

November 30 2009

Dr. Steven Chu  
Secretary of Energy  
Department of Energy  
1000 Independence Ave., SW  
Washington, DC 20585  
Email: [the.secretary@hq.doe.gov](mailto:the.secretary@hq.doe.gov)

**Subject: Implementation Strategy for the Next Generation Nuclear Plant Project**

References: (A) Department of Energy Financial Assistance Funding Opportunity Announcement (FOA), DE-FOA-0000149, issued September 18, 2009, "Next Generation Nuclear Plant Program – Gas Cooled Reactor Design and Demonstration Projects."

(B) Letter to Dr. Steven Chu from the NGNP Industry Alliance, July 15, 2009

(C) Expression of Interest response from the NGNP Industry Alliance, June 8, 2008

Attachment: Next Generation Nuclear Plant Project Implementation Strategy

Dear Secretary Chu:

The undersigned members of the NGNP Industry Alliance are encouraged to see the Department of Energy (DOE) move forward on execution of the Next Generation Nuclear Plant (NGNP) Project through issuance of a Funding Opportunity Announcement (FOA), Ref (A). This letter is not intended as a response to that FOA. Responses to Reference (A) have been prepared and submitted by the respective vendor/supplier members of the Alliance.

The FOA addresses only a limited portion of the Project scope summarized in our previous letter (Ref (B)) and the earlier Expression of Interest (Ref (C)). Consequently, this letter provides amplification regarding the Alliance's interest in the NGNP Project and provides a full scope Project Implementation Strategy (Attachment) that complements the scope of work anticipated to be awarded via the responses to Ref (A). The Strategy outlines the necessary execution and decision framework to continue beyond the scope of Ref (A) through the design, licensing, construction and initial operations of the first-of-a-kind demonstration projects. The Alliance recommends that this Strategy be considered in preparation of the government's forthcoming Project Execution Plan for the NGNP Project.

As interested companies that will develop, design, construct, deploy, own, operate and purchase the delivered process heat and/or electric power generation of this advanced nuclear energy technology, we propose the approach outlined in the attached Strategy. If this approach can be aligned with the expectations of the DOE, then we are committed to execute the plans outlined in the Strategy document and to advance the NGNP Project in a progressive, phased fashion.

### **The Public-Private Partnership**

The ultimate goal of the NGNP Project is enabling the commercialization of the High-Temperature Gas-cooled Reactor (HTGR) technology, especially for applications not within reach of current technology. Including our vendor team members, our Alliance currently represents thirty companies that have united for the express purpose of bringing HTGR technology to commercial deployment. The Alliance is currently an informal industry group in support of the NGNP Project and pending the

finalization of an internal operating agreement, intends to establish a formal entity, including structure, responsibilities and roles, during 2010. Additional companies have expressed interest in Alliance membership if a stable, mutually agreed-upon execution plan can be established within the industry, the Administration and the Congress. Strong international interest has also been expressed to leverage the value of this technology beyond U.S. commercialization, and to obtain significant support in collaborative research, investment and commercialization in response to a long-term U.S. commitment to this technology.

### **The National Interest**

We view the commercialization of the HTGR technology as essential to the National interests in achieving the evolving environmental and energy policy goals in the U.S. and throughout the world. The National interests served by the HTGR technology include:

- Reduced emissions of greenhouse gases (GHG) through large scale displacement of premium fossil fuels in a wide range of industrial and commercial applications.
- Reduced reliance on petroleum imports and limited natural gas supplies as industry fuels.
- Extended longevity of petroleum and natural gas supplies as strategic assets for transportation fuels until alternatives become viable technically and economically.
- Sustainable expansion of U.S. industrial manufacturing capabilities for energy intensive industries.
- Job creation within the U.S. supplying materials and equipment to construct and operate HTGR-based industrial infrastructure.

HTGR technology offers a major opportunity to stabilize the historically volatile prices for premium fossil fuels and extends our limited resources of this commodity. Stabilizing energy costs will encourage a return of process industry facilities to the U.S. from offshore locations where lower and more stably priced fuels and feedstocks have been available. As fossil fuel supplies become more limited several decades from now, process heat from HTGRs promises to provide new sources of hydrogen and ways to shift chemical and fuels production to new feedstocks.

### **The Business Risk**

Over the past decade, the private sector assumed considerable risk by investing hundreds of millions of dollars in development of the advanced HTGR technology. The historical investment and any new investment in the HTGR technology will remain at risk until such time as the technology is commercialized and the foundation for widespread deployment in the commercial marketplace is established. Market forces based on typical projections for fossil resource prices and price volatility, alone, are insufficient to cause industrial energy suppliers and end-users to employ the HTGR technology as a replacement for premium fossil resources. Government policies in the National interest regarding energy security and carbon emissions will be required for the development of this marketplace for the HTGR technology.

Further, the projected costs and financial risks associated with licensing and completing the commercialization of the technology are considered by the Alliance members to be beyond solely private investment practices. To move forward with the Project and therefore make this technology a viable future energy alternative for the Nation, sharing of risks between government and the private sector is required through cost sharing and other financial incentives associated with design and technology development, licensing and initial deployment. While the Alliance recognizes that the cost sharing scheme presented may not appear to be consistent with that documented in legislation, we do believe that it meets the overall cost sharing objective of the legislation and also provides an acceptable investment risk profile for the private sector. Once the high economic risk activities of

commercialization are accomplished and once these National energy and environmental policies are established, the hundreds of billions of dollars of private sector investment to build-out the fleet of HTGRs will follow.

### **The Project Implementation Strategy**

We recommend that the DOE initiate early negotiations with the Alliance to form a public-private partnership based upon the framework in the attached Strategy for the development and implementation of the NGNP Project. Successful negotiation of this framework between the Alliance and the DOE will establish the effective partnering between industry and government and formalize a cost sharing investment structure that will enable commercialization that is desired by both government and the private sector.

We sincerely appreciate your consideration in this regard and your support for the NGNP Project. We are continuing to communicate our interests and intentions to key members of Congress and the Administration to encourage their continued support for this Project. Mr. Kenneth Hughey of Entergy is our primary point of contact for this letter. Should you have any questions regarding this letter, please do not hesitate to contact him at (601) 368-5327 or via email [whughey@entergy.com](mailto:whughey@entergy.com).

Respectfully,



*Signature Sheet Attached*

Michael W. Rencheck  
Chief Executive Officer  
Areva NP Inc.



*Signature Sheet Attached*

M. P. Salomone  
Manager, Business Development  
Babcock & Wilcox Nuclear  
Operations Group



*Signature Sheet Attached*

Fred Moore  
Director Manufacturing &  
Technology, Energy  
The Dow Chemical Company



*- See Support Letter Attached -*

John Parmentola  
Sr. Vice President – Energy Group  
General Atomics



*Signature Sheet Attached*

Jaco Kriek  
Chief Executive Officer  
Pebble Bed Modular Reactor, (Pty)  
Ltd



*Signature Sheet Attached*

James Dietz  
Executive Vice President &  
Chief Operating officer  
PotashCorp



*Signature Sheet Attached*

Bill Winkler  
President, Federal Division  
Shaw Environmental and  
Infrastructure Group



*Signature Sheet Attached*

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Chief Technology Officer &  
Sr. Vice President,  
Research and Technology  
Westinghouse Electric Company

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Attachment

Cc: (electronic copy with attachment)

The White House

Ms. Carol Browner, Director of the White House Office of Energy and Climate Change Policy

[cbrowner@who.eop.gov](mailto:cbrowner@who.eop.gov)

Dr. Joseph Aldy, Special Assistant to the President for Energy and the Environment

[jaldy@who.eop.gov](mailto:jaldy@who.eop.gov)

Dr. John Holdren, Director, Office of Science & Technology Policy

[jholdren@ostp.eop.gov](mailto:jholdren@ostp.eop.gov)

Department of Energy

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Dr. Steven Koonin, Under Secretary for Science

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Dr. Warren "Pete" Miller, Assistant Secretary for Nuclear Energy

[warren.miller@nuclear.energy.gov](mailto:warren.miller@nuclear.energy.gov)

Dr. Peter Lyons, Principal Deputy Assistant Secretary for Nuclear Energy

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Ms. Betty Nolan, Senior Advisor and acting Assistant Secretary, Congressional & Intergovernmental Affairs

[betty.nolan@hq.doe.gov](mailto:betty.nolan@hq.doe.gov)

**Signature Sheets**

Areva *(one page)*

B&W *(one page)*

Dow *(one page)*

PBMR *(one page)*

PotashCorp *(one page)*

Shaw *(one page)*

Westinghouse *(one page)*

**Support Letter**

General Atomics Support Letter *(one page)*



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### The Project Implementation Strategy

We recommend that the DOE initiate early negotiations with the Alliance to form a public-private partnership based upon the framework in the attached Strategy for the development and implementation of the NGNP Project. Successful negotiation of this framework between the Alliance and the DOE will establish the effective partnering between industry and government and formalize a cost sharing investment structure that will enable commercialization that is desired by both government and the private sector.

We sincerely appreciate your consideration in this regard and your support for the NGNP Project. We are continuing to communicate our interests and intentions to key members of Congress and the Administration to encourage their continued support for this Project. Mr. Kenneth Hughey of Entergy is our primary point of contact for this letter. Should you have any questions regarding this letter, please do not hesitate to contact him at (601) 368-5327 or via email [whughey@entergy.com](mailto:whughey@entergy.com).

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Director Manufacturing &  
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W. Kenneth Hughey  
Vice President – Business Development  
Entergy Nuclear Operations

John Parmentola  
Sr. Vice President – Energy Group  
General Atomics

Jaco Kriek  
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Potash Logo





James Deitz  
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Infrastructure Group

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December 8, 2009

The Honorable Steven Chu, Secretary of Energy  
Department of Energy  
1000 Independence Ave., SW  
Washington, DC 20585  
Email: [the.secretary@hq.doe.gov](mailto:the.secretary@hq.doe.gov)

**Subject: Implementation Strategy for the Next Generation Nuclear Plant Project**

References: (A) Implementation Strategy for the Next Generation Nuclear Plant Project submitted by the Next Generation Nuclear Plant Alliance; submitted December 2009

Dear Secretary Chu:

As an interested company that may develop, design and construct this advanced nuclear energy technology, General Atomics strongly supports the approach outlined in the Strategy document submitted with (Ref (A)). General Atomics is encouraged by the participation of potential owner/operators and end users and highlights that there are several more end users that have expressed interest and may move to more formal participation as the program matures.

Along with the other interested companies, General Atomics is continuing to encourage support for this Project. General Atomics appreciates your consideration of support for the NGNP Project. Dr. Timothy Bertch of General Atomics is our primary point of contact for this letter. Should you have any questions regarding this letter, please do not hesitate to contact him at (858) 455-4313 or via email [timothy.bertch@gat.com](mailto:timothy.bertch@gat.com).

Very respectfully,

A handwritten signature in black ink that reads "John Parmentola". The signature is fluid and cursive, with a large, sweeping flourish at the end.

Dr. John Parmentola  
*Sr. Vice President – Energy Group*  
**General Atomics**





**Industry Alliance**

*Clean, Sustainable Energy for the 21st Century*

# **NEXT GENERATION NUCLEAR PLANT PROJECT**

## **IMPLEMENTATION STRATEGY**

**Presented by**

**NGNP Industry Alliance**

**November 30, 2009**

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## **EXECUTIVE SUMMARY**

The following provides a Project Implementation Strategy (Strategy) for the Next Generation Nuclear Plant (NGNP) Project that has been prepared by the NGNP Industry Alliance (Alliance) to enable commercialization of the high temperature gas-cooled reactor (HTGR) technology. This Alliance is currently comprised of thirty companies, including the design team members, who will develop, design, construct, deploy, own, and operate these nuclear facilities and purchase the energy produced. Additional companies have expressed interest in Alliance membership if a stable, mutually agreed-upon execution plan can be established within the industry, the Administration and the Congress.

The Strategy includes formation of a public-private partnership between the US Department of Energy (DOE) and the Alliance consistent with the intent of the Energy Policy Act of 2005 (EPAAct 2005) using a formal agreement, such as a Technology Investment Agreement under the provisions of 10 CFR 600. The Alliance recommends that the DOE initiate negotiations with the Alliance to form the partnership based on the framework in this Strategy.

### **The National Interest**

Enabling commercial deployment of the HTGR technology has increased in importance as the environmental and energy security issues have become more apparent, and the national resolve to solve these issues has become stronger. The Alliance views the commercialization of the HTGR technology as essential to the National interests in achieving the evolving environmental and energy policy goals in the U.S. and throughout the world. The National interests served by the HTGR technology include:

- Reduced emissions of greenhouse gases through large scale displacement of premium fossil fuels in a wide range of industrial applications.
- Reduced reliance on petroleum imports and limited natural gas supplies as industry fuels.
- Extended longevity of petroleum and natural gas supplies as strategic assets for transportation fuels until alternatives become viable technically and economically.
- Sustainable expansion of U.S. industrial manufacturing capabilities for energy intensive industries.
- Job creation within the U.S. supplying materials and equipment to construct and operate HTGR-based industrial infrastructure.

HTGR technology offers a major opportunity to stabilize the historically volatile prices for premium fossil fuels and extends our limited resources of these commodities. Stabilizing energy costs will encourage a return of process industry facilities to the U.S. from offshore locations where lower and more stable prices for fuels and feedstocks have been available. As fossil fuel supplies become more limited several decades from now, process



heat from HTGRs promises to provide new sources of hydrogen and ways to shift chemical feedstocks and fuels production to alternative carbon sources.

### **Scope of the NNGP Project**

The scope of the NNGP Project as described in the Strategy includes:

- Characterizing a broad range of markets for HTGR technology, conducting application studies to characterize application needs and economics, and defining site requirements
- Formalizing design requirements to support development of the design and licensing bases by the design teams.
- Selecting candidate sites for development and licensing
- Completing the development, design, licensing, construction and initial operations of a first-of-a-kind (FOAK) demonstration plant(s) producing process heat that supports the needs of many industrial markets.
- Supporting development of the regulatory process and the basis for licensing and design certification for the HTGR technology by the Nuclear Regulatory Commission (NRC).
- Demonstrating the operational viability of the HTGR and associated technologies via the FOAK demonstration plant(s)

The Alliance's goal is that the Project baseline includes the development, design and licensing through receipt of a combined construction and operating license for two designs (one plant configuration using a pebble bed reactor design and another using a prismatic reactor design) and construction of FOAK plants, one for each of the two designs at two different end-user sites. As a baseline, two designs are planned 1) to establish a long term competitive marketplace, both in terms of vendors and design options, and 2) to assist in mitigating the technical and licensing risks associated with a technology and designs that are not yet commercialized.

One or more owners in collaboration with one or more end-users will select potential demonstration plant sites and the associated designs and form ownership arrangements and implementation teams by the time that respective preliminary designs are being completed. The formation of separate projects for these demonstration plants will mark a shift towards private sector financing and implementation, and will build on maturation of the designs and associated licensing processes. Site selection will consider broadening the commercialization potential of differing end-user site requirements and hazards particularly as plant design and licensing requirements are affected. With planned financial risk mitigation provisions from the government consistent with EPAct 2005, the FOAK plants will be constructed using private sector financing for the commercial portion of each project. This way the market will select the best demonstration projects based on their commercial value.

## **Role of the NGNP Industry Alliance**

The Strategy describes that the Alliance will assume, as appropriate, the role of the Project developer, owner, owner's engineer, license applicant and operator including providing design requirements to the vendor/supplier teams and working with end-users to find the most appropriate sites for candidate demonstrations. The Alliance will interface with

major investors to enable private sector equity positions for the FOAK demonstration(s). In executing its role, the Alliance will maintain the public-private interface with the DOE via

the partnership agreement including those functions required to fulfill the DOE's statutory responsibilities.

As the work on candidate demonstrations advances, the Alliance expects to form demonstration

development/implementation teams that will arrange financing and directly undertake implementation as dictated by commercial arrangements. The Alliance will maintain an important role as the Project is executed to represent broad industry interests and encourage consideration of a wide range of applications and markets to maximize the value of anticipated demonstrations. This will include initiatives to engage with the international project activities (e.g., potentially complementary activities in Canada, South Africa, Japan, China, South Korea, and the European Union) and seek participation and support for NGNP Project activities. Additional international links are provided by the individual end-users, vendor/supplier teams, and other potential owners and operators and will provide the opportunity to expand the value and level of international participation.

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## **Progressive Commitment and Risk Sharing**

The Strategy describes a three phase<sup>1</sup> project summarized as follows:

- Phase 1** Planning and initial design and generic licensing development
- Phase 2** Site(s) specific licensing, implementation planning and project development and design
- Phase 3** Deployment of the FOAK demonstration plant(s) and design certification

Over the past decade, the private sector assumed considerable risk by investing hundreds of millions of dollars in development of HTGR technology. This historical investment and any new investment remain at risk until such time as the technology is commercialized and the foundation for widespread deployment in the commercial marketplace is established. As described further in the Strategy, the three phases support a progressive commitment on the part of government and the Alliance members for overall Project

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<sup>1</sup> The reference to activities and "Phases", as used by the Alliance within this Strategy, differ from those defined in FOA – 0000149 and those specified in the EPOA 2005.

**Table ES-1 Estimated Government Funding and Private Sector Cost Share**

One FOAK	Estimated Government Funding and Private Sector Cost Share														<i>(in millions \$)</i>	
FY	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	
DOE	\$221	\$244	\$252	\$324	\$317	\$173	\$123	\$84	\$75	\$26	\$26	\$24	\$12	\$12	\$12	
Private Sector*			\$26	\$41	\$37	\$158	\$239	\$563	\$730	\$787	\$467	\$178	\$57	-\$36	\$365	

Two FOAK	Estimated Government Funding and Private Sector Cost Share														
FY	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
DOE	\$221	\$244	\$252	\$324	\$317	\$207	\$160	\$114	\$107	\$30	\$28	\$25	\$12	\$12	\$12
Private Sector*			\$26	\$41	\$37	\$313	\$477	\$1,121	\$1,456	\$1,517	\$876	\$295	\$59	-\$127	\$672

\* - Not including "in-kind" contributions

execution, e.g., stages of design and licensing maturation, selection of site(s) for demonstration(s) and decisions to construct demonstration plants.

