THE NEXT GENERATION NUCLEAR PLANT AND HYDROGEN PRODUCTION: A CRITICAL STATUS REPORT

HEARING

BEFORE THE

SUBCOMMITTEE ON ENERGY AND RESOURCES

OF THE

COMMITTEE ON GOVERNMENT REFORM

HOUSE OF REPRESENTATIVES

ONE HUNDRED NINTH CONGRESS

SECOND SESSION

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THE NEXT GENERATION NUCLEAR PLANT AND HYDROGEN PRODUCTION: A CRITICAL STATUS REPORT

WEDNESDAY, SEPTEMBER 20, 2006

HOUSE OF REPRESENTATIVES,
SUBCOMMITTEE ON ENERGY AND RESOURCES,
COMMITTEE ON GOVERNMENT REFORM,
Washington, DC.

The subcommittee met, pursuant to notice, at 1:29 p.m. in room 2154, Rayburn House Office Building, the Honorable Darrell Issa (chairman of the subcommittee) presiding.

Present: Representatives Issa, Watson, Kucinich.

Staff present: Larry Brady, staff director; Lori Gavaghan, legislative clerk; Tom Alexander, counsel; Dave Solan, Ph.D., and Ray Robbins, professional staff members; Joe Thompson, GAO detailee; Shaun Garrison, minority professional staff member; and Cecelia Morton, minority office manager.

Mr. ISSA. A quorum being present, this hearing of the Government Reform Subcommittee on Energy and Resources will come to order.

Nuclear power is enjoying a global resurgence because of the environmental benefits and the expected growth in demand for electricity, and I might say, hydrogen. In the United States, there has also been an interest in building new plants because the current fleet of reactors is aging and the electricity demand is projected to rise 40 to 50 percent by 2030.

The Next Generation Nuclear Plant is part of the Federal Government effort to advance commercial nuclear reactor design beyond the current generation that is being deployed around the world. Additionally, NGNP—although sometimes it is easier to say Next Gen—is a key component of the administration's plan to develop the "hydrogen economy." An important purpose of the advanced nuclear demonstration plant is to produce hydrogen on a large scale.

Congress has given the plant a "drop-dead date" of September 30, 2021, for construction and the beginning of operation. The Department of Energy seems to be following a schedule that will cut it close to that deadline, and I might say on the record, 2021 would have been a date far further in the future than I would have shot for. After all, it took less than 10 years to put a man on the moon. Independent advisory panels and task forces have criticized DOE's schedule as being too slow; and too slow to be used by the private sector, too slow not to die a slow death from the lack of political support.

Of particular concern for Next Gen projects is the development of a number of technologies that will ensure project milestones are met and construction will be completed on schedule. Even meeting the time table does not provide a guarantee that the demonstration plant will not have been overtaken by other commercial technologies that may be developed sooner.

In addition, delays in meeting milestones will call into question the continued support for the Next Gen, considering other nuclear priorities, such as the Nuclear 2010 and Global Nuclear Energy Partnership programs that require a considerable Federal financial backing.

Today we will hear from the Government Accountability Office regarding an assessment that it prepared at my request. We will also hear from a representative of the Idaho National Laboratory, where much of the R&D is being done today. Last, we will hear from a professor at MIT who is a former CEO in the nuclear industry and has a great deal of knowledge regarding advanced reactor design.

Last to put on the record before I yield to the ranking member, also a Californian, is that in the last few weeks our Governor in California has set an ambitious plan for reducing the carbon footprint in California. It is this Member's considered opinion that you cannot reduce the carbon footprint if we retire the nuclear reactors that today are putting out zero emissions in California, so we in California have a particular interest in Next Gen nuclear.

With that, I would yield to the ranking lady for her opening remarks.

[The prepared statement of Hon. Darrell E. Issa follows:]

Committee on Government Reform
Subcommittee on Energy and Resources

Opening Statement of
Chairman Darrell Issa

Oversight Hearing:

"The Next Generation Nuclear Plant and Hydrogen Production: A Critical Status Report"

September 20, 2006

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Of particular concern in the NGNP project is the development of a number of technologies that will ensure project milestones are met and construction will be completed on schedule. Even meeting the timetable does not provide a guarantee that the demonstration plant will not be overtaken by other commercial technologies that may be developed sooner.

In addition, delays in meeting milestones will call into question the continued support for the NGNP considering other nuclear priorities, such as the Nuclear 2010 and Global Nuclear Energy Partnership programs that require considerable federal financial backing.

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Today we welcome:

- Mr. Jim Wells from the GAO;
- Mr. Phil Hildebrandt from INL; and
- Dr. Andrew Kadak from MIT.

I look forward to hearing your testimony.

ONE HUNDRED NINTH CONGRESS

Congress of the United States

House of Representatives

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COMMITTEE ON GOVERNMENT REFORM

SUBCOMMITTEE ON ENERGY AND RESOURCES

DARRELL ISSA, CHAIRMAN

Will Hold an Oversight Hearing:

"The Next Generation Nuclear Plant and Hydrogen Production: A Critical Status Report"

September 20, 2006, 1:00 p.m.
Room 2154 Rayburn House Office Building

WITNESSES

Mr. Jim Wells,
Director,
Natural Resources and the Environment,
Government Accountability Office

Mr. Phil Hildebrandt,
Idaho National Laboratory,
Special Assistant to the Laboratory Director

Dr. Andrew Kadak,
Professor,
Nuclear Science and Engineering Department,
Massachusetts Institute of Technology

Ms. WATSON. Mr. Chairman, thank you for convening today's hearing to discuss this very critical project that can play a major role in shaping the future of America's energy use and production. All of us are aware of the importance of nuclear energy, and I hope that our witnesses today will update us on the progress of the Next Generation Nuclear Plant project and tell us if the goals in completing the project are being met.

There are several concerns as to whether or not this project is on track to meet its 2021 deadline for completion. In a recent GAO study it has come to the committee's attention that there are several technological challenges in completing the NGNP and whether the technologies developed will meet the needs of the private sector.

