GIF Economic Modeling Working Group – IAEA Collaboration

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Co-Chair, EMWG

13th GIF-IAEA Interface Meeting
IAEA Headquarters, Vienna, Austria
March 18-19, 2019
Outline

- Mandate and Membership of EMWG
- Collaborative Activities with IAEA to date
- Current Focus of EMWG
- Outlook
EMWG: Mandate and Membership

- **Mandate:** To develop methodology for assessment of Gen IV systems against GIF Economic Goals
  - Life cycle cost advantage over other systems (lower LUEC)
  - Comparable financial risks (total capital investment cost (TCIC))
- **Extended mandate:**
  - Maintain cognizance of challenges and opportunities for integration of Gen IV systems with renewables on the grid
  - Methodologies for economic impact of integration
  - R&D challenges to meet flexibility requirements
- **Current membership:** Canada, China, France, Japan, Russia, South Africa, South Korea, the USA, IAEA (observer)
Collaborative Activities with IAEA to date

- Focused on benchmarking of economic tools
- **G4ECONS v2.0 and IAEA’s Nuclear Economics Support Tool (NEST) in collaboration with INPRO and PESS**
  - Three types of fuel cycles: Thermal Gen IV SCWR, Break-even fast reactor, Burner fast reactor
  - Results used in the revision of G4ECONS to harmonize with NEST

- **G4ECONS v2.0 and IAEA’s Hydrogen Economic Evaluation Program (HEEP) in collaboration with NPTDS**
  - Large scale production of hydrogen using high-temperature steam electrolysis coupled with SCWR
  - Minor differences due to calculation of interest during construction
Revision of G4ECONS

• G4ECONS v3.0 (Excel-based) released for use; available on CD
• Request can be made at (https://www.gen-4.org/gif/jcms/c_42161/g4econs)
• Incorporates
  ▪ Lessons from benchmarking studies with IAEA
  ▪ Improved user interface
  ▪ Racks transuranic and fission product generation or destruction for fuel cycle study applications
• Co-generation modules (hydrogen, desalination, steam) from v2.0 have been deleted
• Training material under development
Current Focus of EMWG

- Study of issues/challenges of integration of new nuclear with renewable resources

- **Position paper prepared for GIF**
  - Current challenges for nuclear power generation
  - Economic and technical significance of flexibility and grid reliability
  - R&D requirements for Gen IV reactors to meet flexibility challenges
  - Co-generation
  - Policies conducive to nuclear deployment

- **Executive summary of position paper posted on GIF external website** (https://www.gen-4.org/gif/jcms/c_9364/economics)
## GIF-IAEA Coordination Matrix – March 2018

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<tr>
<th>Action Item From Interface Meeting</th>
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<th>Comments</th>
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<th>Action GIF</th>
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<tr>
<td>Economics:</td>
<td>Continue discussions on areas of cooperation between GIF and NENP/PESS on economics. New areas identified:</td>
<td>- G4-ECONS V3 beta release: Benchmark exercises completed and results available and reasons for differences well understood.</td>
<td>A Van Heek (NE) J Phillips (NE) T. Jevremovic/ I. Khamis (NE) for hybrid systems and process heat applications</td>
<td>R Sadhankar (EMWG Co-Chair) T Harrison, M. Berthelemy could also help if necessary (for the work on integrated systems)</td>
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<td>- Hybrid energy systems / integration renewables and nuclear (see meeting at IAEA in Nov)</td>
<td></td>
<td>- IAEA-NEST tool includes multiple cost models covering open and closed fuel cycles, multiple reactors, sensitivity analysis, comparisons to alternative energy sources, etc. Currently migrating NEST to a modular software platform from Excel and including GUI for ease of use by Member States.</td>
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<td>- Studies on (V)HTRs and process heat application economics</td>
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<td>- China, India and Russia have completed INPRO Methodology Sustainability Assessments in the area of Economics on CFR-1000, CFBR-600 and BN-1200.</td>
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<td>- Multi-criteria evaluation tools and study of threshold effects</td>
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<td>- PESS initiated activity in integration of renewables and nuclear with study “Global Review of Integration of Renewable Generation in the Electricity Markets”</td>
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<td>- Contributions invited to Track 8 on economics at the GIF symposium (Oct 2018)</td>
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<td>- NPTDS is finalizing a TECDOC on Options to Enhance Energy Supply Security using Hybrid Energy Systems based on SMRs</td>
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Continuing Information Exchange

• IAEA presented activities relevant to EMWG at the last meeting in October 2018
  o Nuclear cost basis project
  o Update on IAEA tools – NEST, HEEP, DEEP
  o Nuclear energy in markets with larger shares of variable renewables

• EMWG members attend IAEA meetings and feedback to WG
  o Technical meeting on Nuclear Renewable Hybrid Energy Systems for Decarnobized Energy Production and Cogeneration, Oct 2018
  o 16th INPRO Dialogue Forum on Opportunities and Issues in Non-Electric Applications of Nuclear Energy, Dec 2018
  o Workshop on Non-Electric Nuclear Applications: Options, Technology Readiness and Available IAEA Toolkits, Feb 2019
  o Technical Meeting on Costing Approaches for Nuclear Technology Developers, March 2019
Planned Activities

- Assessment of available models for economics of nuclear-renewable integration
  - Briefing note produced on the assessment of four models (MIT, UofT, EPRI, INL)

- Maintaining watch on international work in the areas of nuclear hybrid systems, flexibility and grid reliability

- GIF workshop on flexibility of Generation IV reactors for deployment on the grid with renewable resources
  - Joint workshop with System Steering Committees (GFR, LFR, MSR, SCWR, SFR, VHTR) and Senior Industry Advisory Panel on May 29, 2019, Vancouver
Outlook – Medium and Long Term

- Cost evolution FOAK to NOAK
- Opportunities for reducing capital costs
- Improvement of G4ECONS to include uncertainty analyses
- Economic model for small modular reactors
- Gen IV deployment scenario analysis
  - Hybrid systems, energy storage, co-generation
  - Policies for sustaining nuclear – reliability and resiliency of the grid
- Financing of new nuclear
Thank You!