Investment risks for Project execution and completion are shared between government and the private sector Alliance. The major share of government investment is required in the initial two phases of the Project where the project risks are beyond those acceptable in private sector investments. Table ES-1 summarizes this cost share approach<sup>2</sup>. While the Alliance recognizes that the cost sharing scheme presented herein may not appear to be consistent with that documented in EAct 2005, we do believe that it meets the overall cost sharing objective of that legislation and also provides an acceptable investment risk profile for the private sector. Specifically, during the initial phases of the project, the risks and projected costs associated with licensing and completing the development of the technology are well beyond acceptable private investment practices. To best move forward with the Project and therefore make this technology a viable future energy alternative for the Nation, a cost/risk-sharing scheme consistent with the one outlined herein along with other financial incentives associated with the FOAK related elements of the Project should be adopted.

### **Public-Private Partnership**

Consistent with the Alliance's understanding of the intent of the EAct 2005, this Strategy includes formation of a public-private partnership via a formal agreement (e.g., a Technology Investment Agreement) as the means by which the government and the private sector (industry) achieve collaboration and share the costs for the research, development, design and licensing of the first-of-a-kind demonstration plants. The leadership of the Alliance (the private sector partner) and certain Alliance members are entities incorporated in the United States. As described further herein, this partnership structure is intended to exist throughout the life of the NGNP Project.

This Strategy complements the scope of work anticipated to be awarded via the responses to the DOE financial assistance funding opportunity announcement (FOA)<sup>3</sup>.

<sup>2</sup> The cost information was developed from the three vendor teams (led by Westinghouse, AREVA and General Atomics) during the pre-conceptual design phase of the NGNP Project and normalized for differences in costing methodology and scope to come up with the estimated values in this table.

<sup>3</sup> Department of Energy Financial Assistance Funding Opportunity Announcement (FOA), DE-FOA-0000149, issued September 18, 2009, "Next Generation Nuclear Plant Program – Gas Cooled Reactor Design and Demonstration Projects."





The Strategy outlines the necessary execution and decision framework to continue beyond the scope of the FOA through the design, licensing, construction and initial operations of the first-of-a-kind demonstration projects. This framework includes preparation and implementation of a plan to continue the Project beyond the scope of the FOA and to transition the Project to allow ongoing private sector investment in and management of the Project.

To achieve success in enabling commercial deployment of this important technology, the following are necessary elements of the partnership between the private sector (represented by the Alliance) and the government:

- A commitment by the Administration, the Congress and the private sector to share the upfront risks to enable commercialization of HTGR technology through the NGNP Project. Sharing these risks includes the government ensuring that existing infrastructure within the national laboratories are functional and available for NGNP Project R&D activities as described in the project development plans.
- Formation of a public-private partnership led by the Alliance in a phased Project that starts with project development, design development and establishment of the NRC regulatory infrastructure to support FOAK licensing for the Project. A funding vehicle is needed that ensures continuity through the life of the project – perhaps in the form of a legislative initiative that authorizes a revolving fund concept. Additionally, a substantial and continuing investment is needed to expand the current NRC licensing infrastructure for direct applicability to HTGRs employed as a source of process heat for industrial applications. The Alliance based lead owner/operator, Entergy, will become the potential license applicant to support this on behalf of the Alliance until site-specific projects are defined through major agreements and commitments.
- Long-term cooperation between the Administration, the Congress and the private sector (the Alliance) with a common goal to enable the Project to be built as a timely step toward achieving reduced dependence on foreign energy resources and reducing carbon dioxide emissions. Ongoing technical development of future industrial applications is essential to ensure that the broadest practical energy sectors are supported by the HTGR technology for maximizing its benefit to the long term national energy strategy.

Achieving the scope outlined above is anticipated to require limited enabling legislation and/or changes to the EAct 2005 as described in Section 5. The Alliance will endeavor to work with the DOE and the Congress to enact the necessary legislation at the earliest practical time, but at least by the time of execution of the proposed public-private partnership agreement.

### **Next Steps**

The Alliance recognizes that considerable time and discussion will be required to mature and execute the partnership agreement. The Alliance suggests that the existing NGNP Project managed for the DOE by the Idaho National Laboratory/Battelle Energy Alliance

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be authorized to continue with Project technology development efforts in parallel with the vendor led design and licensing development efforts per the FOA awards and the development and execution of a partnership agreement. The Alliance anticipates that the DOE will then transition the Project over a period of time to allow private industry investment and management through the Alliance under the terms of the partnership agreement.



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## Acronyms

<b>ACRONYM</b>	<b>DESCRIPTION</b>
ALWR	Advanced Light Water Reactor
ATR	Advanced Test Reactor
BOP	Balance of Plant
CM	Construction Management
COLA	Combined Construction and Operating License Application
COL	Combined Construction and Operating License
CPM	Construction Project Management
CTL	Coal-to-Liquids
CTG	Coal-to-Gas
DC	Design Certification
DCD	Design Control Document
DOE	Department of Energy
ESP	Early Site Permit
FOAK	First-of-a-Kind
GHG	Greenhouse gases
HFET	Hot Fuel Examination Facility
HTGR	High Temperature Gas Cooled Reactor
IHX	Intermediate Heat Exchanger
INL	Idaho National Laboratory
IP	Intellectual Property
ITAAC	Inspections, tests, analyses, and acceptance criteria
LWA	Limited Work Authorization
LWR	Light Water Reactor
NGNP	Next Generation Nuclear Plant
NHSS	Nuclear Heat Supply System
NI	Nuclear Island
NOAK	Nth-of-a-Kind
NRAD	Neutron Radiography Reactor
PCS	Power Conversion System
PHDS	Process Heat Delivery System
PPP	Public/Private Partnership
SER	Safety Evaluation Report
TIA	Technology Investment Agreement



## Definitions

There are certain terms and phrases that are used within this document that may have different meanings or connotations than when used in other context. Specific note is made for the terms below to ensure that they are interpreted as intended within the context of this document.

<b>TERM</b>	<b>DEFINITION</b>
Alliance	Next Generation Nuclear Plant (NGNP) Industry Alliance
Design Control Document	Designation for the documentation submitted to the NRC as the application for a certification of a reactor system design
End-user	The ultimate “end-user” or consumer of the product produced by the nuclear facility. The term “off-taker” is also used in this same context at times. The distinction drawn within this document highlights the difference between the entity using or consuming the product(s) produced from the nuclear facility and the entity that actually owns or who will purchase the NI from the vendor supplier entity and be responsible for safe operations of the nuclear facility.
Final Design	For purposes of this document, the term final design will designate the level and maturity of the design necessary for construction of the FOAK facility.
FOAK	Refers to the first module of each design constructed and operated as part of this NGNP Project.
NGNP	Next Generation Nuclear Plant
Nuclear Heat Supply System (NHSS)	Refers to the reactor system and the primary heat transport system, including the steam generator(s) and/or IHX(s), and the circulator, plus the auxiliary support systems such as fuel handling system.
Nuclear Island (NI)	Refers to the portion of the total plant design to be certified for multiple applications and sites. The NI may contain one or more NHSSs plus the structures, systems and components that are replicated for such a standard NI concept.
Operator	The organization hired by the Owner through an Operating Agreement to provide plant staffing, manage the operation and maintenance of the plant, and ensure that regulatory and permit requirements are adhered to. In some cases where the Operator could also be a part-owner through the Ownership Agreement it could be referred to as an “Owner/Operator”.
Owner/Operator	Designates the nuclear facility owner and/or operator as opposed to the product off-taker or the actual site or land owner, which may be the entity using the product (process heat, steam, or electricity) produced from the nuclear facility.
Owner	An entity formed through an Ownership Agreement which provides financing and manages the construction and operation of the facility over its economic life. Participants in an Ownership Agreement normally represent the equity investors who are likely to be major stakeholders in the project, and which could include the Operator, Offtakers, major suppliers, and in some cases the Government. The Owner creates a Management Team for the Project, and enters into various Project Agreements to support implementation and operation. The Owner will need to address major regulatory responsibilities and potential liabilities according to the terms of the COL.
Project Development	The process of selecting a site, defining an application, preparing technical scope and requirements documents, securing necessary permits and licenses, finalizing major contracts and agreements, securing financing and establishing plans for implementation.





## **1. Project Description**

### **1.1 Background**

High temperature gas-cooled reactors (HTGRs) can provide an important addition to the US' and the world's energy supply portfolio. Enabling commercial deployment of the HTGR technology has gained importance as environmental and energy security issues have become more apparent, and the national resolve to solve these issues has become stronger. The Next Generation Nuclear Plant (NGNP) Project authorized by EPAAct 2005 provides for a collaborative effort between government and industry to enable the commercialization of the HTGR technology.

To achieve this goal, the NGNP Project must develop and demonstrate the design, licensing, performance, operational capabilities, and economic viability of HTGR and associated process heat technologies. The Project must further enable development of the commercial vendor/owner/user infrastructure, and support the timely Design Certification of the commercial designs by the NRC to help assure subsequent deployment in the commercial market place.

Currently, the NGNP Project is a Government-sponsored project focused on the development, early design and licensing of an advanced HTGR and the associated advanced technologies to transport the high temperature process heat. The basis for the HTGR technology embodied in the NGNP was first developed over 40 years ago in the UK, the US and Germany. Most of the previous work has focused on the generation of electricity. Seven experimental and demonstration reactors have been built world-wide, including a US commercial scale demonstration of a specific HTGR concept for electric power generation at the Fort St. Vrain plant that operated from 1976 through 1989. Other HTGR system-related development efforts exist in South Africa, France, Japan, Russia and China at the design stage or engineering pilot scale. Additionally, a commercial scale demonstration plant utilizing the pebble technology is currently under construction in China.

As currently envisioned, the NGNP Project will result in full scale First-of-a-Kind (FOAK) facilities that demonstrate the commercial potential of the HTGR and associated technologies. Definition of the specific NGNP facilities to be built as part of the Project will be established over the next several years. The conceptual arrangements for two HTGR designs are described herein – one for the arrangement being developed by the pebble bed vendor team and one by the prismatic block participant vendors. As the conceptual design work progresses and the facility is better defined, costs and economics will be projected with more certainty. The best cost information available to the industry today suggests that either of these designs can be economically viable once the licensing challenges have been overcome.

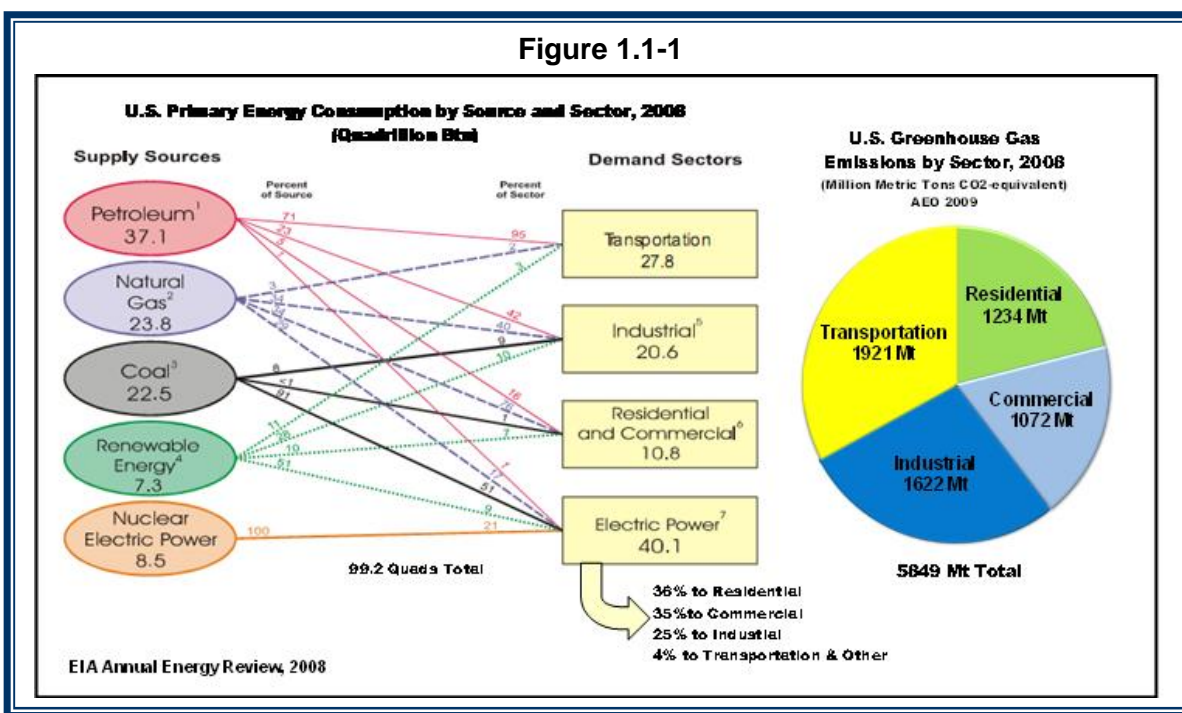
#### **1.1.1 Extending Nuclear into the Broader Energy Sector**

The NGNP Project, as envisioned, will enable the expanded use of nuclear energy as an extremely low life cycle greenhouse gas emission option for process heat for a broad range of industrial and commercial applications. Decades from now as natural gas feedstocks become scarce, nuclear produced hydrogen will support longer term national strategic objectives for a diverse supply of clean energy options.

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There are three inter-linked energy challenges that industry and government face: 1) the volatile prices for premium fossil fuels such as crude oil and natural gas; 2) dependence on foreign sources for these energy resources; and 3) the risks of climate change due to carbon emissions.

Figure 1.1-1 provides a perspective of the energy picture in the US in 2007. Nuclear energy provides about 21% of electric power generation or about 70% of the carbon dioxide emission free power generation. Light Water Reactors (LWRs), a mature technology operating at a maximum temperature of ~300 °C, exclusively produce this power in the US. This is about 8% of the total energy usage in the US.



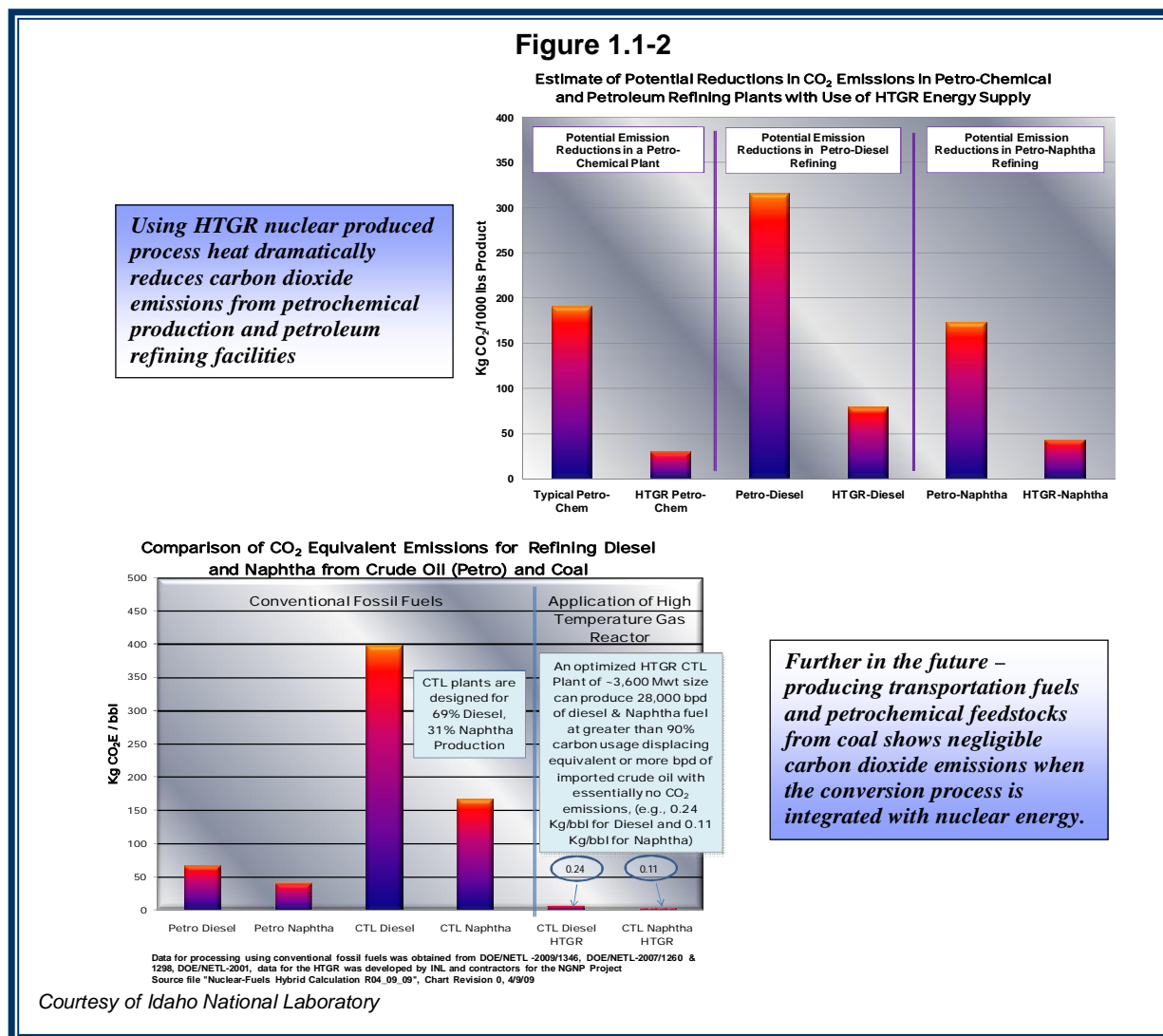
## 1.1.2 Energy Security and Environmental Considerations

As summarized in Figure 1.1-2, there exists the opportunity for nuclear energy to displace the use of fossil fuels in many industrial applications to provide CO<sub>2</sub> emissions-free energy production – possibly up to 20% of the current US energy usage beyond production of electricity. The energy needs for the recovery of petroleum, production of transportation fuels, and other industrial needs including those of the petrochemical industry require process heat provided at temperatures approaching 800 °C. This temperature range is readily achieved by the HTGR technology.