GAO also found that the project's initial research and development results indicate that the likelihood is slim that the project will be able to stay on schedule, considering the amount of research and development that still needs to be done, and this presents a problem. This committee's job is to conduct oversight on Federal spending, and we must ensure that our projects, including this one, are conducted in an expeditious and profitable manner that benefit the American taxpayer. The public should be secure in knowing that we do meet deadlines in the Federal Government, and when we don't we have a viable explanation as to why or why not a deadline was not met.

Every April 15th taxpayers are required to file their taxes or they will face a penalty unless they explain why they need an extension. Shouldn't that same accountability be held on the Government when conducting business?

So, Mr. Chairman, I again want to thank you for your leadership in bringing this issue before the subcommittee, and I am confident that our discussion today will yield us some definite answers on the progress of the Next Generation Nuclear Plant. I hope that the findings of this GAO report will be of benefit to all of the researchers and scientists involved to make this endeavor a success.

I yield back, Mr. Chairman.

[The prepared statement of Hon. Diane E. Watson follows:]

Opening Statement
Congresswoman Diane E. Watson
Ranking Member
Government Reform Subcommittee on Energy and Resources
Hearing: "The Next Generation Nuclear Plant and Hydrogen Production: A Critical Status Report"
September 20th, 2006

Mr. Chairman, thank you for convening today's hearing to discuss a very critical project that can play a major role in shaping the future of America's energy use and production. All of us are aware of the importance of nuclear energy and I hope that our witnesses today will update us on the progress of the Next Generation Nuclear Plant (NGNP) project and tell us if the goals in completing the project are being met.

There are several concerns as to whether or not this project is on track to meet its 2021 deadline for completion. In a recent GAO study, it has come to the committee's attention that there are several technological challenges in completing the NGNP and

whether the technologies developed will meet the needs of the private sector. GAO also found that the project's initial research and development results indicate that the likelihood is slim that the project will be able to stay on schedule, considering the amount of research and development that still needs to be done. This is a problem!

This committee's job is to conduct oversight on federal spending and we must ensure that all projects, including this one, are conducted in an expeditious and profitable manner that benefits the American taxpayer. The public should be secure in knowing that we do meet deadlines in the federal government and when we don't, we have a viable explanation as to why or why not a deadline was not met. Every April 15th, taxpayers are required to file their taxes or they will face a penalty unless they explain why they need an extension. Shouldn't that same accountability be held on the government when conducting business?

Mr. Chairman, I again want to thank you for your leadership in bringing this issue before this subcommittee. I am confident that our discussion today will yield us some definite answers on the progress of the Next Generation Nuclear Plant. I hope that the findings of this GAO report will be of benefit to all of the researchers and scientists involved to make this endeavor a success.

I yield back.

Mr. ISSA. I thank the gentlelady, and I ask unanimous consent that the briefing memo prepared by the subcommittee staff be inserted into the record, as well as all other relevant materials.

[The information referred to follows:]

COMMITTEE ON GOVERNMENT REFORM

SUBCOMMITTEE ON ENERGY AND RESOURCES
DARRELL ISSA, CHAIRMAN

Oversight Hearing:
"The Next Generation Nuclear Plant and Hydrogen Production: A Critical Status Report"
September 20, 1:00 p.m.
Room 2154 Rayburn Building

BRIEFING MEMORANDUM

SUMMARY:

In January 2006, Chairman Issa requested that the Government Accountability Office complete a study to assess the Department of Energy's (DOE) progress in meeting its schedule for design and construction of the Next Generation Nuclear Plant (NGNP) by 2021, as well as DOE's approach to ensure the commercial viability of the project. An operational NGNP will demonstrate advanced, next generation technologies for generating electricity and producing hydrogen on a large-scale for use in fuel cells for automobiles and the transportation sector.

The Energy Policy Act of 2005 set additional requirements and milestones for completion of the NGNP, including the selection of design parameters in 2011. In addition, the NGNP will require a license for construction and operation from the Nuclear Regulatory Commission, and DOE and the NRC must jointly submit a licensing strategy to Congress in 2008. Research and development work on the NGNP are being conducted primarily at the Idaho National Laboratory.

Of particular concern in the NGNP project is the development of a number of technologies that will ensure project milestones are met and construction will be completed on schedule. Meeting the timetable provides a high probability—but not a guarantee—that the demonstration plant will be of use to the private sector and not overtaken by other commercial technologies that may be developed sooner.

In addition, delays in meeting milestones will call into question the decision for continued support of the NGNP considering other nuclear priorities such as the Nuclear 2010 and Global Nuclear Energy Partnership programs that require considerable federal financial support.

This hearing will coincide with the release of the GAO study and assess the progress and outlook for successful completion of the NGNP.

Program Background

Nuclear power is enjoying a global renaissance because of its environmental benefits and the expected growth in demand for electricity. In the US, there is also newfound interest in building new plants as the current fleet of reactors ages and electricity demand is projected to rise 40-50 percent by 2030.

The NGNP is part of a federal government effort to advance commercial nuclear reactor designs to offer safety and improvements over the current generation of nuclear power plants that are being deployed around the world. US efforts in advanced design R&D are part of its participation in the Generation IV International Forum.[1] Additionally, the NGNP is a key component in the Administration's plans to develop the "hydrogen economy" because an associated purpose of the advanced nuclear demonstration plant is to produce hydrogen on a large scale.

Development of the NGNP began in 2003, and the research and development on the new reactor is being conducted primarily at the Idaho National Laboratory. The Department of Energy is supporting research on several reactor concepts but priority has been given to the very-high temperature, gas-cooled reactor.

The NGNP is envisioned as a full-scale demonstration plant that will establish the commercial feasibility of a number of technologies, including fuel fabrication, passive safety design, and advanced reactor design. The Department of Energy estimates that the total cost for the plant, from R&D to construction and production of hydrogen, is approximately $2.5 billion. The Energy Policy Act of 2005 stipulates that the plant must be constructed and operational by September 30, 2021.

