GAIN
Gateway for Accelerated Innovation in Nuclear

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GAIN Gateway for Accelerated Innovation in Nuclear

Idaho National Laboratory · Oak Ridge National Laboratory · Argonne National Laboratory

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GAIN Mission

Mission:
Provide the nuclear energy industry with access to technical, regulatory and financial support necessary to move innovative nuclear energy technologies toward *commercialization* in an accelerated and cost-effective fashion

GAIN is:
The organization principle for relevant, federally-funded nuclear energy RD&D programs.

TRISO Fuel Particle

GAIN Initiative: Simultaneous Achievement of Three Strategic Goals

GAIN
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GAIN: *Organizing Principle for DOE-NE RD&D Programs Through Comprehensive Systems Analysis*

Modeling & Simulation	Crosscutting Design Support	NRC Interface	Base Reactor and Fuel Cycle R&D Programs	Experimentation
HPC Infrastructure	Nuclear Hybrid Energy	Licensing Framework	Advanced Fuel Cycles	Infrastructure
Validated Software	Nuclear Cyber Security	Gradual Risk Reduction	Advanced Reactors	Instrumentation and Sensors
M&S Expertise	Digital I&C Human Factors	Licensing Support Expertise	LW-based Reactors	Manufacturing Expertise

M&S Capabilities | **Knowledge & Validation Center** | **Experimental Capabilities**

– GAIN –

Industry and investor access to DOE capabilities and expertise

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Activities to Date

GAIN Operations

- Established small, agile organization
- Issued GAIN Execution Plan
- Issued Technology Specific Workshops Summary Report
- Implemented Standard CRADAs for NE vouchers

