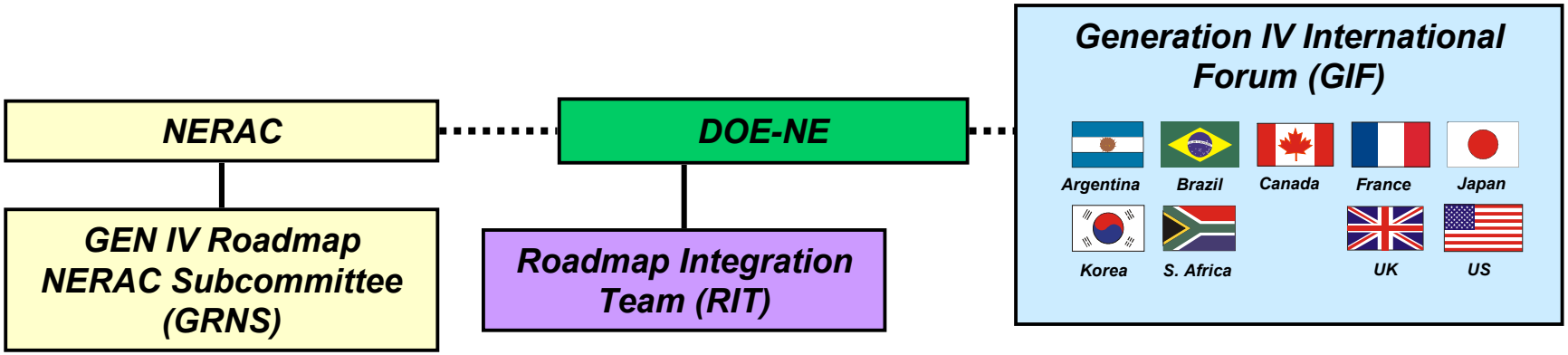
- ***Describes systems deployable by 2030 or earlier***
- ***Determines which systems offer significant advances towards:***
  - ***Sustainability***
  - ***Safety and reliability***
  - ***Economics***
- ***Examines R&D pathways for nuclear technology***
- ***Plans for a Generation IV R&D program***

Key Steps to Prepare the Roadmap

- *Define Technology Goals for Generation IV*
  - *Technology Goals Document approved in March 2001*
- *Identify Concepts with Potential*
  - *Broad-based Request for Information in April 2001*
- *Evaluate Concepts with a Common Methodology*
  - *Qualitative Screening for Potential in Sep 2001*
  - *Quantitative Final Screening in Mar 2002*
  - *Selection of 6-8 long-term concepts with GIF (underway)*
- *Identify R&D Gaps and Needs*
  - *(underway)*
- *Assemble a Program Plan*
  - *Integration and writing: Summer 2002*