Reactor Design

The very-high temperature reactor is the favored design in the US due to its potential for competitive cost use in secondary industrial activities such as hydrogen production and desalinization. The reactor design and operations will be more advanced than other high temperature reactors because of its large size and projected operating temperature that should enable it to use enough "process" heat to produce hydrogen in quantity and at an economically competitive cost.

Current technologies are based on boiling water or pressurized water reactors that are also cooled by water. Water is reactive and highly corrosive, causing high maintenance costs and costly safety systems. Water can flash into radioactive steam in case of a failure, requiring expensive containment facilities as a safety precaution.

Gas-cooled reactors rely on passive systems and the fabrication of the reactor fuel to avoid uncontrolled nuclear reactions. Advancements in fuel fabrication and design are purported to enable safer operation and continuous fueling, rather than requiring reactor shutdowns as with current designs.

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[1] Generation IV refers to the next generation of reactors that are expected to hit the market. Reactors that are currently being constructed are based on Generation III technologies.

Schedule and Funding

The Energy Policy Act of 2005 set scheduling requirements for the development of the NGNP, effectively setting milestones that the Department of Energy, the Idaho National Laboratory, and the Nuclear Regulatory Commission must meet. DOE and the Nuclear Regulatory Commission must submit a licensing strategy for the NGNP to Congress by August 2008 so that a construction and operating license can be obtained according to schedule. DOE is to conduct R&D and select design parameters for the plant by September 30, 2011, and an operational NGNP must be in place by the end of September 2021. To meet these deadlines, DOE and INL have developed plans for R&D on fuels, materials, and hydrogen production. External advisory committees to DOE have expressed reservations regarding DOE's planning and have suggested acceleration of the schedule to ensure that other technologies do not supersede those developed as part of the NGNP and commercialization does not become a secondary issue.

The main source for NGNP funding is DOE's Generation IV Nuclear Energy Systems Initiative. Through 2006, DOE budgeted about $120 million in R&D funding, of which $80 million is for nuclear and $40 million for hydrogen production. For FY 2007, the Administration requested $31.4 million for the Gen IV Initiative. The House-passed funding bill met the Administration request for Gen IV by reducing funding for the NGNP from $40 million to $23.4 million. The Senate Appropriations Committee reported $48 million for the Gen IV program and continued level funding of $40 million for NGNP.[2]

Program Challenges

Continued funding is clearly a challenge for the NGNP because of the duration of the program and its overall cost. In addition, the Administration requested $250 million as part of the new Global Nuclear Energy Partnership (GNEP). GNEP seeks to achieve breakthroughs in recycling nuclear fuel as part of a new nuclear non-proliferation strategy by having nations with secure, advanced nuclear capabilities provide fuel services to other nations who agree to employ nuclear energy for power generation purposes only.

The Administration's prioritization of GNEP, combined with the Nuclear 2010 program,[3] has called into question its commitment to NGNP completion. Congress is also challenged with funding nuclear disposal and storage activities, and the continued delay in completing the permanent facility at Yucca and controversy regarding expensive interim storage solutions has further complicated matters. The Appropriations Committees have struggled with funding these programs against a backdrop of continually changing Administration nuclear priorities. Long-term survival of the NGNP program may be more threatened by a lack of political support than technological hurdles.

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[2] CRS Report for Congress, *Nuclear Energy Policy*, July 20, 2006.

[3] The Nuclear 2010 program will pay up to half of the nuclear industry's costs of seeking regulatory approval for new reactor sites, applying for new reactor licenses, and preparing detailed plant designs. The program is intended to provide assistance for advanced versions of existing commercial nuclear plants that could be ordered within the next few years.

Cancellation of the NGNP would severely endanger the fulfillment of the "hydrogen economy" that the President touted only a few years ago.

ISSUES TO BE ADDRESSED AT THE HEARING:

- What are the technological challenges to completing the NGNP?
- Can the Department of Energy and the Idaho National Laboratory meet the completion deadline, and is the plan sufficient to meet the goals of the NGNP?
- Will the technologies utilized in the NGNP be commercially feasible and meet the needs of the private sector?

WITNESSES:

Mr. Jim Wells, Director, National Resources and Environment, Government Accountability Office

Mr. Phil Hildebrandt, Idaho National Laboratory, Special Assistant to the Laboratory Director

Dr. Andrew Kadak, Professor, Nuclear Science and Engineering Department, Massachusetts Institute of Technology

Staff Contact:
Larry Brady, Staff Director
Subcommittee on Energy and Resources
B-349C Rayburn House Office Building
202.225.6427 / 202.225.2392 fax

Mr. ISSA. With that I would yield to the gentleman from Ohio, who is not without some familiarity on nuclear power, Mr. Kucinich.

Mr. KUCINICH. Thank you, Mr. Chairman. Of course, with that in mind I will be offering a slightly different perspective, but I want to thank the witnesses and I also want to thank the Chair for his dedication on energy issues. This committee has done some very important work, and it has been because of the dedication of the chairman. I just want to let you know how much we appreciate it, Mr. Chairman.

A hydrogen infrastructure is a revolutionary technology. It can power our transportation, heating, and electricity needs because hydrogen is so easy to transport, store, and convert by way of fuel cells. These qualities allow renewable technologies like solar and wind to supply the majority of the energy demanded by our Nation. There is much promise in truly sustainable hydrogen energy distribution system. To achieve the benefits of less dependence on foreign oil, clean air, and a better future for our children, the hydrogen system must strive for sustainability and replace the polluting fuels we depend on today.

Now, a nuclear plant designed to generate hydrogen I believe is antithetical to a sustainable energy system. The advantages of a hydrogen economy are substantial, but to reap all the advantages we desire I think that hydrogen production must come from renewable sources. Anything less and we will have spent significant taxpayer dollars, questionable gain.