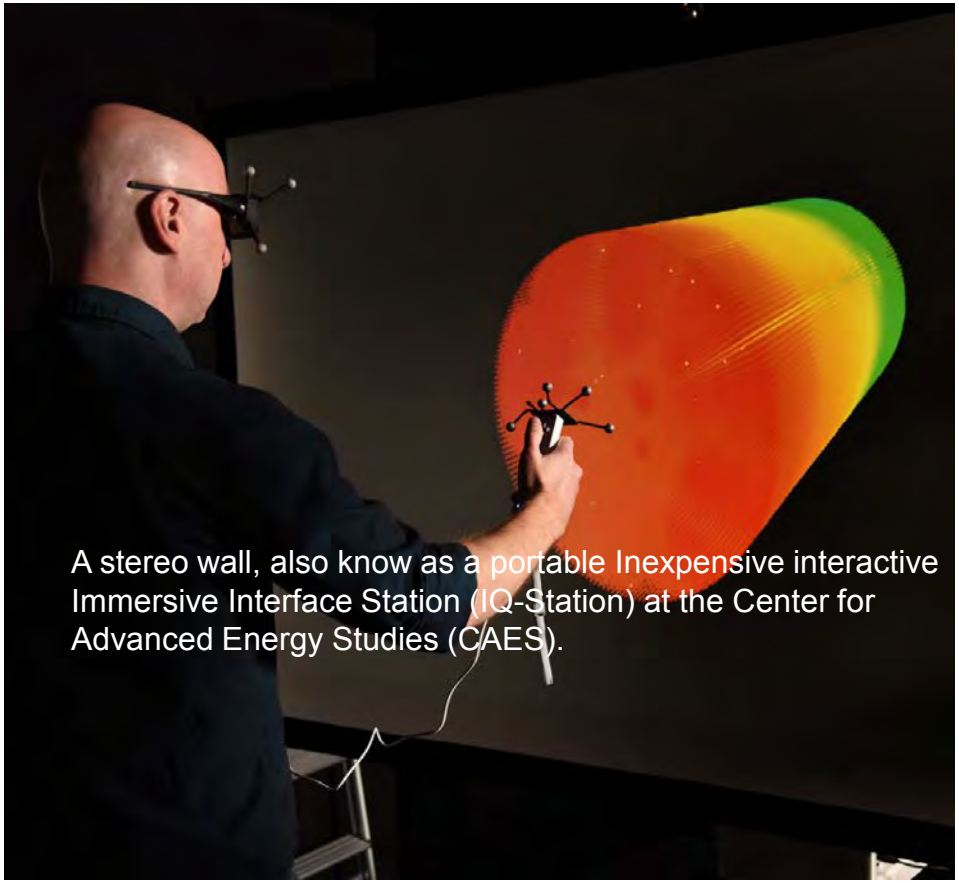
GAIN Outreach

- Presented GAIN to multiple conferences/meetings to solicit input from stakeholders
- Organized 3 Technology Specific Workshops (with NEI and EPRI) to solicit input on private-sector R&D needs for DOE-NE R&D program
- Conducted 2 Modeling & Simulation workshops
  - Model for additional future workshops
- Conducted Fuel Safety Research Workshop

Early Successes: NE Voucher Pilot Program

Goal: Assist businesses in accelerating development and deployment of innovative nuclear technologies by granting access to extensive nuclear research capabilities available at DOE's national laboratories and Nuclear Science User Facilities (NSUF) partners.

- FY 2016: Eight Small Businesses were awarded vouchers for the pilot (~$2M total)
- FY2017:
  - 32 Voucher requests submitted
  - 25 separate small businesses
  - 9 "returnees", 16 new businesses compared to pilot
  - ~$4.2M awarded to 14 small businesses



A stereo wall, also know as a portable Inexpensive interactive Immersive Interface Station (IQ-Station) at the Center for Advanced Energy Studies (CAES).

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Technology-Specific Workshops

- Hosted by GAIN, NEI, and EPRI
- Discussed RD&D needs of advanced nuclear energy technologies
- Identified technical issues that DOE is uniquely suited to address

Molten Salt Reactor Technology Workshop **July 11-12, 2016** *EPRI Offices*	High Temp Gas Reactor Technology Workshop **July 14, 2016** *NEI Offices*	Fast Reactor Technology Workshop **July 21-22, 2016** *NEI Offices*
Elysium Industries Flibe Energy Southern Co. Southern Co./TerraPower LLC Terrestrial Energy USA Transatomic	AREVA General Atomics C\X-Energy	Advanced Reactor Concepts General Atomics General Electric-Hitachi Oklo Westinghouse

GAIN and the CINR FOA

Technology Working Groups

- Feedback/needs provided via multiple mechanisms
  - Technology specific workshops with GAIN, EPRI, and NEI
  - Interaction with GAIN staff in quarterly meetings
  - Letters to DOE

CINR work scopes that directly respond to TWG requests

- RC-1: Materials for Advanced Reactor Technologies
  - Both RC-1.1 and RC-1.2 – MSR materials issues
- RC-2: Salt Behavior in Molten Salt Reactors
  - RC-2.1 and RC-2.2 related to characterization of molten salts
- RC-3: Experimental Investigation of Radioisotope Retention Capability of Liquid Metal Coolants (Sodium and Lead)
  - Applicable to Fast reactors
- RC-4: Advanced Reactor Development
  - RC-4.2 (Fluoride Salt Cooled High Temperature Reactors
  - RC-4.3 (All three types)

GAIN and the CINR FOA

CINR work scopes that directly respond to TWG requests (cont'd)

- FC-2: Advanced Fuels
  - FC-2.2 applicable to Fast Reactors
- MS-NE-2: Nuclear Data Needs for Nuclear Energy Applications
  - Relevant for all three TWGs
- NEET-1: Advanced Methods for Manufacturing
  - Relevant for all three TWGs
- NEET-2: Advanced Digital Monitoring and Control Technology
  - Applicable for all
- NSUF-1: Nuclear Energy Related R&D Supported by NSUF Capabilities
  - NSUF-1.2 is responsive to all three TWGs

GAIN and the CINR FOA

CINR work scopes that are of high interest to the GAIN community

- RC-4: Advanced Reactor Development
  - RC-4.1 is of interest to HTGR developers
- FC-2: Advanced Fuels
  - FC-2.1 is of interest
- FC-3: Advanced Data Integration for Domestic Nuclear Safeguards
- NEAMS-1: Nuclear Energy Advanced Modeling and Simulation
  - All work scopes of interest to GAIN
- NEAMS-2: Separate Effects Irradiation Testing for Validation of Microstructural Models in Marmot
- NE-1: Nuclear Energy-Cybersecurity Research Topics and Metrics Analysis
- MS-NE-1: Integral Benchmark Evaluations