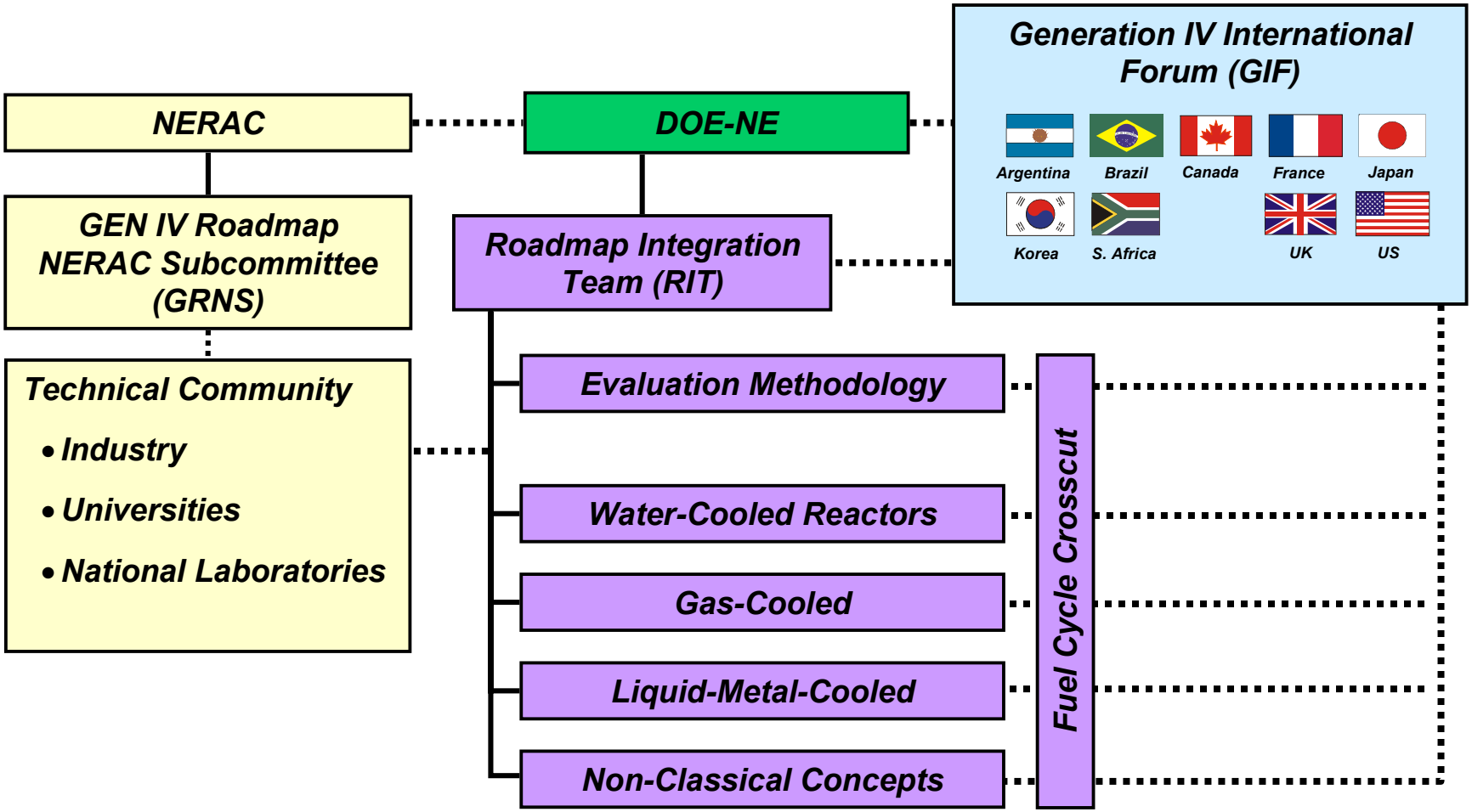
Organizational Evolution

- Jan 2000 First Meeting of 9 Countries on Generation IV
- Sep 2000 Creation of NERAC Subcommittee