The notion of using nuclear power to produce hydrogen looks like an industry attempt to just take more tax dollars for nuclear subsidies. We all remember that existing nuclear power plant technology was heavily subsidized in the last century, and they are continuing to eat up those subsidies today.

Between 1948 and 1998 the Federal Government spent $74 billion on nuclear power research and development, the majority of Federal dollars spent on energy supply R&D during this time. To me, this idea of connection between a hydrogen infrastructure and nuclear power amounts to kind of a greenwashing to prop up the nuclear industry. Nuclear power is not safe, and the wastes generated create an environmental challenge that this country continues not to have an honest answer to.

I want to remind this committee about Davis-Besse. This is why I have a particular concern and an expertise. It is a nuclear reactor upwind from my hometown in Cleveland, Ohio. This nuclear reactor was shut down because of a large cavity the size of a football discovered in the top of the reactor wall. The utility, First Energy, unfortunately knowingly avoided mandatory inspection cleanings, would have prevented this near-miss. Instead, they chose to protect their profits and run their reactor dangerously close to disaster.

Now, I am not going to confuse First Energy with the rest of the nuclear industry, but it has to be said that the NRC, instead of protecting the public, chose to protect the financial interests of First Energy. They repeatedly took minimal actions to prevent this near disaster, punish the utility for its negligence, reform its own operations, and place safety first. The NRC Inspector General found the NRC chose to protect the financial impact on First Energy rather than force compliance with safety regulations.

After the shutdown of Davis-Besse the NRC released the report that documented its lessons learned. The report made a few recommendations as to how the NRC might avoid future incidents like the corrosion problems at Davis-Besse. Since the release of the final report, a draft lessons learned report surfaced that contained several far-reaching recommendations that would, in fact, make a real difference in nuclear power plant safety, because you can't talk about the relationship between nuclear power and hydrogen infrastructure unless you look at the underlying safety issues. But to avoid costly regulation on the industry, those recommendations that are mentioned didn't even make the final report.

I don't have any doubt that a nuclear power plant producing hydrogen will face a similar regulatory system designed to protect industry profits, and such a plant will pose an unacceptable risk to the public.

Mr. Chairman, I just want to mention that I think it would be important for this subcommittee, along with the other wonderful work it does, to examine the complete and total failure of the NRC to regulate the current reactors. The Davis-Besse incident showed a fundamental flaw in how our Nation regulates reactors. It is a failure in every rung of the bureaucratic ladder.

We also must acknowledge that nuclear reactors produce highly radioactive waste the United States is attempting to bury in Yucca Mountain, Nevada. No matter how deep you bury it, no matter where you bury it, this waste is going to re-emerge. Basic geology dictates that over a million years the Earth shifts and water moves and this waste will re-enter our environment. I have no doubt the nuclear waste generated to create hydrogen will have no responsible solution, either.

Mr. Chairman, the lesson we learned here is that the United States should question the taxpayers' money that is being spent for nuclear industry and should question a plan that could end up trashing our environment to prop up a dangerous industry. Hydrogen production should be moved forward from sustainable sources. It will be more cost effective, better for the environment, and safer for our citizenry.

Thank you, Mr. Chairman.

[The prepared statement of Hon. Dennis J. Kucinich follows:]

GROC Energy and Natural Resources Subcmte

Next Generation Nuclear Plant and Hydrogen Production

September 20, 2006

A hydrogen infrastructure is a revolutionary technology. It can power our transportation, heating and electricity needs because hydrogen is easy to transport, store, and convert via fuel cells. These qualities allow renewable technologies, like solar and wind, to supply the majority of the energy demanded by our nation.

There is much promise in a truly sustainable hydrogen energy distribution system. To achieve the benefits of less dependence of foreign oil, clean air, and a better future for our children, the hydrogen system must strive for sustainability and replace the polluting fuels we depend on today.

A nuclear plant designed to generate hydrogen is antithetical to a sustainable energy system. The advantages of a hydrogen economy are substantial, but to reap all the advantages we desire, hydrogen production must come from renewable sources. Anything less and we will have spent significant taxpayer dollars for no significant gain.

The notion of using nuclear power to produce hydrogen is nothing more than an industry attempts to vacuum up more tax dollars for nuclear subsidies. Existing nuclear power plant technology was heavily subsidized in the last century and continues to eat up these subsidies today. Between 1948 and 1998, the federal government spent $74 billion on nuclear power research and development – the majority of federal dollars spent on energy supply R&D during this time.

I object to this use of greenwashing to prop up the nuclear industry. Nuclear power is not safe and the wastes generated create an environmental challenge we continue to have no honest answer to.

Let me remind this committee about Davis Besse, a nuclear reactor downwind from my hometown Cleveland, Oh. This nuclear reactor was shut down because a large cavity, the size of a football, was discovered in the top of the reactor wall. The utility, First Energy, knowingly avoided mandatory inspection and cleanings, which would have prevented this near miss. Instead, First Energy chose to protect their profits and run the reactor dangerously close to a disaster.

The Nuclear Regulatory Commission (NRC), the agency charged with protecting the public, instead chose to protect the financial interests of First Energy. They repeatedly took minimal actions to prevent this near disaster, punish the utility for its negligence, and reform its own operations to place safety first.

The NRC Inspector General has found that the NRC chose to protect the "financial impact on FENOC" rather than force compliance with safety regulations. After the shutdown of Davis Besse, the NRC released a report that documented its "Lessons Learned." The report made a few recommendations as to how NRC might avoid future incidents like the corrosion problems at Davis Besse. Since the release of the final report, a draft "lessons learned" report surfaced that contained several far reaching recommendations that would in fact make a real difference in nuclear power plant safety. But to avoid costly regulations on the industry, those recommendations did not make the final report.

I have no doubt that a nuclear power plant producing hydrogen will face a similar regulatory system designed to protect industry profits. And such a plant will pose an unacceptable and entirely avoidable risk to the public.

Mr. Chairman, I would suggest that before this subcommittee begins examining new nuclear reactors, we examine the complete and total failure of the NRC to regulate the current reactors. The Davis Besse incident showed a fundamental flaw in how our nation regulates reactors. It was a failure at every rung of the bureaucratic ladder.