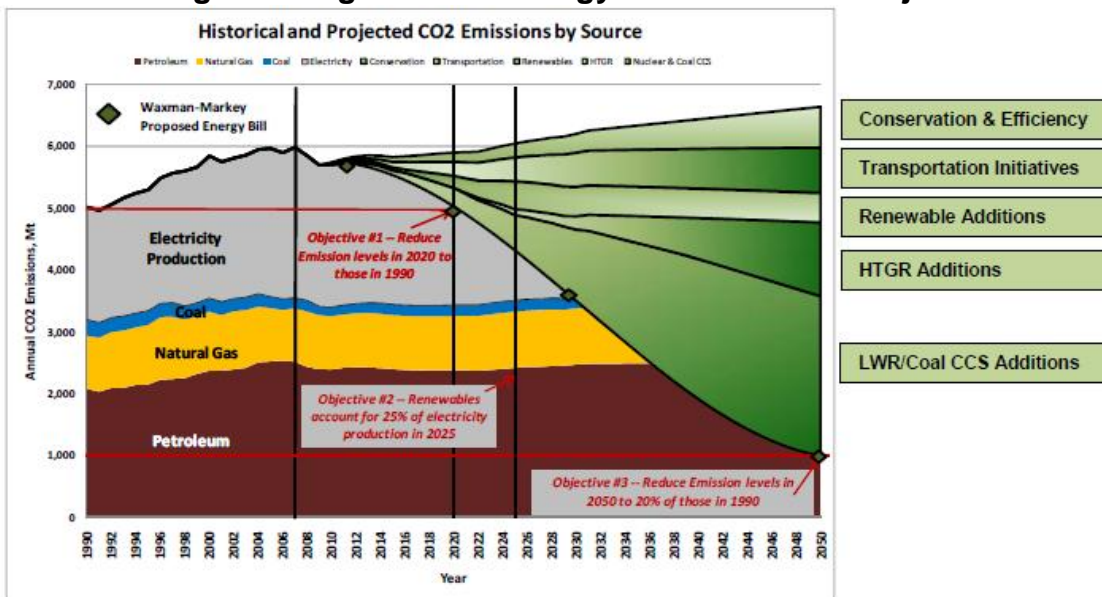
The decrease in CO<sub>2</sub> emissions provided by using HTGRs integrated with petrochemical and petroleum facilities for the production of chemicals, transportation fuel and feedstocks is dramatic. However, use of any energy supply technology whether renewables, nuclear or “clean” coal (carbon capture and storage) must be considered in the larger context of the deployment required to achieve the longer term environmental and energy security goals currently envisioned.

Figure 1.1-3 indicates historic and projected CO<sub>2</sub> emissions from the major energy supply sectors in the US. Specifically, in Figure 1.1-3:

- The upper bound curve represents the projected CO<sub>2</sub> emissions if no actions are taken,
- The goals envisioned by the current Administration and codified in pending legislation of the American Clean Energy and Security Act of 2009 (HR2454) are shown as three objectives in 2020, 2025 and 2050 with a faired curve connecting these points.



**Figure 1.1-3**  
**Meeting the Long Term US Energy and Emissions Objectives**



Idaho National Laboratory, July 2009

- The left portion represents the CO<sub>2</sub> emissions from the major sources of energy used today (electricity generated by coal, nuclear, etc.; petroleum used primarily for transportation; and natural gas used primarily for industrial process heat purposes and residential and commercial heating), and
- The green-colored section is a representation of the CO<sub>2</sub> emissions reductions necessary to meet the Administration's objectives and how these reductions could realistically be achieved through the employment of improved energy efficiencies and energy supply technologies.

It is important to note that the projected CO<sub>2</sub> emissions that are avoided in Figure 1.1-3 (the green-colored section) reflect a realistic implementation of energy efficiency practices and acknowledge the practical limitations associated with build-out and utilization of the various energy supply technologies (e.g., the integration of a variable availability generating supply with baseload). The baseload portion is a combination of nuclear energy and, as available, clean coal sources that are tailored to the energy product that is needed (e.g., electricity, process heat, hydrogen). The nature of the source of energy limits the availability of solar and wind renewables to the order of 30% compared to the >90% availability of nuclear energy.

There are large uncertainties regarding the final form of Congressional legislation intended to effect reductions in US GHG emissions – legislation that is needed to codify long term energy and environmental policy since dependence on fossil fuels for energy will not decrease solely as result of today's market driven forces. The specific mix of



energy supply technologies could vary somewhat, but need to remain generally in the proportions shown to achieve the level of electric power reliability that is the expectation in the US. A total capital investment of about \$4 trillion in energy supply capability will be required by 2050 – about \$100 billion per year. These estimates do not include the investment for a substantially expanded “smart grid” or massive energy storage capability to accommodate renewables, or the costs to decommission an appreciable portion of the existing coal-fired power generating capability that is no longer useable under these emission assumptions.

From the analyses underpinning this graphical representation, the following general conclusions can be drawn regarding the substantial benefits to be derived from the use of HTGRs in this energy supply mix.

- HTGR technology is an essential part of achieving the CO<sub>2</sub> emission level objectives that are portrayed in Figure 1.1-3. Displacing the use of natural gas at the thermodynamic conditions and with the reliability needed to fulfill the needs of the petrochemical, petroleum and related industries cannot be achieved practically by other CO<sub>2</sub> emission-free technologies. In these applications, each HTGR modular reactor nominally rated at 600 MW thermal can avoid ~0.8 million metric tons of CO<sub>2</sub> annually.
- From an energy security standpoint, with the anticipated development of high temperature hydrogen production processes, synthetic fuel production using processes such as coal-to-liquids integrated with HTGR technology can substantially reduce the US dependence on imported petroleum. For example, fifteen 100,000 barrel per day coal-to-liquids plants integrated with 480 HTGR modules can reduce US oil imports by 25% of the current oil import rate with minimal CO<sub>2</sub> emissions.

The private sector capital investment for achieving the energy supply capability using HTGR technology included in Figure 1.1-3 is on the order of \$2 trillion (2009\$). As discussed further below, this important investment in the US energy supply will bring a many-fold return in the creation of long term jobs.

### **1.1.3 Job Creation**

There is substantial job creation associated with achieving the energy supply capability summarized above. Job creation comes initially in the design activities and industrial facilities buildup to provide the materials and equipment for construction of the energy supply facilities. The largest increase is then associated with the construction forces to build the facilities. As the facilities are made operational, there is a permanent staff that operates and maintains each facility. Leveraged from all of these jobs are the service and support sector jobs ranging from home building to living essentials.

To achieve the HTGR energy supply capability that addresses the emissions objectives summarized in Figure 1.1-3 for displacement of natural gas for industrial process heat and improvements in energy security described above, about 1800 modular HTGRs will be required to be built by 2050. Up to about 350,000 jobs will be created in the industrial and construction activities, and the permanent operating staffs in this new energy supply will require about 120,000 new jobs. This job creation for the HTGR build-out is part of the



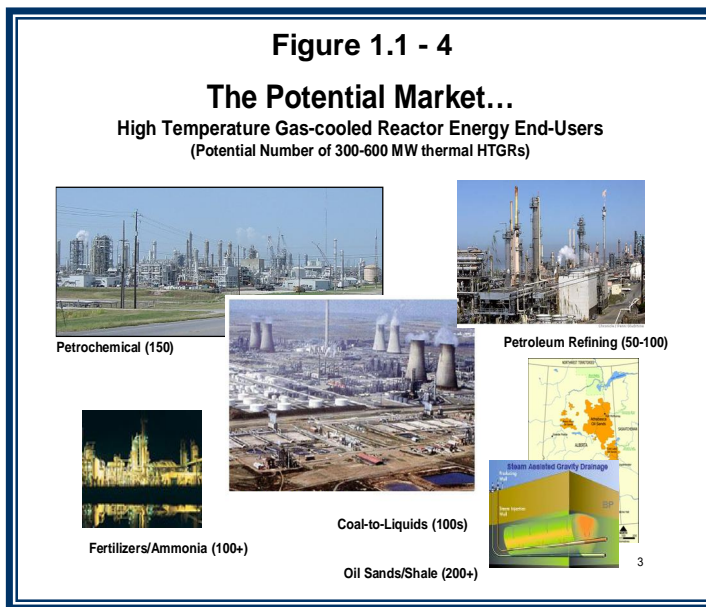
new job requirements that will be needed to achieve the total energy supply capability to fulfill the environmental policy objectives shown in Figure 1.1-3.

### 1.1.4 The Potential Market

The distinct characteristics and capabilities of the NNGP and associated technologies have market place potential well beyond the traditional nuclear energy applications of electric power generation. Potential applications for the high temperature process heat that is produced by an HTGR include

- “Upstream” petroleum recovery operations such as *Enhanced Oil Recovery, Tar Sands Production, and Oil Shale Recovery*
- “Downstream” Petro-chemical/refinery operations
- Industrial Chemical Facility operations
- Coal-to-Liquids (CTL) and Coal-to-Gas (CTG) conversion processes

Studies were conducted in 2008 to estimate the potential size of the marketplace for HTGRs. As indicated in the Figure 1.1-4, there are, conservatively, in excess of six hundred modular reactors (600 MWt) that would be required to satisfy the demand for high temperature process heat in North America’s industrial market place. It is unlikely, even with the emphasis on GHG emissions and improved energy security through reduction of petroleum imports, that this demand for industrial process heat will be satisfied exclusively with HTGR modules. To put this demand in perspective, however, one large petrochemical facility could require eight modular HTGRs to supply the steam, electricity, and other process heat needs for that facility. Thus far, evaluation of such potential applications has been shown to be economically viable. If coal conversion to hydrocarbon feedstocks and transportation fuels proves economically viable as suggested by recent studies, integration with nuclear energy could require several hundred additional HTGR modules.



Deployment of the HTGR as an industrial process heat source will be largely driven by the economics as compared to those for competing technologies. The costs of the HTGR technology will be driven mainly by capital investment, fuel, and operations/maintenance costs. Primary advantages of the HTGR (and any nuclear technology) over conventional fossil fuels are a reduction in fuel cost volatility, security and predictability of fuel supply, and reduction of GHG emissions. The characteristics of the HTGR technology suggest that it is an attractive option to traditional process heat sources.



### **Petrochemical and Petroleum Refining**

In the petrochemical and petroleum refining sectors, the production of chemicals and liquid fuels requires large quantities of high-temperature process heat that is currently being provided through burning of premium fossil fuels. This burning of premium fossil fuels can be displaced by the use of nuclear process heat (the HTGR technology). The use of nuclear process heat can, therefore, make an important reduction in natural gas utilization and oil imports, substantially reduce greenhouse gas releases, and potentially provide an important economic advantage.

### **Upstream Petroleum Recovery**

In upstream petroleum recovery sector, there are three primary areas where NGNP technologies appear to be well suited: 1) enhanced oil recovery for existing fields; 2) in-situ recovery of petroleum from the oil sands; and 3) the eventual in-situ exploitation of the oil shale deposits in the western U.S. Presently, burning natural gas provides the heat source for many of these applications. With the proper heat transfer and transport systems, the HTGR can provide the required heat without burning natural gas and without producing significant amounts of CO<sub>2</sub>.

### **Coal Conversion**

The abundant coal reserves in the U.S. can be converted to non-conventional hydrocarbon liquid and gaseous feedstocks for refineries, petrochemical and chemical plants. The Fischer-Tropsch (F-T) process developed in the 1920's is a proven technology for converting coal to a liquid. This F-T process, however, requires substantial natural gas or coal to provide the required steam and the process feedstock. It also produces substantial CO<sub>2</sub> emissions. An HTGR can be integrated with the F-T process to form a coal-to-liquids plant that does not need an air separation unit, uses 40% less coal and produces minimal CO<sub>2</sub>. A similar approach can be used to convert coal to a pipeline quality syngas.

## **1.2 Objectives**

The primary goal of the NGNP Project is enabling the commercialization of the HTGR technology across new industrial and commercial markets previously not accessible to nuclear technology. Achieving this goal will require not only the full scope of Project activities, as outlined in Section 2.0, but it will also require management of the effort in such a manner that commercial entities can predict future deployment costs and schedules with a high degree of certainty. The philosophy underpinning this Project Implementation Strategy is that the NGNP Project will create the option for deployment of the HTGR technologies for a range of applications and sites not traditionally served by nuclear energy. Key objectives for achieving this goal include:

- Fully characterizing the potential market through end-user collaborations and application studies in order to identify a wide range of viable candidate sites, applications and projects
- Providing guidance to design teams regarding the range of site and application requirements which could impact NGNP design and licensing



- Preparing, submitting, and acquiring multiple Early Site Permits (ESPs) that envelop the range of potential sites and applications for deployment of HTGRs
- Performing the design activities necessary to prepare, submit, and eventually obtain a Combined Construction and Operating License (COL) for both the prismatic block and pebble bed designs.
- Developing the regulatory framework for the licensing of the HTGR technologies.
- Enabling the long-lead developmental activities for fuel, high-temperature materials, and methods that support licensing and subsequent construction of the FOAK facilities.
- Securing the fuel fabrication capacity needed to support HTGR projects
- Completing the final design activities to allow construction, start-up, confirmatory testing, and operation of the FOAK facilities.
- Acquiring the necessary government incentives to make the FOAK facilities economically viable investments for the private sector.
- Construction, start-up, confirmatory testing, and completing a commercial operations run for the FOAK facilities
- Enabling the establishment of the supply chain infrastructure necessary for commercial build-out of the HTGR technologies.
- Obtaining design certifications from the NRC to support the deployment of the initial fleet of commercial plants
- Capturing the lessons learned from FOAK construction and operations and validating the assumptions for future plant construction costs and schedule.

By meeting the objectives above, it is expected that the NGNP Project will establish an acceptable basis for commercial deployment of the HTGR technology in the broader energy sector. Completing the design, licensing, construction and initial operations of two FOAKs provides a solid foundation for commercialization and commitment to the extensive deployment anticipated for the HTGR technology for a range of different HTGR designs, end-user site requirements and hazards, and nuclear-industrial collocation conditions.



## **2.0 Project Scope**

To successfully enable the commercialization of the HTGR technology in the competitive marketplace, the objectives outlined in Section 1.2 above must be achieved. These objectives highlight the need for a broad range of activities that include, design, technology development, licensing, and construction of the HTGR FOAK facilities, start-up and initial confirmatory testing, and a commercial operations run to demonstrate the economic viability. Each of these Project scope elements is outlined briefly in this section. It should be noted that these elements comprise supporting or associated activities that will be more specifically detailed in Phase 1 of the project. Furthermore, there are a number of attendant activities – activities that are not directly associated with Project scope – that will also be necessary to achieve the Project objectives. Some of these attendant activities are briefly described in Section 2.1. During Phase 1, Project schedules depicting the full range of Project tasks and activities for Phase 2 will be developed commensurate with the level of knowledge available.

The Alliance recommends design activities and the enabling technology-driven R&D activities to support Combined Construction and Operating License Application (COLA) preparation for both the pebble and prismatic designs be completed. The Alliance further recommends that both COLAs be processed to the point of COL issuance. Engaging the licensing process for both the pebble and prismatic designs through COL issuance removes a major risk envisioned by the private sector in the commercialization of the HTGR technology. At this stage, both designs are still encumbered with major uncertainties regarding the cost and lead time for nuclear licensing and how this licensing process will ultimately impact the design, cost and operations of commercial projects. With this long term commitment to achieve COLs and other risk management approaches, private sector investment becomes viable for the FOAK engineering and developmental projects. The knowledge gained by the developer/owners/operators and end-user community through the COL approval process is critical to the commercial acceptance and more rapid deployment of the HTGR technology.

As discussed further below, nuclear licensing requirements for conventional light water reactors (LWR) are well established; the requirements for non-LWRs are not. As a consequence, the Alliance believes that the licensing activities will compete for controlling the overall Project schedule. Although several preliminary discussions with the NRC have been conducted, formal and regular engagement with the NRC Staff must begin as soon as possible to establish the requirements, guidance, and bases for licensing the HTGR technology. This will entail direct and frequent pre-application (pre COLA submittal) engagement of the Staff to identify and implement the infrastructure changes necessary for licensing HTGRs in the prospective industrial market place. Entergy Nuclear, the leading owner/operator member of the Alliance, will act as the initial applicant in the pre-application process.

The Project must also address the commercial supply chain required for broad commercial deployment of the technologies. This will entail strategic efforts that ensure the emergence and/or existence of a commercial supply infrastructure for specialty equipment and materials (e.g., TRISO fuel; nuclear grade graphite, major reactor system components). The Project's role in infrastructure development will be to enable selected US manufacturing infrastructure to be developed within the private sector. During Phase

1, the Alliance will formulate the approach and the support necessary from the government to establish supply chain infrastructure.

The major decisions anticipated during execution of the project include those summarized in Table 2.0-1.

**Table 2.0-1  
Major Decision Points**

<b>Decision Point</b>	<b>Decision Authority</b>	<b>Section Reference</b>
Selection of Candidate Sites for ESPs	Alliance Management Committee & DOE	2.2.1.3
Economic Viability Assessment	Alliance Management Committee & DOE	2.2.1.7
Proceed with COLA Preparation	Alliance Management Committee & DOE	2.2.1.8
Site Selections for Candidate Projects	Owner(s) & End-User(s)	2.2.2.2
Construction Decision(s) for Candidate Projects	Owner(s) & End-User(s)	2.2.3.1

## **2.1 Overview of Key Project Scope Elements**

### **2.1.1 Defining Target Markets, Sites, Applications and Project Requirements**

The Alliance will expand its efforts to engage with a broader range of potential end-users, to define several target markets beyond those already identified, to identify the range of site requirements and to develop a range of application designs that will form the design and licensing basis for the NGNP Project. As these efforts progress, the Alliance will undertake the role of project developer, owner, owner’s engineer, operator and end-user by initiating the Project development process which will lead to the formation of candidate FOAK facility deployment implementation teams. These expanded market definition efforts will allow the Alliance to formalize its understanding of promising markets, target economics, site and application requirements as guidance to the design teams to ensure that the NGNP reference designs will evolve to support widespread deployment after FOAK efforts are completed.

### **2.1.2 Design of the NGNP FOAK Facilities**

The design activities element of the NGNP Project will entail the completion of conceptual design, as appropriate following the execution of the scope of work described in the FOA-0000149<sup>4</sup>, followed by preliminary and final design activities for both the prismatic block and the pebble bed based designs. These design activities will encompass the nuclear heat supply system (NHSS), the nuclear island (NI), the power conversion system (PCS), the process heat delivery system (PHDS), and balance of plant (BOP) supporting systems, structures and components. The designs will fulfill the following high level

<sup>4</sup> Department of Energy Financial Assistance Funding Opportunity Announcement (FOA), DE-FOA-0000149, issued September 18, 2009, “Next Generation Nuclear Plant Program – Gas Cooled Reactor Design and Demonstration Projects.”

technical, functional and performance requirements as represented in Table 2.1-1 below. A detailed technical specification incorporating these requirements will be prepared by the Alliance as an early Phase I activity.