GAIN may be able to assist universities with connections to industry partners

- These partnerships are highly encouraged

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GAIN TECHNOLOGY WORKING GROUPS (TWG)

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Molten Salt Reactor	
Duke Energy	Charlotte, North Carolina
Elysium Industries	Boston, Massachusetts
Exelon Corporation	Chicago, Illinois
Flibe Energy, Inc.	Huntsville, Alabama
Southern Company	Birmingham, Alabama
TerraPower, LLC	Bellevue, Washington
Terrestrial Energy USA Ltd.	New York, New York
ThorCon USA	Stevenson, Washington
Transatomic Power Corporation	Cambridge, Massachusetts

High Temperature Gas Reactor	
AREVA NP, Inc.	Lynchburg, Virginia
BWX Technologies, Inc.	Lynchburg, Virginia
Duke Energy	Charlotte, North Carolina
Kairos Power	Oakland, California
StarCore Nuclear	Montreal, Canada
X-Energy, LLC	Greenbelt, Maryland

Fast Reactor	
Advanced Reactor Concepts, LLC	Chevy Chase, Maryland
Columbia Basin Consulting Group, LLC	Kennewick, Washington
Duke Energy	Charlotte, North Carolina
Elysium Industries	Boston, Massachusetts
Exelon Corporation	Chicago, Illinois
General Atomics	San Diego, California
General Electric-Hitachi	Wilmington, North Carolina
Hydromine, Inc.	New York City, New York
Oklo, Inc.	Sunnyvale, California
Southern Company	Birmingham, Alabama
TerraPower, LLC	Bellevue, Washington
Westinghouse Electric Co., LLC	Cranberry Township, Pennsylvania

***GAIN, DOE NTDs, EPRI and NEI participate in all of the TWG teams.

What is the GAIN Initiative?
Gateway for Accelerated Innovation in Nuclear

What are the issues?

- Time to market is too long
- Facilities needed for RD&D are expensive
- Capabilities at government sites have not been easily accessible
- Technology readiness levels vary
- Some innovators require assistance with regulatory processes

What do we need to do?

- Provide nuclear innovators and investors with single point of access into DOE complex
- Provide focused research opportunities and dedicated industry engagement
- Expand upon DOE's work with Nuclear Regulatory Commission (NRC)

What is the DOE initiative?

- Public-private partnership, dedicated to **accelerating** innovative nuclear energy technologies **time to market**

DOE recognizes the magnitude of the need, the associated sense of urgency and the benefits of a strong and agile public-private partnership in achieving the national goals.

GAIN Vision

By 2030,
The U.S. nuclear industry is equipped to lead the world in development of innovative nuclear technologies to supply urgently needed abundant clean energy both domestically and globally.

GAIN is,
A public-private partnership framework aimed at rapid and cost-effective development of innovative nuclear energy technologies towards market readiness.

GAIN Successes

FY16

Q1
- Nov. 6: GAIN announced at the White House

Q2
- National Laboratories Workshop
- NE Voucher – RFA closes March 30

Q3
- INL-ANL-ORNL Options Report for Test/Demo Reactor
- NE Voucher Recipients Selected
- DOE-NRC Workshop for Advanced Reactors Licensing

Q4
- Technology Workshops (MSR, HTGR, FR)
- GAIN Execution Plan – Rev. 0
- Technology Workshops Summary Report
- Standard CRADAs/TAPAs for NE-Vouchers Authorizations to start work for NE-Voucher recipients

FY17

Q1
- "Applied Tech" label cancelled
- DOE NRC MOU on Implementation of GAIN
- ORNL MSR Workshop
- MSR/FR legacy docs on GAIN website

Q2
- R&D requests from MSR, FR, & HTGR TWGs
- GAIN EPRI M&S Gap Analysis Workshop
- RELAP5-3D Single-use license
- M&S Tools Catalog on GAIN website
- 2017 GAIN NE Voucher call launched
- Integration Working Group (IWG) 1st meeting
- Third Way's 2nd Annual Advanced Nuclear Summit and Showcase