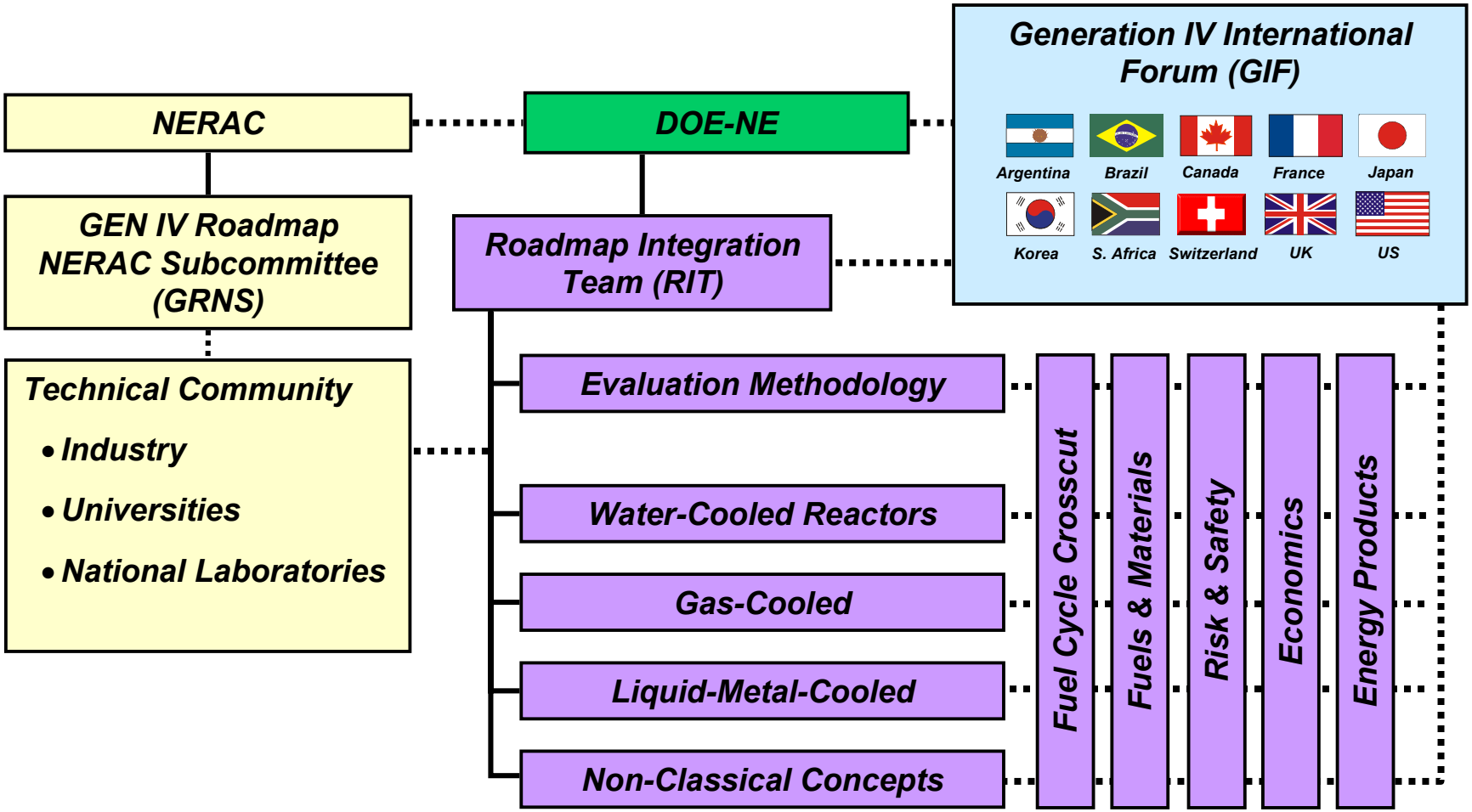
Organizational Evolution

- Dec 2000 Creation of Working Groups and Fuel Cycle Crosscut
- Mar 2001 Incorporation of International Membership



Organizational Evolution

- Sep 2001 Organization of Crosscut Groups
- Feb 2002 Switzerland joins the GIF



GIF Charter and Operation

Charter signed in July 2001 to:

- ***Identify potential areas of multilateral collaborations on Generation IV nuclear energy systems,***
- ***Foster collaborative R&D projects,***
- ***Establish guidelines for the collaborations and reporting of their results,***
- ***Regularly review the progress and make recommendations on the direction of collaborative R&D projects,***

Operation of the GIF:

- ***No permanent staff or centralized funding of projects***

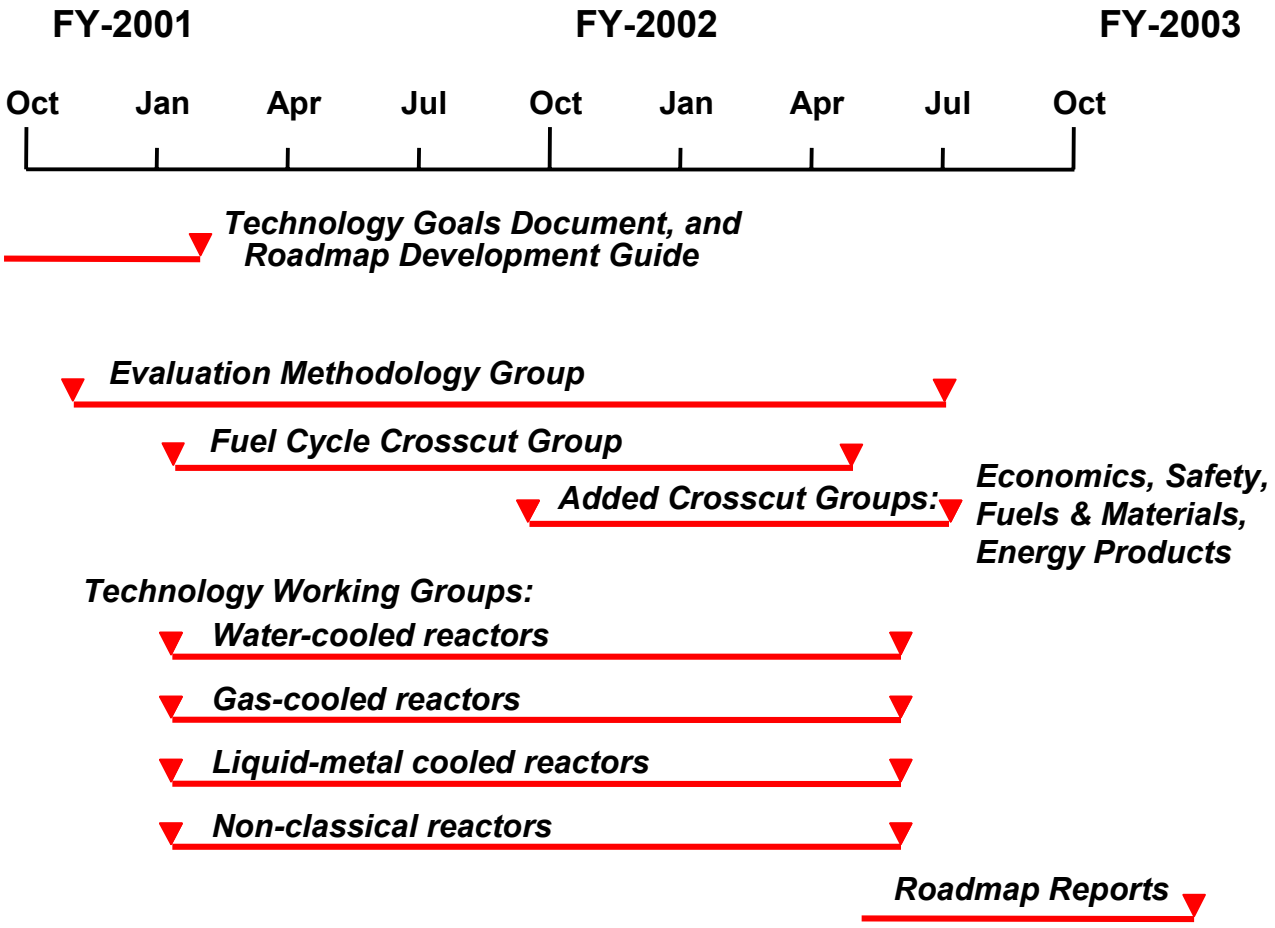
GIF Roles in Generation IV

- Sponsors nearly 50 staff on the roadmap
- Reviews and brings international perspective
  - Gen IV Technology Goals
  - Gen IV Roadmap
- Endorses key elements: Concepts, Roadmap
- Collaborates on Generation IV R&D

GIF Meetings

January 2000	Washington	Countries support Gen IV idea
April 2000	Washington	Experts convened on path forward
August 2000	Seoul	Comment on goals, write charter
March 2001	Paris	Finalize charter, support roadmap
October 2001	Miami	Comment on methodology
February 2002	London	Discuss concepts and selection
April 2002	Washington	Review concept evaluations
May 2002	Paris	Select 6-8 long-term concepts
July 2002	Rio de Janeiro	Review R&D plans
November 2002	Tokyo	Plan R&D collaborations

Two-year Gen IV Timeline



Concept Evaluation

Broad Request for Information (Apr 2001)

- ***Over 100 ideas submitted, about 1/3 international***

Qualitative Screening (Sep 2001)