**Table 2.1-1 Representative High-Level Requirements**

Elements	Requirements
Reactor outlet temperature	750 – 800°C (higher for future high temperature direct heat delivery such as water splitting and catalyst reactors,...)
Nuclear Island power rating	400 – 615 MW thermal (depending on selected end-user application)
Energy delivered as ...	Steam, hot gas and electricity based on the needs of the associated end-user applications. These are expected to include steam turbine generators, steam turbine mechanical drives, process steam, process heat exchangers and reactors, district energy systems, and thermal desalination processes.

These high level requirements represent the anticipated initial applications for process heat from the HTGR designs. However, the Alliance considers that the development of the high temperature hydrogen production capabilities should be continued as part of and within the scope of the NGNP Project to support anticipated later, follow-on industrial applications.

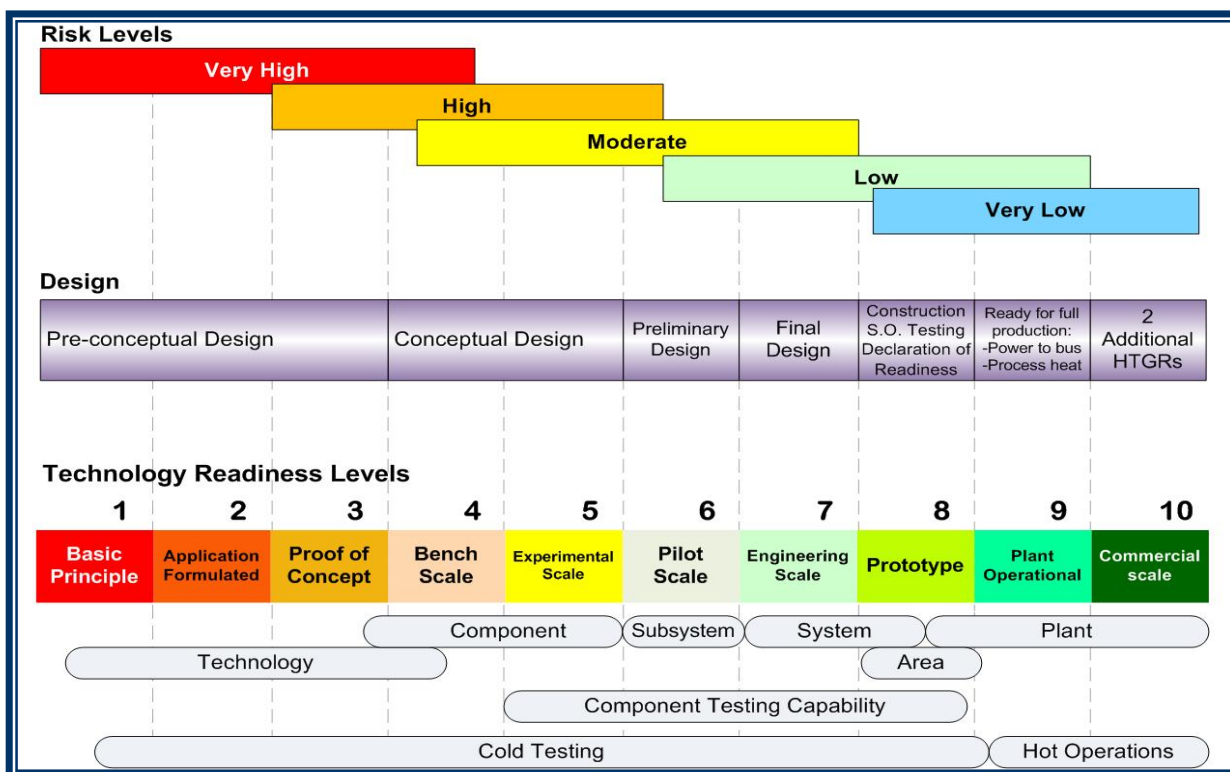
The Alliance will add considerable value to the design teams' efforts by clarifying site and application designs and economics in support of NHSS and application plant optimization. Once COLs are accepted and the NHSS technology is certified for other projects, it is beneficial to avoid amendments to the certification which could delay subsequent projects. Project development efforts must precede and proceed in parallel with NI design in a way that balances project risk, as follows:

- NHSS design bases and safety case work can maximize applicability and value of the technology if they address the widest range of anticipated site and project requirements.
- Design activities typically make assumptions based on experienced judgment, first principles analysis, and/or extrapolation/interpolation of similar design information in order to meet top level user requirements. These are typically documented as “unverified assumptions” that require specific design or development activity to validate the design assumption or require modification of the design once the specific capabilities are determined.
- The risks that initial unverified information proves inconsistent with project requirements can be minimized by introducing a progressive parallel understanding of Project and site requirements and the design evolution process.

As the HTGR designs are being advanced for initial deployment, much of the design efforts are primarily confirmatory in nature. Hence, there is reasonable confidence that the results from the development activities are predictable and that the finalized design

will require a minimum of re-work as application designs are completed much later. Note the examples in Section 2.1.2.

**Figure 2.1-1 Comparison of Project Technical Risk, Design Stage and Technology Readiness Level**



This perspective is further illustrated via the comparative depiction of Project technical risk, design maturity and the technology readiness level in Figure 2.1-1. The Technology Readiness Levels for the NHSS range from 3 to 6 for the major components, subsystems and systems in the two designs recommended for development in the Project.

### 2.1.2 Technology Development

Technology development within the NGNP Project will include the areas of fuels and materials qualification (including graphite), heat transfer processes, and analytical methods development. The scope of technology development work will primarily determined by the Nuclear System Suppliers based on design and licensing needs and will be accomplished at the facilities best suited for the work. The Alliance will provide an oversight function to assure that the work is coordinated for maximum cost and schedule effectiveness. It is anticipated that contracts will be placed with the National Laboratories



and other technology development entities directly to coordinate the required support for the two design teams.

Examples of the anticipated development needs follow:

- TRISO fuel testing, modeling and qualification – primarily development directed toward confirming the anticipated performance derived from experience in previous development and operational testing can be replicated at production scale and within the expectations of the US regulatory process.
- Graphite material testing, modeling and qualification – primarily development directed toward confirming that graphite behaviors of contemporary graphites are similar to that experienced in graphite types used in previous experimental and demonstration HTGR designs, and to specifically qualify the specific material characteristics for use in the current HTGR designs.
- High temperature materials testing, modeling and qualification – a primarily development directed toward extending the material properties for existing metals for the specific design and operating conditions for the HTGR designs. An exception and higher design risk area is the use of composite materials for selected reactor internal structures which is expected to require an iterative design process.
- Analytical methods work to complete qualification of analytical tools and to develop new analytical tools as required.
- For other systems within the HTGR, the development activities are integral with design activities. Here, the development activities lead the design activities with an expectation of employing an iterative process. With a closely coordinated, iterative process, re-work can be minimized. As an example, high temperature metals and composites testing, modeling and qualification.
- Development of prototypic equipment for high temperature service and testing for operational reliability, maintenance, and performance.

### **2.1.3 Design, Construction, and Operation of Test Facilities**

Test facilities will need to be designed, constructed and operated as necessary (or existing facilities within US or abroad will have to be modified) for HTGR systems and components development and operational confirmation separate from the FOAK facilities. In addition to private sector capabilities, the Alliance anticipates the need for certain government facilities and capabilities in order to successfully achieve these Project needs. These facilities include both existing infrastructure as well as new or planned facilities. Examples of this infrastructure are highlighted below.

- Existing infrastructure – Certain government facilities and capabilities are assumed to be available as part of the planning for this Project (e.g., Advanced Test Reactor (ATR); selected capabilities of the Hot Fuel Examination Facility (HFEF) and the Neutron Radiography Reactor (NRAD) at the Idaho National Laboratory).
- New infrastructure – Certain new government facilities and capabilities are assumed to be available as part of the planning for this Project (e.g., the Component Test Capability under consideration for INL).



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A comprehensive description of the required facilities and capabilities will be developed as part of establishing the agreement for the public-private partnership. The government is expected to provide the so-described facilities and capabilities for a pre-agreed scope of work and on a pre-established schedule. This includes assuring that necessary infrastructure funding is appropriated to ensure the reliable operations of these facilities. Maximum utilization of existing international HTGR testing facilities, e.g., Japan, China, South Africa, and the EU, will be planned to minimize the need for additional NNGP Project funding.

## **2.1.4 Licensing**

### **2.1.4.1 Broad Licensing Scope**

The construction and operating licensing and design certification elements are critical to achieving the Project objectives. Licensing activities will include:

- Establishing the licensing framework and basis for the HTGR technology through a combined effort of industry and the NRC
- Preparing multiple Early Site Permits or equivalent site permitting process (up to four) to envelope the range of potential sites for locating the FOAK facility. It is anticipated that the sites to be chosen would include locations such as: 1) an existing industrial site to support a candidate application for providing process heat for cogenerated steam, electricity, and high temperature gas in an industrial facility setting; 2) an existing nuclear plant (preferably near industrial end-users) to provide process heat to local petrochemical and refining facilities – a “brownfield” location; 3) an Oil Sands site in Alberta – to provide foundation for a remote location with substantial Canadian market potential with Canadian funding support; 4) a federal government site where application of the technology is potentially viable. The sites would be chosen to envelope the range of siting issues that are most informative to the licensing process, both in terms of NI design and collocation with other industrial facilities.
- Preparing two COLAs, one utilizing the pebble bed reactor design and one utilizing the prismatic block reactor design, each associated with a corresponding site and specific industrial application. It is intended that the COLAs will be processed with the NRC up to and including the point of COL issuance in order to support deployment of facilities with each technology. Processing of the outstanding issues (e.g., ITAACs) beyond COL issuance will be included in Phase 3, the FOAK deployment phase. While dependent on the site selected, the Alliance anticipates that each COLA will be for a multiple unit license with provision for step-wise construction and operations.
- Submitting two design certification applications, and subsequent receipt of the Design Certifications.

The overall strategy for licensing the NNGP FOAK facilities was summarized in a report to Congress in August 2008 that was jointly prepared by the NRC and DOE [*Next Generation Nuclear Plant Licensing Strategy, -- A Report to Congress*, dated August 2008]. The general assumptions and resulting approach in that report continue to support the strategy being recommended by the Alliance, with certain exceptions including specific



schedule assumptions, the number of designs to be pursued, and the operational conditions and configurations for those designs.

#### **2.1.4.2 General Licensing Approach**

The approach to licensing the HTGR is to establish a process that creates the greatest certainty and shortest path to both the licensing of the NGNP demonstrations and follow-on HTGR commercial plants. For the initial FOAK deployments, this will require defining HTGR specific requirements for aspects of the design different from LWRs and utilizing existing practices and requirements common to all reactors where appropriate. Once the FOAK project COLs are granted, a more permanent regulatory framework can be completed from the precedents established for design certification and commercial COLA development.

From a commercial perspective, the risk management features embodied in 10 CFR Part 52 are important to commercial investors in the Alliance for the NGNP Project implementation and for the subsequent deployment of the technology in the various applications of industrial interest. The strategy envisioned by the Alliance is to establish early and extensive engagement with the NRC in pre-application work for the ESP and COLA. This should help ensure that there is a common understanding on the unique issues involved with the HTGRs and the NGNP demonstration applications, that the requirements for such applications are clearly established and understood, and that there is agreement on specific research and design work required to support these applications. The development of ESP applications also reveals the site, site conditions, emergency planning requirements and owner/applicant requirements such as quality assurance programs – all of which are essential to an effective regulatory process.

Entergy Nuclear, a member of the Alliance and owner/operator and license holder for several LWRs for electric power generation will become the surrogate license applicant for the ESP and COL activities and will take the licensing lead for pre-application discussions with the NRC for the NGNP Project.

It is possible that the follow-on commercial HTGR units will differ from the NGNP demonstrations in important ways, yet still represent a standard, generic offering that can be referenced in multiple COLAs as the technology is adopted by industry. Once the specific requirements for licensing HTGRs are clarified via the NGNP Project, pre-application engagement with NRC on design certification (DC) can commence. The DC applications build on the specific work of the NGNP demonstration to establish fundamental Nuclear Island (NI) configurations as a reference for subsequent use. This DC application program will be funded by the private sector Nuclear Island vendors and will be timed to utilize the valuable outputs of the NGNP Project at each stage of development. The DC application is intended to be submitted in time to complete the review by NRC within a reasonable period after commencement of initial operation of the NGNP demonstration, which would allow feedback from the initial operation of the NGNP to be factored into the DC Application before approval. This allows the earliest possible reference by COL applicants and the shortest path to commercialization.

#### **2.1.4.3 Establishing HTGR Licensing Requirements and Process**

Licensing of HTGRs will require substantive adaptation to the requirements and guidance currently used by industry for licensing-related applications and for review by the NRC. As is well understood, the current requirements and guidance have been developed

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around a limited number of variations on light water reactor technology. Initial licensing of the HTGR FOAK designs will require regulatory changes, interpretations, exemptions or, exclusions as the design and licensing requirements are iterated to achieve a basis for review. Further development of HTGR stable requirements appropriate for commercial rollout of HTGR technology will flow from the foundation built by the NGNP Project.

The extent of the regulatory changes needed for HTGR NI designs will vary based on the safety case for each specific reactor design type, the form of end-use energy delivered, the end-user industrial configuration and the siting of the NI. Areas in which substantive regulatory changes are anticipated include policies and high level technical requirements for emergency planning, mechanistic source terms for HTGRs, reactor containment functional performance requirements, collocation of NIs with industrial facilities and population centers, risk informed safety basis concepts, and a wide range of NI-specific technical requirements and guidance integral to the design of each type of NI.

Without such regulatory initiatives, the environmental, energy security and economic benefits offered by HTGRs may not be realized.

It is recognized that there are important challenges to the NRC in addressing the licensing of HTGRs, including:

- Resources – both personnel and funding
- Technical knowledge and experience of NRC personnel regarding HTGR technology
- Conflicting and shifting priorities of the nuclear industry as the renaissance in the use of nuclear energy moves forward
- Possibly having to accommodate other advanced reactor concepts within the current review processes.

The Alliance will support initiatives to address the objectives and challenges in licensing of HTGRs. In order to improve the focus on this critical effort, the Alliance supports approaches such as the formation of a senior management task force to act as a bridge between NRC, the private sector and the DOE to identify alternative approaches to deal with the extensive list of high level issues that must be resolved to move forward with efficient licensing of HTGRs that have the promise to move nuclear energy into industrial settings heretofore not considered. Such a task force should include experienced representatives from NRC, selected owner/operators, NI vendors, the Nuclear Energy Institute, DOE, and the national laboratories.

Use of the US national laboratories and other large sources of technical and management resources to extend the capabilities of the NRC could provide a competent source of technical capabilities and facilities, and a surge volume for resources. The concept that could be implemented differs from the current task-oriented support provided by the national laboratories and other contractors to the NRC. With the general oversight of the Advanced Reactors Office, these resources could be assigned responsibility for and perform many of what are traditionally NRC staff functions including, for example, establishing the requirements for the safety case for the HTGR, preparing the proposed policy changes and high level technical requirements for consideration by the Commissioners, preparing the review infrastructure (e.g., regulatory guides, review

requirements) and performing the review of license applicant submittals. Pre-application and license application interaction with applicants in a public setting would remain a function of the NRC staff.

Over the longer term, the objective would be to transfer the knowledge and experience of these resources to permanent NRC staff for licensing of HTGRs. However, this approach provides a transition strategy with the primary purpose of addressing the most difficult challenges that face NRC in licensing HTGRs and other advanced reactor technology.

### **2.1.5 Nuclear Fuel Supply**

Ensuring a long-term domestic supply of fuel for the NGNP Project first-of-kind demonstration plants and subsequent commercial HTGR deployment is an important objective in fostering rebuilding of the US nuclear industrial infrastructure. The cost, risk and value added to the NGNP Project associated with fuel supply are driven by multiple considerations including availability of data for reactor licensing and, from a commercial perspective, rights and access to data, intellectual property and pricing assumptions for fuel to be supplied. Because of the long lead time needed for irradiation and post-irradiation accident heating tests to qualify the fuel, agreements on terms and conditions of fuel supply most favorable to the NGNP Project need to be established during Phase 1.

The Alliance considers it essential the pilot coater and compact forming capabilities currently being funded by DOE at B&W (Lynchburg) be completed as planned. The capabilities at the B&W facilities in the US and the PBMR (Pty) Ltd. facility in South Africa will then be sufficient to supply the initial prismatic and pebble fuel, respectively, for the NGNP Project demonstrations. With modest extensions to their current fuel lines, such facilities are capable of producing fuel for refueling of both reactor designs for the NGNP first-of-a-kind demonstrations. Subsequent core reloads and additional demand can be met with parallel construction of larger fuel fabrication facilities. Licensing for such modifications to existing facilities and construction of new facility is anticipated to be straight-forward as such sites are currently licensed to possess and process similar nuclear materials. As the market warrants, PBMR (Pty) Ltd. and potential partners, such as Westinghouse, and B&W are then anticipated to build commercial facilities to fabricate fuel for one or both HTGR designs and establish a bona fide US fuel commercial supply capability.

### **2.1.6 FOAK Facility Construction, Startup & Testing**

Final design, manufacturing, prefabrication, construction, start-up, confirmatory testing, and cost validation must be completed and documented to provide experience and confidence for follow-on projects. The Alliance plans that the option to build two “FOAKs” be included within the NGNP Project. It is anticipated that several candidate projects will evolve through project development and that the option to complete two projects may be supported by owners and end-users for very different sites and applications, depending on the ability to draw private financing and government support at that time and based on the merit of the prospective projects. This deployment decision rests with the private sector; however, the Government will be requested to provide loan guarantees, investment tax credits, standby support, and production tax credits to make these investments commercially viable.





### **2.1.7 Performance of a Commercial Demonstration Run**

After the FOAK facility start-up and commissioning, a commercial demonstration run will be performed. This commercial demonstration run will simulate as close as reasonably possible the steady state plant operations anticipated of a commercial facility. It is envisioned that this commercial demonstration run and initial steady-state operations experience along with the post initial-operations inspections will provide the evidence necessary for commercial entities to make construction decisions for follow-on units.