We also must acknowledge that nuclear reactors produce highly radioactive waste that the U.S. is attempting to bury in Yucca Mountain, Nevada. No matter how deep you bury it, and no matter where you bury it, this waste will reemerge. Basic geology dictates that over a million years the earth shifts and water moves, and this waste will reenter our environment. I also have no doubt that nuclear waste generated to create hydrogen will have no responsible solution either.

The lesson to be learned here is the US should stopping wasting taxpayer dollars and trashing our environment to prop up a dangerous and dirty industry. Hydrogen production should come from renewable sources that will be more cost effective, better for the environment, and safer for our citizenry.

Mr. ISSA. Thank you, Mr. Kucinich. I would second one very important portion of what you said, and that is that I look forward to the day in which renewables represent a substantial, if not all, of our production of fuels, both for fixed and mobile through hydrogen.

With that I would like to welcome today our guests. You are more than guests. We hopefully, though, will treat you as well as guests. We have Mr. Jim Wells from the Government Accountability Office; Mr. Phil Hildebrandt from INL; and Dr. Andrew Kadak from MIT. I look forward to your testimony. As all guests here, I would like to begin by asking you to rise for the administration of an oath. It is always good to have people with Ph.Ds. They know to raise their right hands without being asked.

[Witnesses sworn.]

Mr. ISSA. The record will show all nodded yes.

Mr. Wells, we will kick off with you. We normally give 5 minutes. Is that going to be sufficient for you to summarize your written testimony?

Mr. WELLS. Yes, sir.

Mr. ISSA. All of it will be placed in the record. Great. The lights will show you the time remaining, and we only ask that you respect the light, not that you stop the instant it turns red.

Mr. WELLS. Fair enough.

Mr. ISSA. Thank you.

STATEMENTS OF JIM WELLS, DIRECTOR, NATURAL RESOURCES AND THE ENVIRONMENT, GOVERNMENT ACCOUNTABILITY OFFICE; PHIL HILDEBRANDT, IDAHO NATIONAL LABORATORY, SPECIAL ASSISTANT TO THE LABORATORY DIRECTOR; AND ANDREW KADAK, PROFESSOR, NUCLEAR SCIENCE AND ENGINEERING DEPARTMENT, MASSACHUSETTS INSTITUTE OF TECHNOLOGY

STATEMENT OF JIM WELLS

Mr. WELLS. Thank you, Mr. Chairman and members of the subcommittee. GAO is pleased to participate in this oversight hearing.

We are releasing today, Mr. Chairman, as you requested, our GAO report on this particular project. It is available on the GAO Web site. You also asked us to describe the progress and the status of DOE's attempt to deliver a $2.4 billion R&D project that will build and demonstrate an advanced high-temperature nuclear reactor that DOE plans to link to a new hydrogen production plant. The report, itself, describes the project, the players, and the intended purposes.

You held a hearing last year, Mr. Chairman, and heard testimony from DOE and others about where they were, their efforts, their progress to date, and their future plans. Two separate, independent groups have since reviewed the project plans and have offered suggestions and recommendations. This report gives you and the Congress a third assessment of where the NGNP project is.

Here are our quick findings. DOE has budgeted $120 million so far from 2003 to 2006. This breaks down to about $80 million for the reactor, $40 million for the hydrogen product side system. Overall projections are that this would break out about $2 billion for the reactor and $300 million or so for the production of hydrogen.

DOE has laid out a timeline schedule, as you can see on the graph that we give you here on the left. The chart starts in 2006, ends in 2021. It proceeds through R&D testing, proof of concepts and capabilities, NRC licensing strategy by 2008, moves into 2011 design, construction start by 2016, and startup by 2021.

Among the many stakeholders in this process, Mr. Chairman, there are controversy, disagreements, significant technology organizational funding, and unknown challenges to completing this almost 20 year effort.

First, let me say that the people that we encountered in this audit who were working on this project appear to believe in the goals and the need for this project, but they do share cautious skepticism as to whether it will continue to make the cut and advance to the end in 20 years. DOE's current R&D approach we would characterize as trying to advance the science of building a new Generation IV advanced reactor that has high-end, very-high-temperature capabilities to achieve superior efficiency in terms of fuel use and of heat transfer capabilities to allow magnitude improvements in the economical, commercial production of hydrogen. What we are talking about is designing something that will potentially double today's 25 percent efficiency of producing hydrogen.

This effort ties closely to the administration's goal of transitioning to the future of a hydrogen economy. Early R&D results have been favorable, especially as it relates to fuel testing, but most of the important R&D remains to be done.

The Idaho National Lab, which you will hear from today, who has the designated lead and the location for the building of this full-scale reactor and a hydrogen production plant, are, in fact, gung-ho and anxious to deliver the product as asked for. The program and management team that we talked to at the working level at DOE, they share, too, a passion to meet the future energy challenge driving this particular project. This is the good news, Mr. Chairman; however, there is bad news.

Between the times DOE last testified before you, they reported to you they were making steady progress. The priority for funding nuclear energy has changed, resulting in this project going a little slower. Today, first priority in the Department of Energy is Nuclear Power 2010. Second is Global Nuclear Energy Partnership [GNEP], second priority. And the new generation, or Next Generation, as you refer to this project, has fallen to third place in terms of their priorities. The competition today is scarce for the existing R&D dollars.

Getting the private sector, what we call the industry, the end users, the vendors, the utilities, and the people that are actually going to use the hydrogen, getting these people involved has been slow in this project, and DOE is just now beginning to get that started. Suggestions generated from the earlier two independent assessments that I referred to earlier have looked at the DOE project with some suggestions for changes. DOE has agreed to some of those changes, made some changes, but DOE has not made all the changes, particularly as they believe that the stated path is better, in their opinion.