- ***Qualitative criteria for each Gen IV goal***
- ***Many ideas combined into 30 concepts, a few did not advance***

Quantitative Evaluation (Mar 2002)

- ***Further refinement into 19 concepts***
- ***Quantitative criteria and metrics***

Selection of Most Promising Long-term Systems

- ***Discussed at the April & May GIF meetings***

System Concepts

Reactor System	Fuel Cycle
Integral Primary System Reactors	LEU Once-through
Simplified Boiling Water Ractors	LEU Once-through
CANDU Next Generation	DUPIC – partial fissile recycle
Supercritical Water Reactors – Thermal Spectrum	LEU Once-through
Supercritical Water Reactors – Fast Spectrum	Full actinide recycle
High Conversion Boiling Water Reactors	Full actinide recycle
Pebble Bed Modular Reactors	LEU Once-through
Prismatic Modular Reactors	LEU Once-through
Very High Temperature Reactors	LEU Once-through
Generic High Temperature Gas Reactors – Closed Cycle	Full actinide recycle (U,Th)
Gas Fast Reactor	Full actinide recycle
Sodium cooled, MOX fuel, advanced aqueous process	Full actinide recycle
Sodium cooled, metal fuel, pyroprocess	Full actinide recycle
Medium Pb/Pb-Bi cooled, Russian design	Full actinide recycle
Medium Pb/Pb-Bi cooled, US design	Full actinide recycle
Small Pb/Pb-Bi cooled	Full actinide recycle
Liquid Core (Molten Salt) Reactors	Full actinide recycle (U,Th)
Vapor Core Reactors	Full actinide recycle
Molten Salt Cooled Prismatic Fuel Reactor	LEU Once-through

Highlights of System Concept Strengths

- *Sustainability*
  - *Closed cycle fast-spectrum systems*
    - » *Na and Pb alloy liquid metal concepts*
    - » *Fast gas-cooled concepts*

- *Safety and Reliability*
  - *Thermal gas-cooled concepts*

- *Economics*
  - *Water- and gas-cooled concepts*
    - » *Life cycle cost points to large/monolithic plants*
    - » *Investment risk points to small or modular plants*

- *Hydrogen production and high-temperature applications*
  - *Very high temperature gas-cooled reactor*
  - *Molten salt-cooled prismatic fuel reactor*
  - *Pb alloy liquid metal concepts*

Selected Highlights of the R&D Challenges

- *Higher temperatures for fuels and materials*
- *Increased corrosion/erosion in alternative coolants*
- *Design with inherent safety*
- *Fuel fabrication methods*
- *Recycling technology and methods*
- *Manufacturing and constructability*
- *Hydrogen by thermochemical processes*
- *Component technologies to match coolant conditions*
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R&D Scoping: Gaps and Needs Example

Techology Gap: 1400ºC service temperature needed for coated fuel particles to reach conditions for efficient thermochemical hydrogen production

R&D need: New coating material

R&D task: New coating technology

R&D task: Fuel irradiation testing

R&D task: Fuel modeling and validation

R&D need: Improved inherent safety features and design

R&D need: Improved component materials for ducting, heat exchangers, etc.

R&D Integration

Concept Specific R&D

- ***Resource requirements***
- ***Facilities***
- ***Duration and sequencing with other tasks***
- ***Prioritization***
- ***Risk***

Crosscutting R&D

- ***(as above)***

Basic Science & Technology Needs

Opportunities for International Collaboration

Schedule for Completion

- *Finalization of concept selection* — *May ’02*
- *R&D Integration* — *July ’02*
- *Roadmap Report finalized* — *Sep ’02*
- *Transmittal to NERAC* — *Fall ‘02*

Summary

- *The roadmap is a two-year project, to be completed at the end of FY-02*
- *The primary objective of the Roadmap is to define an overall R&D plan to advance the next generation, with significant international participation of the 10 countries in the Generation IV International Forum*
- *Nearly 100 international experts staff the working groups, with significant industrial participation*
- *Over 100 ideas and concepts have been refined to about 20 most promising concepts; the objective is to get to the 6-8 with the best long-term potential and develop an R&D program that advances them*