## **2.2 Phased Approach**

Despite the parallel activities and the natural overlap in the execution of the various tasks, it is useful and plausible to segregate the overall Project into three phases, with the decision to proceed to the latter phases dependent on the outcome of the earlier phases. The Alliance has characterized these phases in accordance with the activities and labeled them as follows:

- Phase 1** Planning and initial design and generic licensing development
- Phase 2** Site(s) specific licensing, implementation planning and project development and design
- Phase 3** Deployment of the FOAK demonstration plant(s) and design certification

In the first phase, a number of activities will be conducted to set the stage for the follow on phases. Contracts and agreements between and among Alliance members will be revised, as necessary, for consistency with the negotiated agreement with the DOE. An Alliance project office will be established to execute the agreement with the DOE. This initial phase will include targeted market evaluations, additional user engagements and application studies, identification of candidate sites, and the preparation of technical guidance documents for the NI design teams emphasizing site and application requirements.

ESP preparation work will be initiated based on the selection of candidate sites and some initial agreement with end-users which support project concepts. The COLA pre-application program with the NRC will be continued, project definition and application designs will be initiated, NI conceptual design work should be completed (if not completed through execution of the scope of the FOA<sup>5</sup>), and more definitive cost estimates for FOAK and NOAK projects will be established. Further, the NGNP licensing strategy will be established and the commercial market potential for the NGNP technologies will be further evaluated and developed.

The second phase will include those activities necessary to complete the necessary design work for COL application for the two (2) HTGR designs – one prismatic block core design and one pebble core design. This second phase should also include the preliminary and final design work for both the NI and application facilities and the preparation, submittal, and review of two (2) COLAs – one for each of the designs in

<sup>5</sup> Department of Energy Financial Assistance Funding Opportunity Announcement (FOA), DE-FOA-0000149, issued September 18, 2009, "Next Generation Nuclear Plant Program – Gas Cooled Reactor Design and Demonstration Projects."





parallel with COLA review, FOAK facility project development activities (owner/operator/end-user contract negotiations, long-lead item procurement, financing, and preparation of project technical documents and detailed implementation plans) should occur.

The third phase of activities should include completion of the final design and commitments to proceed with implementation of one or more demonstration projects. The decision to finance and implement each demonstration project will require a detailed commercial review of each, including financial projections and incorporation of available government supports such as loan guarantees, tax credits and other risk management arrangements such as export financing from international participants. At this point in time, projected energy and CO<sub>2</sub> displacement value streams will be determined and the gap, if any, between revenues and costs will be evaluated to determine the amount of government support needed. The uncertainty of projecting energy and CO<sub>2</sub> values, along with project technical risks, will have to be fully addressed through each demonstration project agreements, technical documents and implementation plans in order to support private financing. The amount of private financing available for each demonstration project will be determined by projected revenues, and would be enhanced in the event that future energy and CO<sub>2</sub> prices rise from what is known today. In parallel with the completion of the COLA review, initial design of the commercial NI should commence as well as the initiation of pre-application work for the Design Certification licensing process.

As activities in each of the first two phases progress and milestones are achieved, better cost definition (capital costs, licensing costs, O&M costs, etc.) will become available. These costs and the anticipated benefits will be evaluated to support the major decisions listed in Table 2.0-1, and will provide the bases for continuing the Project.

### **2.2.1 Planning and Initial Developmental Activities Phase**

In Phase 1, the primary objectives are to:

- (i) Formalize contractual arrangements among Alliance members,
- (ii) Determine whether selection of the Alliance for award by DOE will result in commitments from new Alliance participants in addition to those identified in Section 4.0,
- (iii) Develop site and project requirements as input to the design teams based on further market evaluations, application studies, and identification of candidate sites and projects,
- (iv) Complete conceptual design activities,
- (v) Initiate or continue interactions with the NRC staff to establish HTGR technology and demonstration project licensing strategy and application requirements,
- (vi) Select candidate sites for the NGNP demonstration projects, and
- (vii) Prepare ESP applications for the selected sites.

#### **2.2.1.1 Formalize Alliance Organization**

An operating agreement establishing the legal framework for the Alliance has been drafted and is currently under review by prospective members of the Alliance. This operating agreement describes members' respective rights and responsibilities with respect to governance and business operations. Although this legal framework for the Alliance has been initiated, once a Notice of Award is made, final agreement on and approval of the operating agreement by members of the Alliance will be necessary. During this phase of Project activity Alliance members will explore opportunities for and seek out other organizations to participate in the Project. A special effort to engage with the Alberta oil sands industry as an active participant is anticipated.

#### **2.2.1.2 Establish Contractual Relationships**

It is anticipated that negotiation of the Public-Private Partnership Agreement will potentially require amendments to the operating agreement currently under review by Alliance members and will likely require additional contracts to be executed between the Alliance and other Alliance participants. This task will culminate in the required amendments, supplements, and finalization of the necessary legal documents to address the relationships of the members and equity participants of Alliance as well as those members that are not equity participants so as to ensure the ability of the Alliance to fulfill its obligations under the partnership agreement. The Alliance will, however, need to enter into detailed agreements with the NI vendors establishing requirements for protection of intellectual property, audit rights, reporting obligations and other contractual matters prior to finalization and execution of the partnership agreement. As negotiation of the partnership agreement nears completion, the Alliance's Management Committee will adopt principles and guidelines for budgets, annual retention and implementation of the partnership agreement.

As indicated in Section 2.1.4, Entergy will become the potential license applicant for the COL<sup>6</sup> until site-specific projects are defined through major agreements and commitments. Regulations require a COL applicant to describe its structure, organization, management, ownership, financial responsibility, program information, and other related items in the COL application. These details will need to be resolved in a timeframe consistent with COLA preparation and submittal.

Further, the Alliance will contract with the party or parties selected to prepare the COL applications (including the NI vendor) and will need to contract with one or more owners of the selected site(s) in order to obtain required site investigation and information rights. These contractual agreements will be negotiated and executed in Phase 1.

#### **2.2.1.3 Identification of Candidate Sites**

This task addresses the selection of sites for Early Site Permits, and builds on earlier efforts to identify candidate sites and applications. This will also include preliminary discussions with the host site owners to formalize the conditions associated with the use

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<sup>6</sup> For the purposes of this Strategy, it is envisioned that Entergy Nuclear will be the COL applicant. It is possible, however, that the COL applicant will be another experienced nuclear operator who joins the Alliance after Notice of Award. This outcome would be a function of the location of the site, strong individual preference of a particular Project member, and other related variables. This issue is expected to be resolved in the initial phase of the Project activities.

of the particular site through initial forms of a host site agreement. Prior to selection of a single site for the ESP, the host site owner will be required to contract with the Applicant to establish how the site can be used and what long term conditions are imposed regarding responsibilities, contamination and decommissioning. Also, the site host will have to provide the Applicant and its contractors with access to site information and previous environmental studies and documentation needed in order to proceed with preparation and submittal of the ESP applications. Public announcements identifying the planned use of industrial sites for a nuclear demonstration project will need to be supported by appropriate public outreach efforts to satisfy host site owners that its business will not be hurt by public reactions.

As part of the ESP application process, candidate sites will be scrutinized for environmental vulnerabilities, political and community support, and suitability of site physical, environmental, meteorological, geotechnical and seismic characteristics.

The Applicant in conjunction with the host site owner and prospective end-user will begin the process of structuring the major project agreements for the project.

Based on the selected sites, application designs will evolve as end-user needs can be addressed within their planning time frame. Application designs will be formalized as part of project definition to support project development. As more definitive cost information becomes available and agreements on the commercial terms and conditions evolve through execution of the Phase 1 activities, a more definitive business case can be established. Assuming that a viable business case for each HTGR design can be established, it is anticipated that two potential sites for the FOAK facility (one for each HTGR design) will be chosen for preparation of the respective COLAs. This candidate site selection and designation are required for COLA preparation to proceed.

#### **2.2.1.4 Completion of Conceptual Design**

This NNGP conceptual design work is required to (1) support the licensing process, (2) derive more definitive cost estimates and economic projections, and (3) provide direction for the technology development activities so as to allow the design work to progress in a manner that will meet end-user requirements. While the PPP agreement is being negotiated, the Alliance recommends that the conceptual design work initiated for the scope of the FOA<sup>7</sup> awards be continued.

#### **2.2.1.5 Developing The Licensing Implementation Strategy**

During this first phase of project activities, the Alliance will engage in discussions with the NRC and staff to establish the requirements, guidance and bases for licensing the HTGR technology and designs under 10CFR52 per the DOE-NRC joint licensing strategy. Discussions thus far have indicated a desire on the part of the Staff to proceed with licensing the HTGR designs under the 10 CFR, Part 52 process (Part 52). This Part 52 process accommodates various approaches to plant licensing but generally entails (1) a review of the design addressed in a COLA and ultimately the Design Certification (DC), (2) a review of the site addressed in the Early Site Permit (ESP), and (3) integration of the DC and the ESP into the COL process. In theory, an applicant has the flexibility to pursue

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<sup>7</sup> Department of Energy Financial Assistance Funding Opportunity Announcement (FOA), DE-FOA-0000149, issued September 18, 2009, "Next Generation Nuclear Plant Program – Gas Cooled Reactor Design and Demonstration Projects."



each of these licensing activities in sequence, or combine all of the activities into the COL application. Within these extremes, there exist various options involving overlap of the component parts.

The existing licensing processes and bases for commercial nuclear facilities in the U.S. are based on light water reactor technology. Peach Bottom 1 and Fort St. Vrain, both gas-cooled reactors and built in the U.S. were licensed largely by exception – exception to light water reactor rules, requirements, and guidelines. To capture the full potential of the HTGR technology and set the stage for widespread commercial deployment in the industrial sector will require the establishment of rules, regulations, and guidelines that are appropriate to gas-cooled reactor technologies, the strategy for establishing these new bases will be formulated through a collaborative pre-application review effort between industry and the NRC staff. For the NGNP Project, however, it is important that the foundation for future rules, regulations, and guidelines be developed on a program specific basis, precedents established by trial use and then, in conjunction with the development of design certifications, establish the firm regulatory infrastructure needed for commercialization. This will allow greater flexibility in the initial licensing of the NGNP plants and avoid the extended timeframe of regulatory developments except where absolutely needed for initial plant licensing.

Section 2.2.2 provides a description of the overall approach to licensing planned for the NGNP Project by the Alliance

#### **2.2.1.6 Market Evaluation**

Over the past several years, considerable effort has been expended by both industry and government to identify and quantify the potential market for the HTGR technology. The evaluations thus far have been largely conceptual but the results have clearly indicated not only a huge potential market for the HTGR technology but the results have also shown substantial benefits in terms of GHG emissions reductions and in the preservation of premium fossil fuels. (The reduction in environmental emissions and the reduction in use of premium fossil fuels have been highlighted in Section 1 of this Strategy.) Although the market studies to date have indicated a large market with substantial environmental and energy security benefits, further application assessment studies must be performed. These further studies should include in-depth analyses of user requirements and recommendations to support HTGR conceptual designs (as appropriate), feasibility of deployment, and assessment of the commercial requirements for long term nuclear heat supply.

#### **2.2.1.7 Economic Viability Assessment**

This task entails several key activities to determine whether the HTGR facilities can be an economically attractive investment for the private sector under various future energy price and CO<sub>2</sub> value scenarios. These activities include determining under what circumstances the economic projections support a viable commercial investment, determining the conditions under which debt financing can be structured, as well as determining what government incentives will be required and whether they are realistically available to support deployment of FOAK facilities.

Substantial cost information will be available from the conceptual design activities. This information will be used in economic modeling of specific candidate projects and the results will be a factor in determining the business case. Upon review and acceptance of



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the business case, it is anticipated that the owners interested in deploying the FOAK facilities will engage potential investors and lenders to establish the availability of financing and to determine the associated ownership structure.

Demonstration project risk mitigation will be a critical step, demonstrating that an acceptable, finance-able risk profile can be achieved by mitigating technical and implementation risks through an effective network of agreements, project documents and implementation plans.

Costs for the FOAK demonstration facilities will be higher than the later commercial deployments and therefore government support through tax incentives, loan guarantees, and standby support will be required to make the industry investment in the FOAK facilities economically viable. The specific nature and quantity of this government support will become better defined as the cost and economic projections for the FOAK mature and as likely project revenue projections can be prepared. As conceptual design is completed and as experience with the licensing process matures, overall cost information will become better established and the required incentives better defined.

Results from the studies outlined in Section 2.2.1.6 along with the more accurate plant cost information available from the conceptual design activities should allow interested commercial parties (an owner/operator and an end-user or product off-taker) to begin definitive discussions surrounding site specific commercial arrangements. With the availability of debt financing and the availability of government incentives to support deployment of the FOAK facilities reasonably assured, the viability of the business case between an owner/operator and a product off-taker can be pursued in the final stages of project development.

#### **2.2.1.8 Decision to Proceed with COLA Preparation**

Inherent in a phased approach is the opportunity to evaluate the merits of continuing the project into the subsequent phases. This task affords the Alliance with a formal opportunity to reaffirm their plans for proceeding with preparing the COLAs.

The results of other tasks within this phase particularly completion of the conceptual design, the market place evaluation, and the economic viability of the FOAK facilities will influence the decision to proceed. Should conditions, in the opinion of the Alliance be unacceptable to proceed with the commencement of the preparation of the COLAs, the Alliance will advise the DOE and commence discussions with the DOE to either modify the Project plan in manner mutually agreeable, or terminate the Project.

#### **2.2.1.9 Confirmatory Technology Developmental Work to Support Design**

As described in Section 2.1.2, there will be technology development work that enables or confirms design choices. Developmental activities, as outlined earlier, have already been initiated as part of the NGNP Project being managed by the INL. These activities will continue throughout Phase 1 and into Phase 2 as necessary to support design maturation.

### **2.2.2 Licensing and Deployment Preparation Phase**

During the second phase, the Alliance recommends that sufficient design be completed so as to support the development and submission of a combined Construction and Operating License Application (COLA) for both the pebble bed and prismatic HTGR technologies.





The Alliance also recommends that this second phase of activities include the preparation, submittal, and the processing of the COLAs to the point of COL issuance.

#### **2.2.2.1 Combined Construction and Operating License (COL)**

This task consists of those activities needed to prepare two separate COLAs, one for each HTGR technology, to submit the COLAs to the NRC for processing, and to engage with the NRC staff as necessary during the review process to obtain the COLs for the FOAK facilities. In keeping with the objective of furthering both designs as much as possible, the Alliance intends to submit both COLAs and have each design evaluated by the NRC and carried to the point of COL issuance. The knowledge gained from this approach is a critical input to the overall Project viability evaluation and ultimately the FOAK facility construction decision process for either technology.

As previously mentioned, it is expected that individual members of the Alliance – specifically members that have experience in commercial nuclear operations would be responsible for the preparation of the COLAs. Contractor(s)<sup>8</sup> will be retained by the Alliance for the purpose of preparing the COLAs. These contractors will be selected based on their expertise in environmental, site safety analysis, engineering, and emergency planning. Responsibility for completing tasks will rest primarily with the Project Director and ultimately with the Management Committee (see Section 4.3).

#### **2.2.2.2 Site Selection for Initial HTGR Deployments**

Final selection of sites and applications for the FOAK deployments will be made jointly between the nuclear facility developer/owner and the end-user based on a variety of considerations including the following:

- Receipt of the necessary site permits and licenses
- Economic projections and risk mitigation planning that are satisfactory to an owner/operator as well as product pricing that is attractive to the off-taker
- Execution of a supply/off-take agreement between the owner/operator and the end-user with mutually acceptable terms and conditions

#### **2.2.2.3 Project Development**

Commercialization of HTGR technology for a wide range of applications requires an understanding of the potential market, adequate technical and commercial participation by end-users, and a long term business planning effort that is responsive to the range of issues likely to be encountered in defining, licensing, financing, and implementing projects.

The overall objectives of the initial Project development effort are to:

1. Develop a broader understanding of likely sites and applications,
2. Secure the participation of more potential end-users of the technology,

<sup>8</sup> It is expected that highly competitive pricing can be leveraged should the Applicant seek a single contractor to prepare both COL applications.

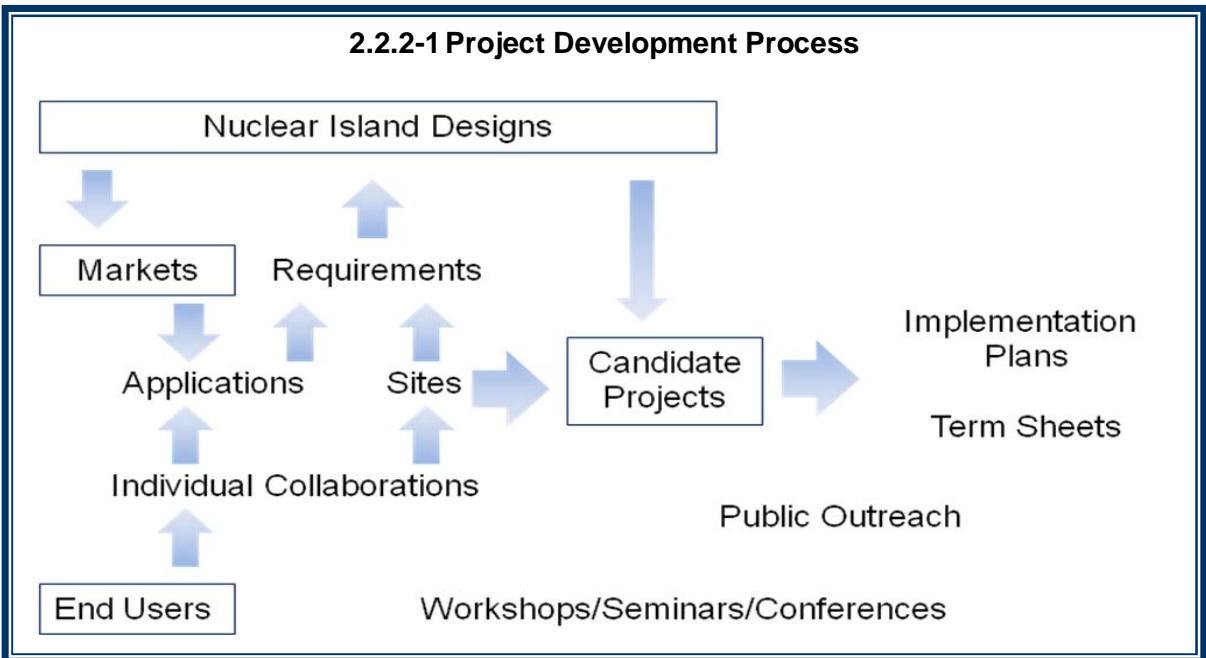


3. Formalize important site, application and planning requirements, which are key drivers of NGNP design and project development.