For example, you are going to hear today about the belief that the current schedule needs to be accelerated, with a quicker completion before 2021. Those that support acceleration say you stand the risk of losing commercialization and private sector buy-in. DOE says that doing so presents unacceptable risk to them and increases the technical challenges, as well as not keeping with the existing Department's current funding priorities.

We are weighing in after doing this audit, Mr. Chairman, in a belief that we would agree that it may be too soon to accelerate, in our view, to support that decision today. Our rationale is based not so much on the science but more on the management concern that we have in terms of DOE's ability to get it right.

To speed up the project today narrows the plan R&D and reduces the known unknowns. Moving forward could result in a re-work if future research results are not supporting the decisions that have been already made. DOE has only just now moved to get involved in the industry, which is really going to be critical to knowing what type of production facilities do they want, do they need, and what are they going to be willing to invest in. DOE doesn't have those answers yet.

Finally, GAO has documented a long history within the Department of Energy regarding problems in managing large projects. Their poor management skills have been on a high-risk list for over 16 years. The risk taking this path to accelerate is further elevated by the fact that the DOE Nuclear Energy Office that has responsibility for this project has no experience in managing a project of this size and complexity. There might be a time later to make this critical path change as DOE gets further into the schedule.

Mr. Chairman, I want to conclude. My time has expired here. This, to us, is the highlights and the lowlights, if you will, of what we found.

I want to commend this committee in holding these hearings. As a Nation it is clear we need energy. We need more energy. We need environmentally responsible ways to meet this energy need. How we can use nuclear power in the future deserves the Congress' attention.

On a personal note, Mr. Chairman, I want to say, having testified before you many times on energy issues, I am retiring from Government service after 37 years and I really appreciate your interest and your committee's interest in government reform with quality oversight.

With that I will conclude and answer any questions you may have. Thank you.

[The prepared statement of Mr. Wells follows:]

United States Government Accountability Office

GAO

Testimony
Before the Subcommittee on Energy and Resources, Committee on Government Reform, House of Representatives

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NUCLEAR ENERGY

DOE's Next Generation Nuclear Plant Project Is at an Early Stage of Development

Statement of Jim Wells, Director
Natural Resources and Environment

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GAO-06-1110T

September 20, 2006

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Highlights

Highlights of GAO-06-1110T, a testimony before the Subcommittee on Energy and Resources, Committee on Government Reform, House of Representatives

NUCLEAR ENERGY

DOE's Next Generation Nuclear Plant Project Is at an Early Stage of Development

Why GAO Did This Study

Under the administration's National Energy Policy, the Department of Energy (DOE) is promoting nuclear energy to meet increased U.S. energy demand. In 2003, DOE began developing the Next Generation Nuclear Plant, an advanced nuclear reactor that seeks to improve upon the current generation of operating commercial nuclear power plants. DOE intends to demonstrate the plant's commercial application both for generating electricity and for using process heat from the reactor for the production of hydrogen, which then would be used in fuel cells for the transportation sector. The Energy Policy Act of 2005 required plant design and construction to be completed by 2021.

This testimony, which summarizes a GAO report being issued today (GAO-06-1056), provides information on DOE's (1) progress in meeting its schedule for the Next Generation Nuclear Plant project and (2) approach to ensuring the project's commercial viability. For the report, GAO reviewed DOE's research and development (R&D) plans for the project and the reports of two independent project reviews, observed R&D activities, and interviewed DOE, Nuclear Regulatory Commission (NRC), and industry representatives.

www.gao.gov/cgi-bin/getrpt?GAO-06-1110T.

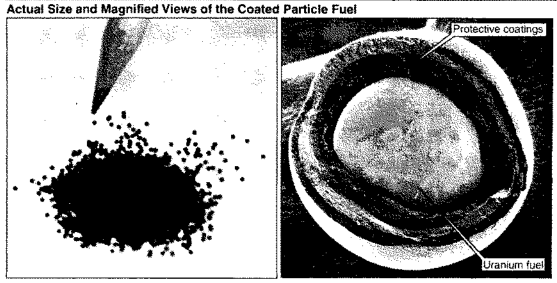
To view the full product, including the scope and methodology, click on the link above. For more information, contact Jim Wells at (202) 512-3841 or wellsj@gao.gov.

What GAO Found

DOE has prepared and begun to implement plans to meet its schedule to design and construct the Next Generation Nuclear Plant by 2021, as required by the Energy Policy Act of 2005. Initial R&D results are favorable, but DOE officials consider the schedule to be challenging, given the amount of R&D work that remains to be conducted. For example, while researchers have successfully demonstrated the manufacturing of coated particle fuel for the reactor, the last of eight planned fuel tests is not scheduled to conclude until 2019. DOE plans to initiate the design and construction phase in fiscal year 2011, if the R&D results support proceeding with the project. The act also requires that DOE and NRC develop a licensing strategy for the plant by August 2008. The two agencies are in the process of finalizing a memorandum of understanding to begin work on this requirement.

DOE is just beginning to obtain input from potential industry participants that would help determine the approach to ensuring the commercial viability of the Next Generation Nuclear Plant. In the interim, DOE is pursuing a more technologically advanced approach, compared with other options, and DOE has implemented some (but not all) of the recommendations made by two advisory groups. For example, as recommended by one advisory group, DOE lessened the need for R&D by lowering the reactor's planned operating temperature. In contrast, DOE has not accelerated its schedule for completing the plant, as recommended by the Nuclear Energy Research Advisory Committee. The committee was concerned that the time frame for completing the plant is too long to be attractive to industry, given that other advanced reactors may be available sooner. However, DOE believes the approach proposed by the committee would increase the risk of designing a plant that ultimately would not be commercially viable. GAO believes DOE's problems with managing other major projects call into question its ability to accelerate design and completion of the Next Generation Nuclear Plant.

Actual Size and Magnified Views of the Coated Particle Fuel



Sources: General Atomics (left); DOE (right).