Q3
- GAIN NE Voucher RFA closes
- GAIN Fuel Safety Research Workshop
- GAIN NE Voucher Panel Review

Technology-Specific Workshops
Collaboration

Formation of Industry-Led, Technology Working Groups (TWGs)

- Initial meetings held in September 2016
- Molten Salt Reactor
- Fast Reactor
- High Temperature Gas Reactor

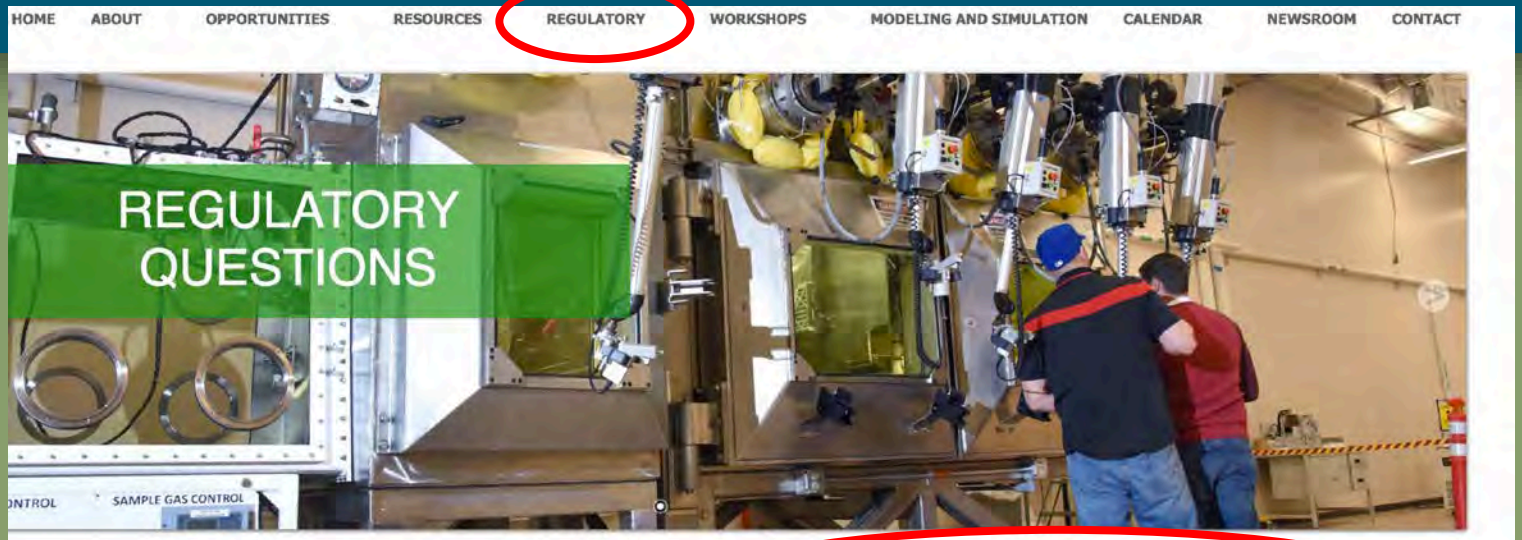
Roles and Responsibilities

- EPRI: Engage with subject matter experts & stakeholders
  - Define gaps in M&S code development and V&V for design and licensing for advanced reactor technologies
- NEI: Facilitate and coordinate activities of TWGs with those of NEI Advanced Reactor Working Group (ARWG)
  - Coordinate with GAIN and EPRI to support working groups
  - Work with industry, DOE, and NRC to understand issues associated with obtaining 5% < enriched uranium <20%

Recent Successes

Regulatory:

- MOU between NRC and DOE on GAIN, November 10, 2016
  - NRC provides DOE and GAIN community with current, accurate information on NRC licensing processes and regulations
- GAIN website:



Recent successes

FY2017 NE Small Business Vouchers:

- 41 Letters of Intent
  - 3 ineligible, 8 chose not to continue
- 32 Voucher requests submitted
- 25 separate small businesses
- 9 “returnees”, 16 new businesses compared to pilot
- ~$4.2M awarded to 14 small businesses