Successful development and implementation of the NGNP's FOAK facility(ies) and follow-on projects will require a combination of technical and commercial activities leading to the development of nuclear island (NI) designs, identification of Candidate Projects, and engagement with end-users through initial term sheets leading to major agreements.

A Project Development Plan will be formulated to formalize the role of the Alliance in representing the needs of owner, operator, end-users, and other stakeholders normally engaged in deploying conventional industrial projects. Establishing an integrated long term plan for developing HTGR projects is needed to establish credibility with private industry planners to cultivate serious consideration of entering into major project agreements.

The effort to identify candidate projects can be organized into three tasks, as depicted in the process diagram in Figure 2.2.2-1. Key goals of this effort are to define one or more



Candidate Projects and assist in the definition of standardized NI designs that support initial target markets for this technology.

### 2.2.3 FOAK Deployment Phase

Major activities within this final project phase will encompass completion of the final design, long-lead item procurement, construction, commissioning, start-up, and early operational testing activities necessary to satisfy COL ITAAC, to confirm design parameters necessary to obtain Design Certifications, and to confirm operational performance metrics through a commercial operation run. A more detailed listing of the tasks and milestones to be accomplished in this phase will be developed during the earlier phases of the Project. It is premature for the Alliance or its member companies to make a construction decision until sufficient information is established for all stakeholders. In



addition to removing regulatory uncertainty with the NRC licensing process and completion of the project development and design activities, the Alliance’s strategy for Project implementation includes a number of critical activities, such as (1) a market place feasibility determination, (2) the establishment of better cost definition, (3) the availability of FOAK financing, and (4) the identification and subsequent government approval of the incentives necessary to make the FOAK facilities economically viable. Accordingly, once receipt of the COL is reasonably assured and once the business case has been established, a decision to construct will inevitably be made. There is ample evidence from the ALWR development program to suggest that once the business case is evident, the private sector will act. The Alliance anticipates that the construction decision for the FOAK facilities will be made during the latter stages of COL application review.

During the early part of this Phase 3, activities will focus on finalizing the management structure needed to oversee and represent the interests of the owner in construction and establishing the contractual arrangements necessary for procurement of the long-lead time equipment. It is likely that the owner(s) of the FOAK facilities will be one or more Alliance member companies along with additional investors and parties interested in seeing the HTGR technology commercialized.

Prior to any site construction activities, binding financial commitments from the owner(s), the lenders, and other stakeholder participants will be obtained. Further, long lead-time equipment orders will be placed, and the necessary site related permits will be obtained.

The subsections that follow characterize tasks necessary for deployment of the FOAK facility.

#### 2.2.3.1 **Construction Decision**

Once sufficient cost definition is available and deployment of the FOAK facilities appears economically viable, agreements between the owner/operator (or multiple owner/operators) and the vendors will be negotiated. These procurement agreements will, of course, likely be contingent on successful negotiations between the owner/operator and the end-user (product off-taker). It should be noted that ownership of the FOAK facilities will be in the private sector with the exact arrangement to be determined only after completion of the business case evaluation tasks described earlier. The negotiations and decisions regarding a construction decision are also between and among private sector entities – the vendor/supplier teams, the owners/operators, and the end-users.

Following COLA submittal, the owner/operator and end-user members of the Alliance will evaluate the progress of all licensing and engineering design activities, and confirm Project financial viability and financing arrangements. Extensive economic analyses will be conducted and agreements between an owner/operator entity and an end-user entity will be negotiated. The Alliance envisions that multiple owner/operators and multiple end-users will be actively participating in the Project at the time and the precedent in the ALWR program suggests that multiple agreements between multiple end-users and owner operators will likely be established. Consultation with the Government will likely take place to determine and solidify the legislative support required for the initial FOAK facilities as well as any support deemed necessary for the next several deployments. Assuming that appropriate economic conditions exist, the owner/operators and the end-users will exercise the option to proceed with construction. The criteria for making the construction

decision will primarily be those factors that influence the business case. These will include:

- Availability of government support (loan guarantees, construction tax credits, production tax credits, standby support);
- Availability of acceptable financing;
- Availability of an acceptable site with an interested product off-taker;
- Reasonable assurance of receipt of the COL;
- Receipt of the necessary site permits and licenses;
- Economic projections that are satisfactory to an owner/operator as well as product pricing that is attractive to the off-taker;
- Execution of an ownership agreement;
- Execution of a supply/off-take agreement between the owner/operator and the end-user with mutually acceptable terms and conditions;
- Execution of an acceptable procurement contract with the NHSS vendor/supplier;
- Execution of an acceptable EPC contract;
- Execution of an acceptable fuel supply agreement;
- Execution of other major Project Agreements (i.e. grid interconnection, O&M agreement, technical support, etc); and
- Agreement on decommissioning funding strategy and obligations.

Some of these agreements will form at least provisionally to support private investment in the latter stages of preconstruction work, including commitments for long lead fabrication, detailed engineering, and modularization arrangements. Upon construction decision and approximately twelve months prior to initiating construction, the Owner will negotiate and execute certain contracts/commercial agreements with the major suppliers and contractors for construction. Some earlier agreements may be necessary to arrange for fabrication of long lead items. This will ensure that fabrication of long-lead items is properly queued ensuring their timely availability consistent with the construction schedule. Finally, the owner will commence site planning activities and the commencement of site preparation activities permitted under an ESP and/or Limited Work Authorization as applicable.

#### **2.2.3.1.1 Finalize Construction Financing and Agreements**

While preliminary discussions regarding the acquisition of financing, site lease/purchase agreements, and product purchase agreements will have been initiated during the initial phase of activities, these agreements and arrangements must be finalized to support commencement of construction. This activity will focus on finalizing the agreements between the Owner and investors, the government, and other lending institutions. It also includes finalizing the financing arrangements and the contract with the NI vendor so as to support construction, begin acquisition of the long lead items, and begin site preparation work. The Owner will also finalize any product/power purchase agreements with the end-user.



#### **2.2.3.1.2 Construction Communication Plan**

While there will be a communication plan established early in the Project, the event of commencing construction will have special significance to the public and exposure to the stakeholders. Early in this phase of activities, a construction-specific communication plan will be developed so that the objectives of the Owner and the prospective end-user are properly and timely communicated to the public. The construction communication plan would be an ongoing effort dedicated to the promotion of the construction objectives as well as to the inherent benefits of utilizing nuclear in the broader energy market place. Close coordination with the DOE and the Nuclear Energy Institute are expected, as well as local and national community outreach to garner public support for the Project and its objectives.

#### **2.2.3.5 Construction Management**

After a Construction Decision is made, the Owner will commence establishment of its construction organization. Selection of the Construction Management (CM) organization will occur under this task. Following selection, the Owner will establish the appropriate contractual relationship with the CM organization. Contracts with other supporting parties, as may be necessary, will also be negotiated and executed at this time.

Once construction decisions for the FOAK facilities are made, the NI vendor/supplier teams will begin implementing their construction management plans. In order for costs to be definitively determined and for the business case to be established, the vendor/supplier teams will have had to develop their construction project management plans and have submitted these to the prospective owner(s) for evaluation.

#### **2.2.3.6 Site Preparation**

Within this work scope, non-safety related construction activities pursuant to an ESP and if requested, a Limited Work Authorization (LWA) would be managed and performed. These activities would include clearing, dewatering, grading, transmission facility modification or installation, office building construction, and other actions needed to prepare the site for safety-related construction. At this time, the Owner's construction quality program and other administrative controls would be finalized and implemented.

#### **2.2.3.7 Facility Construction**

This category of tasks encompasses the activities for the Owner's Engineer to oversee the actions of the NI vendor/supplier organization and to manage site construction activities not included within the scope of the NI vendor's contract. Activities included within the scope of this task are all site work and construction activities needed to achieve commercial operation of the particular FOAK facility. It includes assurance that the licensing activities necessary to satisfy the terms of the COL and EIS with respect to inspections, tests, analyses and acceptance criteria (ITAAC) are integrated into the Construction process and satisfactorily accomplished.

#### **2.2.3.8 Staff, Organize & Train Operating Staff**

At the appropriate time, the Owner's organization that will be needed to support the operation of the new FOAK facility will be established. This will include the on-site, as well as the off-site support staff. These individuals will be trained in keeping with their job



classification, such that at the time of fuel load, licensed operators and other support staff needed to properly operate the facility are in place.

#### **2.2.3.9 Fuel Load, Start-up, and Operation**

In conjunction with establishing the appropriate qualified staffing, this task involves those actions commencing with the NRC's approval to load fuel, construction finalization, power ascension, and startup testing, and ultimately concluding with commercial operation.

#### **2.2.2.10 Design Certification (DC)**

This task consists of the activities needed for both designs to obtain a design certification pursuant to 10 CFR 52, Subpart B, *Standard Design Certifications*. The activities to obtain a DC include: 1) preparation of the Design Control Document (DCD) submittal of the DCD (application for design certification); 2) review of the application by the NRC; 3) receipt of the draft and final safety evaluation reports (SERs); 4) opportunity for public hearing; and 5) granting of the design certification by the NRC.

The design certification applications will be submitted following commencement of prototype construction. It is anticipated that only a conditional or draft SER will be granted until such time as the prototype facilities are built and confirmatory testing provides the remaining demonstrated bases for issuance of the final Design Certification SER. However, it is important to recognize that a design certification application that has been accepted by NRC for review establishes the point that follow-on commercial projects can reference the design certification and not have to repeat the development in individual COLAs. This process is a significant step in the early commercial fleet deployment subsequent to the NGNP Program.



## **3.0 Project Costs, Risk Mitigation, & Cost Share**

### **3.1 *Estimated Project Cost***

The overall reference cost estimate for the NGNP Project is on the order of \$6.8 billion (2009\$) through all the design, research & development, licensing, construction, and initial operations phases for the reference baseline project schedule for two FOAKs constructed at two different end-user sites. There is, at this early stage of the overall project, uncertainty in this estimate - particularly regarding construction costs, since limited design work has been completed on the NI process heat designs.

The current estimated cost information for the overall NGNP Project was developed from input by the three design teams (led by Westinghouse, AREVA and General Atomics) that participated in the pre-conceptual design phase of the NGNP Project. These estimates were then evaluated by the Idaho National Laboratory (INL), normalized for differences in costing methodology and scope to come up with the overall reference cost estimate for the Project. The reference cost estimate has been reviewed by the Alliance at a summary level and concurred with as a reasonable starting point for overall Project planning.

### **3.2 *Business Risk Mitigation & Industry Investment***

From the Alliance's perspective, the primary consideration in determining whether Government support is warranted in mitigating business risk is whether a substantive national interest is being served. Contemporary issues such as reducing greenhouse gas emissions, improving energy security through reducing energy imports, resource stewardship, energy cost stability, and improving the nation's long-term economy through growth of domestic industry are all of substantive national interest. Each is addressed in important part by the development and implementation of HTGR technology and should be weighed in determining the extent and form of such risk mitigation in support of commercialization of the HTGR and supporting technologies.

Once it is determined that substantial national interest is being served, there are several key areas where the Alliance considers that Government assistance is warranted to enable commercialization of the technologies. These key areas include:

- Sharing the cost and risk of technology development where such investment cannot yet be justified by a credible business case and acceptable business investment risk;
- Supporting the development of the regulatory infrastructure and processes within the NRC; and
- Facilitating financing and improving the early business case by providing vehicles similar to the approaches taken in EPAct 2005 for Advanced Light Water Reactors.

Business risk includes many considerations, but can be reduced to a common denominator of whether the financial exposure is adequately rewarded by the anticipated return on investment. Considerations such as market viability, size of investment, and time to realize a return on investment are all factors.





Commercialization of the HTGR technologies involves specific areas that warrant sharing of risk by the Government. The nature and substantial degree of the risk inherent in these specific areas of development cannot be justified as conventional business investments.

- **Specific technology development** including the high performance TRISO fuel, graphite structural material, high temperature metals and composite materials, heat exchanger design for energy transport from the Nuclear Heat Supply System to the end-user applications, including advanced hydrogen production.
- **Licensing infrastructure and process development** within the NRC to modify and augment existing light water reactor requirements and guidance to make these applicable to HTGRs and their end-user applications. This includes anticipated modifications to current policies regarding emergency planning, collocation with industrial facilities and containment performance.
- **Early design activities (conceptual and preliminary design)** that directly support and are directly affected by the anticipated design iterations and re-work as licensing infrastructure and process are matured.
- **Assistance in obtaining financing and ensuring a viable business case** for construction and initial operations of a first-of-a-kind demonstration facility(ies) through such mechanisms as loan guarantees, investment tax credits, production tax credits and regulatory “standby support.”

The risks associated with the first, second and third items can be addressed via cost sharing between the Government and the Industry. As shown in comparing the timeline in Figure 3.2-1<sup>9</sup> and the proposed cost share models summarized in Figure 3.2-2<sup>10</sup>, the extent of Government cost share decreases as the scope of confirmatory technology development lessens, the licensing infrastructure matures, and the design uncertainties are reduced. The remaining final design and construction activities are fully funded by Industry under the provisions of the fourth item that is basically a “Government insurance policy,” the premium for which is paid by Industry.

In summary, the highest risks associated with the project are at the initial stages of development, design and licensing. Several hundred million dollars of private investment would be at risk in this initial period. Once these initial risks are addressed and market viability of the HTGR technology can be established with more confidence, then commercial decisions can be made to go forward with constructing the FOAK facilities and planning for the follow-on initial fleet. Hence, constructing the FOAK facilities and follow-on fleet becomes a more straight-forward commercial business decision from a risk perspective. Even so, private sector investment for building the FOAK facilities is at risk for several years until such time as market viability can be established.

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<sup>9</sup> This NGNP Project Baseline was developed by the INL and has been used by the Alliance for illustrative purposes only. Timeline durations and timing will be confirmed/established as part of the Phase 1 activities.

<sup>10</sup> Figure 3.2-2 charted from data in Table 3.3-2 (page 44)



Figure 3.2-1 NGNP Project Baseline Tim eline

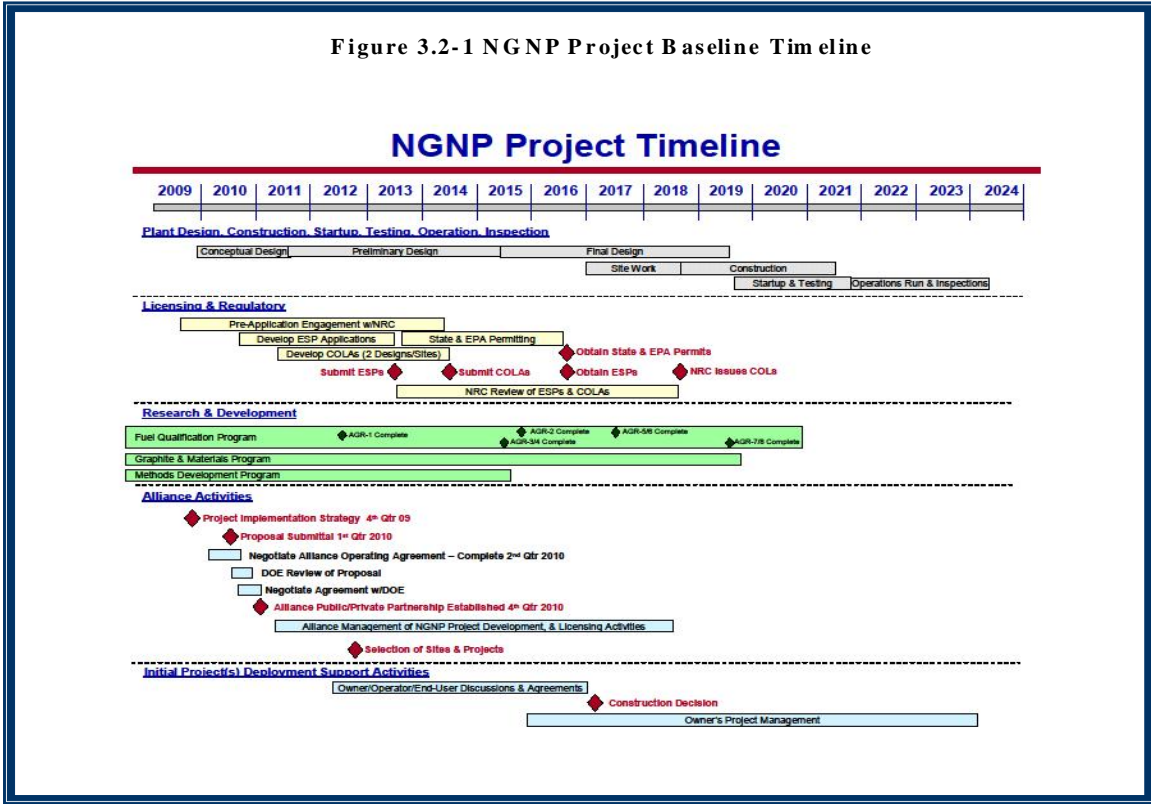
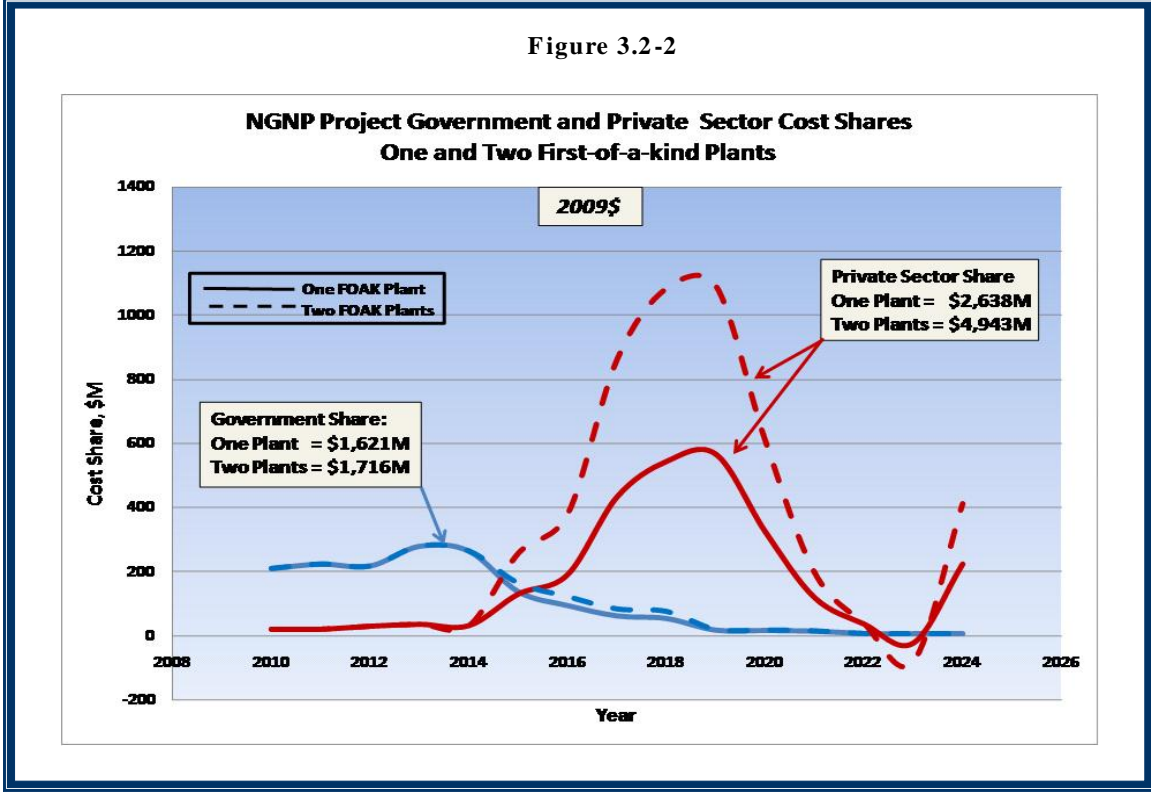


Figure 3.2-2



### 3.3 Proposed Cost Share Model

This Project Implementation Strategy envisions a cost – share of greater than 50% by private industry over the life of the project. In the initial phase of the Project, as described in Table 3.3-1, the Alliance is proposing 100% funding by the US government. While the Alliance recognizes that the cost sharing scheme presented in this section may not appear to be consistent with that documented in EAct 2005, we do believe that it meets the overall cost sharing objective of that legislation and also provides an acceptable investment risk profile for the private sector. There are several reasons for the suggested cost-share profile.