Mr. Chairman and Members of the Subcommittee:

I am pleased to be here to discuss the Department of Energy's (DOE) progress on its Next Generation Nuclear Plant demonstration project. My testimony is based on our report being issued today, entitled *Nuclear Energy: Status of DOE's Effort to Develop the Next Generation Nuclear Plant* (GAO-06-1056). As you know, the administration's National Energy Policy calls for the greater use of nuclear power and hydrogen to meet the nation's growing energy needs. The purpose of the Next Generation Nuclear Plant project is to establish the technical and commercial feasibility of producing both electricity and hydrogen from an advanced nuclear reactor. DOE has been engaged since fiscal year 2003 in research and development (R&D) on such a plant. The Energy Policy Act of 2005 formally established the Next Generation Nuclear Plant as a DOE project and set further requirements for the project's implementation, including obtaining a license from the Nuclear Regulatory Commission (NRC) to operate the plant and completing the project by fiscal year 2021.[1] DOE estimates the total cost of the plant to be approximately $2.4 billion. The act also designated DOE's Idaho National Laboratory as the lead laboratory and construction site for the plant and gave it responsibility for carrying out cost-shared R&D, design, and construction with industry partners. The Idaho National Laboratory has considerable experience with nuclear energy technologies. Since 1949, 52 nuclear reactors have been designed and tested at the site.

DOE has chosen the "very-high-temperature reactor," which is cooled by helium gas, as the advanced reactor design for the Next Generation Nuclear Plant. As its name implies, this reactor would operate at a much higher temperature than existing nuclear power plants—up to about 950 degrees Celsius (1,742 degrees Fahrenheit). This temperature would be roughly three times the temperature of a light water reactor, which is cooled by water and is the technology generally in use in the United States and around the world. Despite the high temperature, there is general agreement that a gas-cooled reactor offers the potential for improved safety. In addition, DOE considers the very-high-temperature reactor to be the nearest-term advanced nuclear reactor design that operates at temperatures high enough to generate the heat (called "process heat") needed to produce hydrogen. Under the administration's National

[1] Pub. L. No. 109-58 (2005).

Hydrogen Fuel Initiative, hydrogen is envisioned to be used in fuel cells for the transportation sector as an alternative to imported oil.

Over the course of the last several years, two independent groups have reviewed DOE's plans for the Next Generation Nuclear Plant. The Independent Technology Review Group—coordinated by the Idaho National Laboratory and composed of an international group experienced in the design, construction, and operation of nuclear systems—issued a report in 2004 on the design features and technological uncertainties of the very-high-temperature reactor. The report concluded that the uncertainties associated with the project appeared manageable and that the project's objectives could be achieved.[2] In 2006, as required by the Energy Policy Act of 2005, DOE's Nuclear Energy Research Advisory Committee also completed an initial review of the project.[3] The advisory committee reviewed DOE's R&D plans in light of the Independent Technology Review Group's report and recommended that DOE accelerate the project. Both reviews also made recommendations to modify DOE's R&D plans to ensure the project's success.

DOE is managing the Next Generation Nuclear Plant under its project management process for the acquisition of capital assets, which sets forth planning requirements that have to be met before DOE may begin design or construction activities. The goal of these requirements is to complete projects on schedule, within budget, and capable of meeting performance objectives. Our reviews of DOE's management of other major projects have found that project management has long been a significant challenge for DOE and is at high risk of waste and mismanagement.[4] In an effort to improve cost and schedule performance, DOE issued new policy and guidance on managing and controlling projects in 2000, but performance problems continue on major projects. For example, we testified in April 2006 that DOE's fast-track approach to designing and building the Waste Treatment Plant Project at DOE's Hanford site in Washington state

[2]Idaho National Engineering and Environmental Laboratory, *Design Features and Technology Uncertainties for the Next Generation Nuclear Plant*, INEEL/EXT-04-01816 (Idaho Falls, Idaho; June 30, 2004).

[3]The Nuclear Energy Research Advisory Committee was established in 1998 to provide independent advice to DOE on complex science and technical issues associated with the planning, management, and implementation of DOE's nuclear energy program.

[4]GAO, *High-Risk Series: An Update*, GAO-05-207 (Washington, D.C.: January 2005); and *High-Risk Series: An Update*, GAO-03-119 (Washington, D.C.: January 2003).

increases the risk that the completed facilities may require major rework to operate safely and effectively and could increase the project's costs.[5]

My testimony discusses the results of our report being issued to you today and addresses DOE's (1) progress in meeting its schedule for the Next Generation Nuclear Plant and (2) approach to ensuring the commercial viability of the project, including how DOE has implemented the recommendations of the two advisory groups. For the report, we analyzed DOE's project plans, interviewed DOE and Idaho National Laboratory officials, and observed R&D efforts at Idaho National Laboratory. Furthermore, we reviewed the two independent assessments of the project and how DOE had responded to their recommendations. We also reviewed NRC documentation related to the development of a licensing strategy for the Next Generation Nuclear Plant, and we interviewed DOE and NRC officials regarding licensing issues. We performed our work from April to September 2006 in accordance with generally accepted government auditing standards.

Summary

DOE has prepared an R&D schedule designed to support the design and construction of the Next Generation Nuclear Plant by fiscal year 2021, as set forth in the Energy Policy Act of 2005. Initial R&D results have been favorable, but DOE officials consider this schedule to be challenging, given the amount of R&D that remains to be conducted. For example, DOE officials told us that researchers have successfully demonstrated in a laboratory setting the manufacturing of nuclear fuel for the reactor, which is critical to the plant's operation. The first of eight planned experiments to irradiate the fuel in order to test how well it performs will not begin until early in fiscal year 2007, and the final experiment is not scheduled to end until fiscal year 2019. DOE plans to initiate design work in fiscal year 2011, but only if the R&D results support proceeding with design and construction of the plant. With regard to licensing the Next Generation Nuclear Plant, DOE and NRC are in the process of finalizing a memorandum of understanding so that the two agencies can work together to develop a licensing strategy by August 2008, as required by the Energy Policy Act of 2005. In the long term, NRC will need to address "skill gaps" related to the agency's capability to license a gas-cooled

[5]GAO, *Hanford Waste Treatment Plant: Contractor and DOE Management Problems Have Led to Higher Costs, Construction Delays, and Safety Concerns*, GAO-06-602T (Washington, D.C.: Apr. 6, 2006).

reactor such as the Next Generation Nuclear Plant. A 2001 NRC assessment identified these skill gaps, but the commission has taken limited action to address them because until recently it had not anticipated receiving a license application for a gas-cooled reactor.