**Table 3.3-1, Phased Approach to the NNGP Project \***

<b>Phase 1 Activities</b>	<b>Phase 2 Activities</b>	<b>Phase 3 Activities</b>
<b>Conceptual Design</b>	<b>Preliminary Design</b>	<b>Design Finalization</b>
R&D	Final Design for systems important to safety	Construction, Startup, Testing, Operations
Licensing “Pre-Application” Activities	Design to support the development of 2 COLAs	Design Certification (development and submittal)
Licensing Activities (NRC Fees, Contracted Labor Associated with ESP & COLA Development)	Design to support the NRC review to acquire ESPs & COLs	NRC review of construction testing program and ITAAC closure
<b>Funding Profile</b>	<b>Funding Profile</b>	<b>Funding Profile</b>
100 % Government + “in-kind” private sector contributions	80 % Government / 20% Industry	100 % Industry + Government risk management

\* The Alliance “Phases” differ from those defined in FOA – 0000149 and those specified in the EAct 2005.

The NNGP Project is expected to extend about twelve years before commercial operation of the initial FOAK facility. After commercial operation, it is envisioned that other orders will be forthcoming in the marketplace for this type of HTGR plant. It will be many years, however, before a return on private sector investment can be realized from pursuing this technology. A time scale of this magnitude is well beyond current private sector practice for any appreciable investment or cost-share other than exploratory ventures.

Further, the federal policy structure that will make the HTGR commercially viable does not presently exist. Concerted long-term government action to implement policies that contribute to climate change mitigation, national security, energy security, and job creation will all likely contribute to a positive policy environment for the HTGR. Today, this environment does not exist, however, and the risk level for success without such policy in place is high. The uncertainty and variation in support for this Generation IV HTGR Project within DOE over the past seven years is one indicator of this lack of a policy structure.

With this underpinning argument and the risk mitigation discussion in the preceding section, the Alliance recommends a cost share scheme as summarized in Table 3.3-1 that covers the entire life of the NGNP Project presuming that there is a decision to license, build and operate at least one FOAK facility. Increasing detail regarding estimated costs and cost sharing will be a deliverable during Phase 1 of the project after additional design and engineering is completed, pre-application interaction with NRC has progressed and the project risks are understood better.

As indicated, the Alliance envisions the NGNP Project will be implemented in phases with increasing industry commitment and cost sharing as the costs, risks and timeline are understood and demonstrated to be manageable. Where uncertainty and risks are high, the majority of the cost sharing should be by government. As the Project progresses and a better understanding of these factors are understood, industry will pick up more of the Project cost. Based on the successful completion of the recommended scope of the overall NGNP Project, the cost sharing for the government is anticipated to be less than 50%.

Separately and additionally, there are opportunities for cost sharing with other countries through international cooperative agreements, most notably with South Africa, Canada, Japan, Russia, the EU, and China that will be pursued through the Alliance and Partnership activities.

**Table 3.3-2 Estimated Government Funding and Private Sector Cost Share**

One FOAK		Estimated Government Funding and Private Sector Cost Share															<i>(in millions \$)</i>
FY	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024		
DOE	\$221	\$244	\$252	\$324	\$317	\$173	\$123	\$84	\$75	\$26	\$26	\$24	\$12	\$12	\$12		
Private Sector*			\$26	\$41	\$37	\$158	\$239	\$563	\$730	\$787	\$467	\$178	\$57	-\$36	\$365		

Two FOAK		Estimated Government Funding and Private Sector Cost Share														
FY	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	
DOE	\$221	\$244	\$252	\$324	\$317	\$207	\$160	\$114	\$107	\$30	\$28	\$25	\$12	\$12	\$12	
Private Sector*			\$26	\$41	\$37	\$313	\$477	\$1,121	\$1,456	\$1,517	\$876	\$295	\$59	-\$127	\$672	

\* - Not including "in-kind" contributions

Applying these cost sharing principles of Table 3.3-1 to the overall scope of the project, as described earlier, and allowing for a 3.3% annual inflation rate, the Alliance projects the following funding requirements for DOE's budget planning purposes as shown in Table 3.3-2. As indicated in the table, the DOE annual costs decline rapidly as deployment of the FOAK facility by the private sector is initiated. Also shown in Table 3.3-2 is the cost share by the private sector consistent with the funding model in Table 3.3-1. Annual



funding estimates shown in Table 3.3-2 are provided for planning purposes and are based on the best available information<sup>11</sup>. The values shown in Table 3.3-2 and the curves depicted in Figure 3.2-2 reflect the deployment of one or two FOAK demonstration facilities. As indicated earlier, an important deliverable of Phase 1 will be a detailed cost estimate and implementation timeline for the remaining scope and subsequent phases of the Project to include refined numbers for the one and two FOAK options. This will then form the basis for subsequent preliminary design, final design, construction, and initial operations cost estimates.

### **3.3.1 Historical Investment by the Industry**

This cost share model shown in Table 3.3-1 does not demonstrate the considerable historical investment that has been made by members of this Alliance, particularly Westinghouse, PBMR (Pty) Ltd, AREVA and General Atomics that has brought the HTGR to its current state of maturity.

In the 1960s and 1970s, General Atomics invested over \$1 billion dollars (an amount that would be substantially more if converted into today's dollars) developing its prismatic core design. These investments have resulted in the design, construction and operation of two early generation HTGR commercial demonstration units in the U.S. and the associated unique and invaluable operational experience and data. In addition, there has been extensive General Atomics development of computer codes and models for HTGR core design as well as plant design and analysis. General Atomics and its partners have also demonstrated important innovations in prismatic fuel design and its manufacture, nuclear grade graphite, helium heated steam generators, and HTGR core configurations.

More recently, Westinghouse has invested on the order of \$100 million to understand and further develop the PBMR technology. Westinghouse has gained substantial experience in fuel manufacture and operations, and in the development of instrumentation and controls systems. In addition, Westinghouse has supported the PBMR (Pty) Ltd. company in the development of their staff, including safety culture, ASME code and standards for high temperature materials, and their licensing strategy. In total, the investors in PBMR (Pty) Ltd. have spent approximately \$1 billion over the last decade to build a nuclear engineering company of approximately 900 people, develop analysis methods, create plant and equipment designs/specifications, develop fuel manufacturing processes and full scope laboratory to make prototypic pebbles, conduct fuel irradiation testing, build full scale, full temperature, and full pressure facilities to test critical systems and components and to test the thermal hydraulics of pebble cores, and establish a licensing basis for demonstration HTGR plant.

Over the past decade, AREVA has invested approximately \$100 Million to further the development of the prismatic high temperature gas cooled reactor technology. They have collaborated with General Atomics in the conceptual design of the GT-MHR for consuming weapons plutonium. Subsequently, AREVA initiated the ANTARES project which resulted in the definition and exploration of R&D in many critical HTR technologies, as well as a pre-conceptual design of a combined cycle power generating HTR. This ANTARES project effort answered many crucial questions about the technology.

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<sup>11</sup> The cost information was developed from the three vendor teams (led by Westinghouse, AREVA and General Atomics) during the pre-conceptual design phase of the NNGP Project and normalized for differences in costing methodology and scope to come up with the estimated values in this table.

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This prior investment by the participating supplier teams has established a unique base of experience that will be essential in the success of the NGNP Project.

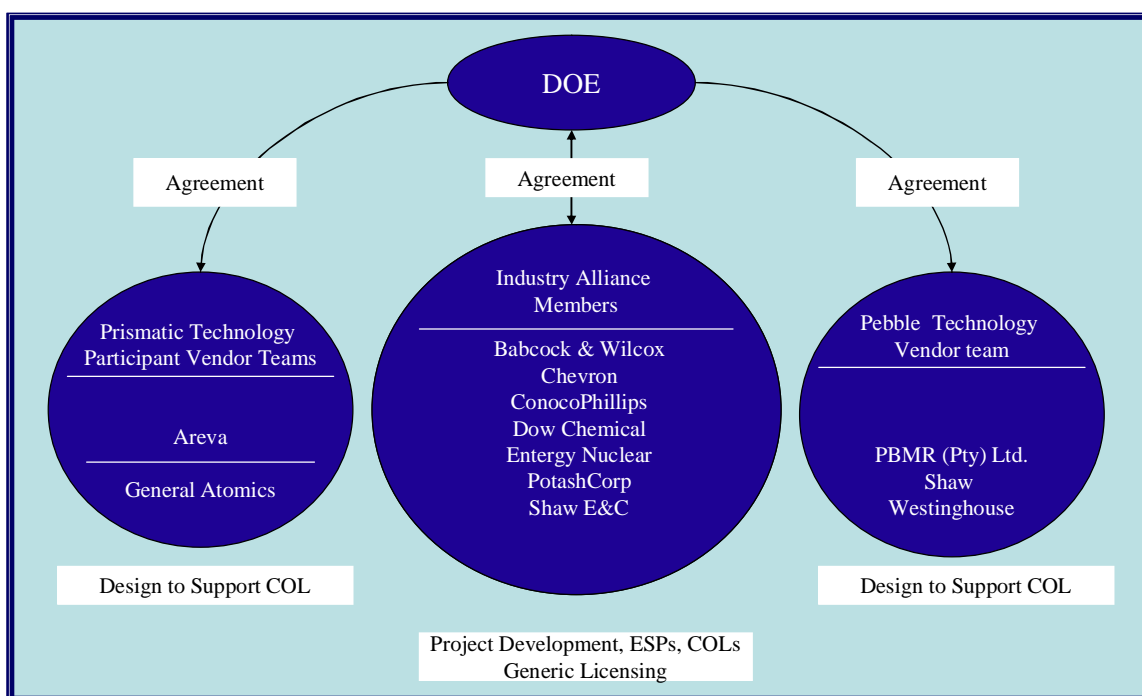


## 4.0 Public Private Partnership

While this recommended Strategy is being submitted by the Alliance, it is supported by and has the commitment of private sector companies comprised of nuclear system vendors, nuclear facility equipment suppliers, an experienced commercial nuclear operator, and a variety of major industrial end-users. Because the Alliance is comprised of vendor/supplier teams, a commercial nuclear operator, and companies that have an interest in and need for the products from the NGNP technologies, the NGNP Project will have the benefit of objective commercial decisions in design, licensing, and deployment. The Alliance intends to utilize key personnel that have been actively engaged in the NGNP Project efforts thus far to manage and direct the activities of the Project. These experienced personnel will ensure smooth transition from a government managed project to a private sector managed project. The Alliance's intentions regarding organization and management of the Project are presented further in this section and in Section 5.

The Alliance is planning to use the NuStart and NP-2010 Public / Private Partnership structure as the model for the NGNP project. Figure 4.0-1 below depicts this proposed structure<sup>12</sup>.

**Figure 4.0-1 Public /Private Partnership Structure**



As indicated in Figure 4.0-1, however, the emphasis for the participating vendor teams is performing the design work necessary to support COL application preparation and acquisition as well as in supporting the Alliance in the overall scope of activities as addressed in Section 2 of this document.

<sup>12</sup> General Atomics has been an active contributor to the Alliance, but did not sign the memorandum of understanding as a full member.



#### **4.1 The Proposed Nature of the Public/Private Partnership**

The mission of the Alliance is to work with Government to commercialize High Temperature Gas-cooled Reactor technology expanding the use of clean nuclear energy and significantly reducing the dependence on premium fossil fuels.

The private sector Alliance is being established for the specific purpose of leading the NGNP Project development effort consistent with the sense of urgency and pragmatism used in significant industrial projects of this nature. Prospective members of this Alliance represent the future marketplace and the suppliers to that marketplace for the commercial deployments of the HTGR technologies and believe that leadership of the NGNP Project by the Alliance is essential for success.

The Alliance will:

- Work with end-users to identify candidate sites and applications, and to understand implementation requirements and market potential
- Select the most promising sites and applications for ESP licensing and COL development for one or more FOAK demonstrations
- Develop the user requirements, specifications, and operational standards for the NGNP to ensure that the commercially deployed design meets the end-user community requirements and that it provides a commercially attractive investment
- Guide the NGNP Project to ensure that the HTGR technology and the two designs are demonstrated and are licensable in the U.S. (Successful demonstration of the designs and licensing by the Nuclear Regulatory Commission are essential elements in the commercial sector deployment strategy.)
- Develop a Project funding plan and establish a formal risk/cost sharing arrangement with the Department of Energy based on the cost sharing model described in Section 3.3 of this Strategy

The Alliance recommends that a public-private partnership be established with the Department of Energy and envisions a functional relationship consistent with that depicted in Figure 4.0-1. During Phase 1, the specifics of the appropriate agreement with the DOE will be established. At present, a Technology Investment Agreement (TIA) appears to be the preferred vehicle for the partnership. It is envisioned that the Alliance will assume full management responsibilities for the NGNP Project once such an agreement with the DOE is executed.

To complement the Alliance activities it is expected that separate agreements will be place with the vendor/supplier teams. These teams will enter into agreements that will complement the Alliance agreement with the DOE. Work performed by the vendor/supplier teams will be managed by the vendors in response to the requirements established by Alliance. Oversight of their activities will be provided by the Alliance as the agent for the DOE. As the most promising sites and applications are selected for development as the NGNP Project, the Alliance will initially act as the project developer, owner, owner's engineer and operator until commercial teams form to finance and implement this work.



Governance of the Alliance will reside with the membership through Management Committee comprised of executives from the member companies of the Alliance analogous to that for NuStart in the NP-2010 program. The DOE will have representation on this Management Committee. It is anticipated that this representation and authority will be delineated in the agreement with the Alliance and similar to that in the NP-2010 program and NuStart. This Management Committee will have oversight responsibility for the operations of the Alliance as well as the activities associated with execution of the NGNP Project. It is currently envisioned that a small staff will be employed by the Alliance as functionally shown in Figure 4.0-1. This staff will manage the partnership with the DOE, maintain ongoing communications with members regarding Project information, and potentially perform such functions as outreach and public relations. Additionally, it is anticipated that the Alliance will secure the services of an experienced project management organization to direct the day-to-day activities of the NGNP Project on its behalf, manage the licensing efforts, establish/maintain requirements, conduct assessments, etc.

The Alliance, through its project management organization, will employ commercial project management tools and techniques to manage the NGNP Project. These contemporary project management tools and techniques have proven effective in major commercial projects and are fully capable of meeting mission performance objectives as well as environmental, safety, health, and regulatory standards. The Alliance acknowledges the need for, and will support, the inclusion of provisions within the partnership agreement to satisfy the DOE's statutory responsibilities associated with a major project, such as selected aspects of DOE O 413.3, "Program and Project Management for the Acquisition of Capital Assets." The necessary information to fulfill these DOE statutory requirements and any conditions that affect ongoing decisions by the Management Committee (e.g., change control) will be specifically delineated in the partnership agreement as required.

The project management organization established to implement the NGNP Project will be guided by commercial interests and sanctioned by the major Project Agreements. Initially, the Executive Director of the Alliance will represent these interests before commercial agreements develop a formal project organization that represents the Owner/Operator entities. This project management organization, managed by the Project Director, will:

- Act as the agent for the Alliance and as the agent for the DOE to the extent established in the agreement for the Alliance
- Manage the agreement interface with the DOE and change control regarding scope and cost
- Define the scopes of work and direct the activities of the various entities performing work throughout the various phases of the NGNP Project
- Establish the technical, functional and performance requirements for the NGNP FOAK facilities
- Review and advise on the design and technology development activities performed by and for the vendor/supplier teams based to ensure that the technical, functional and performance requirements are being satisfied.

- Maintain, as may be required, separation of design and licensing work by the vendor/supplier teams to protect confidential and proprietary information, and manage identification of Intellectual Property as appropriate to each of the teams, the Alliance and other service providers
- Contract for and contractually manage the R&D services as required for the project

The Alliance seeks to partner with the US Government to complete design, development and licensing activities and build the FOAK facilities – in short, to enable commercialization of the HTGR technology. As discussed in Section 1, the HTGR technology is an essential part of achieving the long-term national environmental and energy security goals – clearly a government interest. The private sector end-users and vendors anticipate that in the future, once demonstrated, the HTGR will become a viable market-driven energy supply technology, stabilizing both the price and supply of energy – of major interest to the private sector.

## 4.2 Alliance Members

The Alliance members are listed in Table 4.2-1 below. At the present time, members of Alliance fall into two categories as follows: 1) Full Member companies each of which have indicated an interest in contributing both cash and in-kind services to the Project; 2) Contributory Services Member companies which intend to initially commit only non-cash resources to the Project.

**Table 4.2-1  
NGNP Industry Alliance Members**

Name	Full Member	Contributing Member
Areva	X	
Babcock & Wilcox	X	
Chevron		X
ConocoPhillips		X
Dow Chemical Company		X
Entergy Nuclear	X	
General Atomics <sup>13</sup>		X
PBMR/WEC/Shaw Team	X	
PotashCorp		X
Shaw Energy and Chemicals	X	

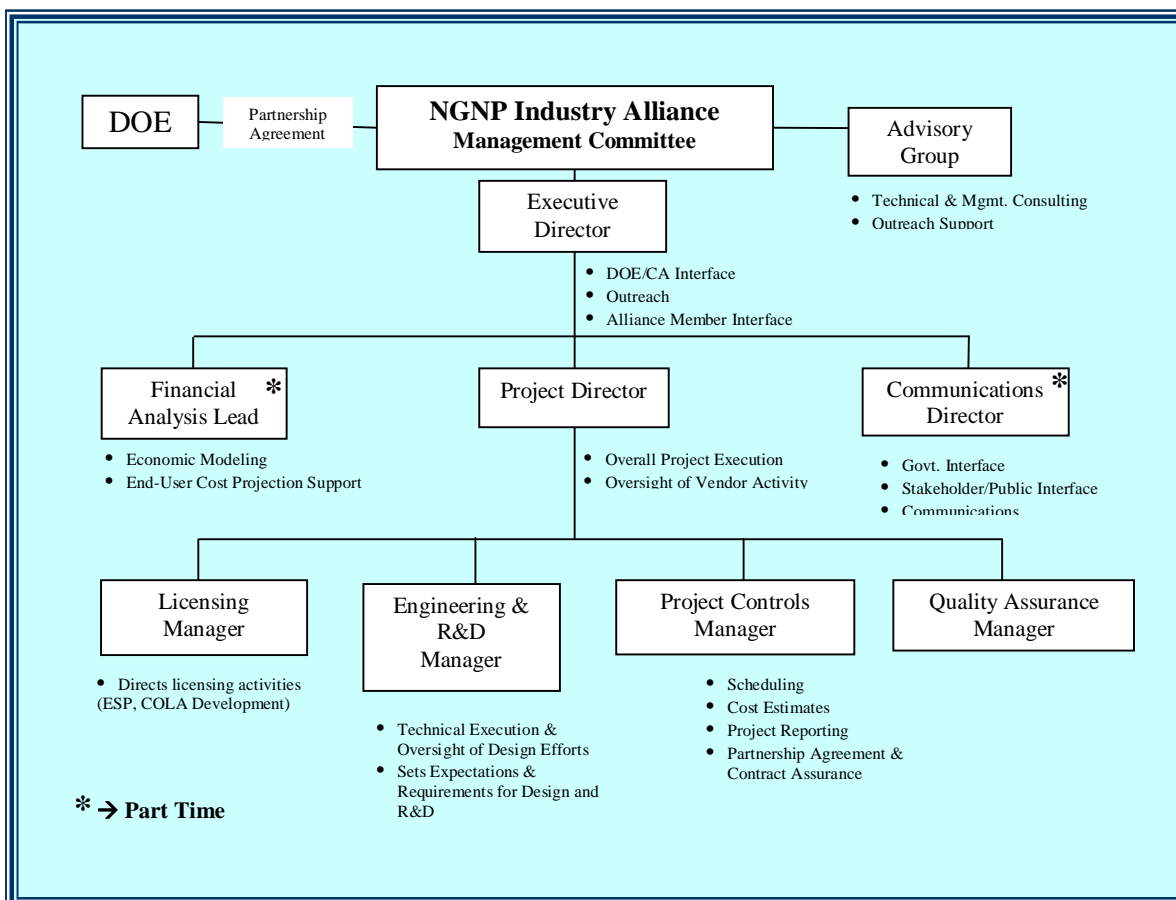
As indicated in Section 2 of this document, current Alliance members will engage in outreach efforts to encourage participation by additional parties. These outreach efforts will continue throughout Phases 1 & 2 of the Project.

<sup>13</sup> General Atomics has been an active contributor to the Alliance, but did not sign the memorandum of understanding as a full member.

### 4.3 Project Organization

The Alliance is prepared to implement the NGNP Project as further defined in Section 5.0 of this proposal. Member companies will staff key positions within the Project organization and establish contracts with key individuals who have extensive experience with the NGNP Project and the HTGR technology to ensure effective execution of the NGNP Project scope and successful achievement of the NGNP Project objectives.

A Management Committee, comprised of a senior executive from each of the Alliance member companies, will oversee the Project. Day-to-day Project activities will be managed by a full time Executive Director. A project team comprised of experienced



personnel will be assigned to manage the discrete functions necessary to achieve the Project objectives. The vendor/supplier teams and other contractors to the Alliance will support the needs of the Project Team.

**Figure 4.3.1 Functional Project Organization**

The Alliance will apply special emphasis overseeing the activities of the NI vendor/supplier teams through an individual designated as the “Project Director”. This Project Director will provide general oversight for the overall licensing, development, and design activities, and ensure that the vendor/supplier teams conform to owner, operator and end-user requirements as developed and maintained by the Alliance.



The Executive Director will receive strategic direction from the Management Committee. One individual of the Management Committee will be assigned as the primary point of contact between the Alliance and the DOE. Key positions identified in Figure 4.3-1 are briefly discussed in Section 4.4. Further discussion on the functional organization is provided in Section 5.0

## **4.4 Key Project Personnel**

### **4.4.1 Alliance Lead Representative**

An Alliance member company executive will be elected President of the Alliance and designated by the Alliance to be the primary point of contact between the Alliance and the DOE. In this capacity, the President of the Alliance will execute on behalf of the Alliance, all agreements and amendments thereto with the DOE in connection with this Project.

### **4.4.2 Management Committee**

The Management Committee will be comprised of a senior manager or an executive (and an alternate) from each of the Alliance member organizations. This committee will have responsibility to oversee the activities of the Project and ensure that the tasks of the Project are being accomplished in a manner acceptable to the Alliance participants and the DOE.

### **4.4.3 Project Team Personnel**

The Project will be supported by a number of key individuals with specific assignments aimed at achieving the objectives of the Project. Each position is discussed in more detail below.

#### **4.4.3.1 Executive Director**

The Executive Director will have overall responsibility for the conduct of the Alliance tasks necessary to satisfy the objectives of this proposal and the terms of the agreement with the DOE. This Executive Director will answer to the Management Committee and will be the primary point of contact and interface with the Management Committee and the DOE. The Executive Director will also direct the outreach efforts to stakeholders, members of Congress, and other potential end-users, as deemed appropriate by the Management Committee.

#### **4.4.3.2 Project Director**

The Alliance acknowledges the importance and key role that the NI vendors have in satisfying the NGNP Project objectives. The Alliance further recognizes that the NGNP Project requires developmental activities and licensing activities that must be coordinated and integrated with the design and licensing activities being conducted by the vendor/supplier teams. As one or more specific projects are defined through major agreements, including an Ownership Agreement, the Owners will then form a management team that will implement the project and represent the needs of the private investors in the project. The Alliance will shift its role to coordinate overall long term NGNP Project and commercialization objectives.

During the initial phase of the Alliance's Project efforts, a Project Director will be designated and functionally report to the Executive Director. This Project Director will





provide oversight of the licensing, engineering design, and technology development efforts. The Project Director will also be responsible for maintaining the overall project schedule, monitoring vendor/supplier costs and performance, and compiling reports as required by the agreement.

#### **4.4.3.3 Financial Analysis Lead**

The Alliance will assign an individual with the responsibility for collecting the information needed by the Alliance member companies' business development representatives. Assigning a single point of accountability to collect the needed information will ensure that consistent objective information is being used by all owner/operator & end-user parties in their financial analysis of each design. The Financial Analysis Lead will also support the Alliance members' internal analyses, as necessary, with the Decision to Proceed with COL Preparation task outlined in Section 2.2.1.8, as well with any financial analyses that may occur as the Alliance Member companies commence internal consideration regarding HTGR utilization at member owned sites. The Management Committee will select the Financial Analysis Lead following Notice of Award.

#### **4.4.3.4 Communications Director (Lead)**

The Alliance will select and assign a Communications Director to the Project. This individual will collaborate with the communications individuals at each of the participating organizations to develop and execute a common stakeholder outreach plan, ensuring that common messages are prepared and stakeholder input is received and integrated. Although the Communications Director will functionally report to the Executive Director, the communications relating to the Project can affect all Alliance member companies and therefore, the Communications Director will have direct access to the Management Committee members to ensure timely information exchange. The Communications Director will be responsible for preparing and delivering to stakeholders the Alliance's key messages, responding as appropriate to their inquiries regarding the Alliance's activities, coordinating communications activities with the DOE, and facilitate the Alliance's interface with Congress. The Management Committee will select and assign a Communications Director following Notice of Award. Until such time as a Communications Director is assigned, the Alliance President will be the spokesperson for the Alliance.

#### **4.4.3.5 Licensing Manager**

The Alliance will select and assign a Licensing Manager to the Project. The Licensing Manager will oversee and direct the development of generic licensing positions common to all designs, development of early siting strategies for identified sites and assure licensing plans are developed and integrated with engineering and R&D project plans that will support the overall licensing strategy agreed with NRC. Before there are individual projects developed by one or more Alliance members, the Licensing Manager will fill the role for the surrogate applicant and point of contact within the Alliance for regulatory matters. This will require close coordination with design vendors and INL licensing activities to assure a common voice on generic matters that represent owner, operator, designer and end-user perspectives.



## **5.0 Key Industry Expectations**

There are several issues which must be addressed in the formal agreement for the NNGP Project Public-Private Partnership in order to provide an acceptable business risk position for investment by Alliance members. These issues include, for example, the nature of the contractual relationships that may be established between the Alliance, vendors and the National Laboratories to provide developmental support for the project, uncertainties in annual Congressional appropriations over the life of the Partnership, ownership of intellectual property rights, and the location for deployment of the FOAK facilities.

The broad scope of activities envisioned for the NNGP Project, as outlined in Section 2, is considered necessary to set the stage for commercialization of the HTGR technology. Unless the goal of the Project is to set the stage for commercialization and unless there is a clear commitment on the part of the government for the full scope and supporting activities as described herein, sufficient private sector interest in Project and participation in the public-private partnership project will not exist.

The issues which are considered essential are briefly described in the paragraphs that follow. In some cases, a suggested approach may be included, but the Alliance is open to an alternative means of acceptably mitigating the risks as long as any requisite enabling legislative that is required is in place concurrent with executing the Partnership agreements.

### **5.1 Continuity of Project Funding**

A major concern of the Alliance is the uncertainty of Project funding from Government for ongoing Project activities. As examples, inadequate funding may result from enactment of an extended Continuing Resolution or from inadequate annual appropriations as a consequence of changing priorities within an Administration or the Congress and/or a change of Administrations. The Alliance considers that this risk must be acceptably mitigated to ensure successful execution of the project and particularly if substantial sums of private sector investment are to be realized as envisioned in the cost share provisions of EPLA 2005. For the same reasons that cost sharing by government to mitigate risks as described in section 3.2, incomplete or interrupted government funding re-introduces that risk.

Further, the Alliance intends to enter this Partnership because it considers that commercialization of the HTGR technology will be shown to be a viable business endeavor and of substantial National interest. Beyond the investment risk with these government funding uncertainties there is the substantial risk that this energy production option will not be available to the end-users to address the energy and feedstock needs that are integral to the original objectives for this Project.

Suggested approaches to resolving this issue:

- **Administration of the Partnership** – by an independent agency within Government similar in concept to the Clean Energy Deployment Administration that has no competing priorities for use of the appropriated funding. An even stronger position could be established if the administering agency has a vested interest in the successful deployment of the HTGR technology (e.g., the



Department of Defense for improved security in the production of energy for defense purposes such as aviation fuels from indigenous resources).

- **Project Line Item** – Establishing a separate congressional budget line item for the NGNP Project such that appropriated funds are not subject to unpredictable and non-Project related demands at the discretion of the administering government agency
- **Multi-year Funding Mechanism** – Establishing via legislation a funding method similar in concept to that used in the Department of Defense for the assured continuation of major acquisition funds. One such alternative is a revolving fund. If a revolving fund, it would be made available to the Public-Private Partnership to carry out the NGNP Project without appropriation or fiscal year limitation, and would not be subject to apportionment under subchapter II of chapter 15 of title 31, United States Code.
- **Recovery of Cost Shared Monies** – If the government should unilaterally withdraw support of the Project before deployment of either FOAK facility for reasons not involving failure to fulfill obligations by the Alliance or its members, as a remedy the Alliance and its member invested monies under this Project will be reimbursed by government.
- **Change Control** – Change control regarding scope, schedule and funding allocation for the Project will be managed by the Alliance using commercial practices within pre-established cost limits and schedule milestones.

## **5.2 Intellectual Property Rights**

Creation of an Alliance presumes a significant participation by primary suppliers of related technologies for the NGNP. As a result of NGNP Project activities, there will be the development of technology and related patents representing licensable intellectual property (IP). There will also be IP related to design details and expertise gained through the collaborative efforts of the Alliance, the supporting national laboratories, and the technology suppliers (vendors). In addition, there will likely be IP developed relating to marketplace requirements and business strategies. The individual and collective contributions to develop IP and the equitable allocation of the IP rights must be addressed in the establishment of any commercial arrangements among the members of the Alliance and in the Alliance's agreement with the DOE.

The undersigned believe that several principles should guide the agreements on IP. First, IP rights held by suppliers or Alliance members (background IP) shall be protected. This is an important consideration since each Alliance member has a value invested in such background IP that could represent a substantial cost and schedule savings to the NGNP Project. Second, IP developed through Project activities (new IP) should be allocated in a fair and equitable manner consistent with contribution to the project. Specifics regarding the allocation and use of this new IP will constitute a critical element of the agreements among Alliance members and between the Alliance and the DOE. Third, certain aspects of some developmental areas may be reserved from allocation of IP and therefore be available to be used broadly for follow-on projects by other commercial entities. These may include generic elements in the development and qualification of fuel, graphite, high-temperature materials, and analytical methods. The specific details and provisions

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relating to each of these principles must be established among the industry members and subsequently between industry and the government.

### **5.3 Government Infrastructure**

The Alliance acknowledges the need for certain government facilities and capabilities in order to successfully achieve the Project objectives. These facilities include both existing infrastructure as well as new or planned facilities. Examples of this infrastructure are highlighted below.

- **Existing infrastructure** – Certain government facilities and capabilities are assumed to be available as part of the planning for this Project (e.g., Advanced Test Reactor (ATR); selected capabilities of the Hot Fuel Examination Facility (HFEF) and the Neutron Radiography Reactor (NRAD) at the Idaho National Laboratory).
- **New infrastructure** – Certain new government facilities and capabilities are assumed to be available as part of the planning for this Project (e.g., the Component Test Capability under consideration for INL).

A comprehensive description of the required facilities and capabilities will be developed as part of establishing the agreement for the public/private partnership. The government will provide the so-described facilities and capabilities for a pre-agreed scope of work and on a pre-established schedule. This includes assuring that necessary infrastructure funding is appropriated to ensure the reliable operations of these facilities. If these facilities and capabilities are not provided or a viable alternative is not provided, the government will be considered to have withdrawn from the Project with the remedy described in Section 5.1.

### **5.4 Contracts with National Laboratories**

It is anticipated that the Alliance or individual NI vendor/supplier teams may place contracts with the Battelle Energy Alliance as a single point of access to the national laboratory complex for management and execution of selected research and development needs to support the Project (e.g., fuel, graphite and high temperature materials qualification). This work will be driven by the NI vendors' Design Data Needs as maintained and controlled through respective Technology Development Roadmaps. The Alliance will provide a key oversight role to assure maximum cost and schedule effectiveness of such work. The form of these contracts will be based on the typical work-for-others provisions in the management and operations contract with the Battelle Energy Alliance for INL, with additional provisions that reflect typical commercial practices including, without limitation, the conditions for sales prescribed in 10 U.S.C.2563(c). The Alliance understands that the provisions of the cited reference will require enactment via legislation. The net effect of these additional provisions is that the Alliance can seek remedy for management performance inadequacies as prescribed regarding cost and schedule performance. Without such contract provisions, there is no contractual incentive for performance, and all cost and schedule risk would be borne by the Alliance and its members. We understand that the Battelle Energy Alliance, LLC has agreed to provide these services using these provisions.



## **5.5 Continued Market Definition**

During conceptual design, the development and definition of the potential market will continue to provide confirmation and/or establish the functional and performance requirements that should apply to the Nuclear Heat Supply System design. Agreements may be established with other activities such as PTAC in Canada, the European Commission's Seventh Framework Programme, EUROPAIRS, to the extent such relationships support the NGNP Project's needs and schedule. Market study work is included in the proposed project development effort to ensure that standardized NI designs will encounter minimum need for amendments to Design Certification documents for broad commercial application.

## **5.6 FOAK Facility Location**

Presuming all other pre-conditions have been fulfilled, the Alliance will choose candidate locations and applications for the construction of the FOAK facility. Unless market conditions dictate otherwise, the Alliance envisions a FOAK facility for each HTGR design to be deployed. The Alliance anticipates that the FOAK facility for each design will be collocated within or in close proximity to an existing industrial facility as the first module of a multi-module facility. As project development efforts continue for one or more candidate projects, ESP and COL applications will be developed as decided by the Alliance and supported by private interests that collaborate for deployment of each demonstration project.

## **5.7 Handoff of the Current NGNP Project to Alliance Management**

As the NGNP Project is defined it is anticipated that an Ownership Agreement (i.e. Shareholder Agreement) will be developed which establishes the basis for private equity investment in the project. It is anticipated that the NGNP Project Owner, defined by this agreement, will represent many project stakeholders. This Ownership Agreement will establish a project management team which takes over most of the roles initiated by the Alliance as a commercial venture with Government support. The Alliance forms the bridge to private investment and implementation of the NGNP project.

## **5.8 Fuel Disposition**

During the first phase of the Project, the government will develop plans for taking ownership of the used fuel produced in the FOAK facilities consistent with the requirements imposed by the Nuclear Waste Policy Act of 1982, as amended. These plans will be developed on a schedule to support the decision process by the Alliance whether to proceed with construction of the FOAK facilities.