DOE's approach to ensuring the commercial viability of the Next Generation Nuclear Plant is to significantly advance existing gas-cooled reactor technology in order to support the development of a plant design that utilities and other end users will be interested in deploying to help meet the nation's energy needs. For example, if successful, DOE's R&D would enable the reactor to operate at a higher temperature compared with other high-temperature gas-cooled reactors. The higher temperature would result in more efficient fuel use and hydrogen production and thus would be a more economically attractive plant. In addition, DOE is seeking industry involvement on the design of the plant and the business considerations for deploying it. In some cases, DOE officials' views on how best to achieve technological advances and ensure the commercial viability of the plant differ from the two independent advisory groups that have reviewed DOE's plans, and DOE has implemented some but not all of the advisory groups' recommendations. For example, in accordance with a recommendation of the Independent Technology Review Group, DOE lessened the need for R&D on advanced materials by lowering the planned operating temperature of the reactor from 1,000 degrees Celsius to no more than 950 degrees Celsius. In contrast, DOE has not implemented recommendations to scale back other planned technological advances or accelerate its schedule for completing the plant. For example, the Nuclear Energy Research Advisory Committee had recommended accelerating the schedule to make the plant more attractive to industry compared with other advanced gas-cooled reactors that may be available sooner and thus attract greater industry participation.

DOE believes accelerating the project would increase project risk—for example, the risk of cost overruns or a failure to meet project specifications—and would require significant additional resources that are not in keeping with the department's current priorities. According to DOE officials, additional R&D conducted early in the project would reduce overall project risk but would require additional resources. However, DOE has limited funding for nuclear energy R&D and has given other projects, such as developing the capability to recycle fuel from existing nuclear power plants, priority over the Next Generation Nuclear Plant.

Background

One of DOE's strategic goals is to promote a diverse supply of reliable, affordable, and environmentally sound energy. To that end, DOE is promoting further reliance on nuclear energy under the administration's National Energy Policy.[6] According to DOE officials, the department has three priorities for promoting nuclear energy. The first priority is deploying new advanced light water reactors under the Nuclear Power 2010 program. The second priority is the Global Nuclear Energy Partnership, launched in February 2006. The partnership's objectives are to demonstrate and deploy new technologies to recycle nuclear fuel and minimize nuclear waste, and to enable developing nations to acquire and use nuclear energy while minimizing the risk of nuclear proliferation. The third priority is R&D on the Next Generation Nuclear Plant. According to DOE officials, the department remains committed to this project even though the Global Nuclear Energy Partnership has assumed a higher priority.

DOE is engaged in R&D on the Next Generation Nuclear Plant as part of a larger international effort to develop advanced nuclear reactors (Generation IV reactors) that are intended to offer safety and other improvements over the current generation of nuclear power plants (Generation III reactors). DOE coordinates its R&D on advanced nuclear reactors through the Generation IV International Forum, chartered in 2001 to establish a framework for international cooperation in R&D on the next generation of nuclear energy systems.[7] In 2002, the Generation IV International Forum (together with DOE's Nuclear Energy Research Advisory Committee) identified what it considered the six most promising nuclear energy systems for further research and potential deployment by about 2030. DOE has selected one of the six advanced nuclear systems—the very-high-temperature reactor—as the design for its Next Generation Nuclear Plant, in part because it is considered to be the nearest-term reactor design that also has the capability to produce hydrogen. According to DOE officials, the very-high-temperature reactor is also the design with the greatest level of participation among the Generation IV International Forum members.

[6]While DOE is the federal agency tasked with promoting nuclear energy, NRC is responsible for ensuring public health and safety with regard to nuclear power.

[7]Members of the Generation IV International Forum include Argentina, Brazil, Canada, the European Atomic Energy Community (Euratom), France, Japan, South Africa, South Korea, Switzerland, the United Kingdom, and the United States. In July 2006, DOE announced that China and Russia are also expected to join the forum.

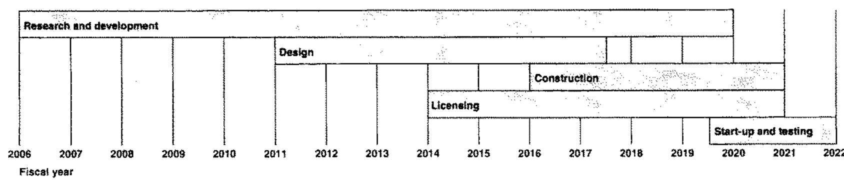
Furthermore, the very-high-temperature reactor builds on previous experience with gas-cooled reactors. For example, DOE conducted R&D on gas-cooled reactors throughout the 1980s and early 1990s, and two gas-cooled reactors have previously been built and operated in the United States. The basic technology for the very-high-temperature reactor also builds on previous efforts overseas, in particular high-temperature gas-cooled reactor technology developed in England and Germany in the 1960s, and on technologies being advanced in projects at General Atomics in the United States, the AREVA company in France, and at the Pebble Bed Modular Reactor company in South Africa. In addition, Japan and China have built small gas-cooled reactors.

DOE Has Made Initial Progress Toward Meeting Near-Term Milestones for the Next Generation Nuclear Plant

DOE has developed a schedule for the R&D, design, and construction of the Next Generation Nuclear Plant that is intended to meet the requirements of the Energy Policy Act of 2005, which divides the project into two phases. For the first phase, DOE has been conducting R&D on fuels, materials, and hydrogen production. DOE also recently announced its intent to fund several studies on preconceptual, or early, designs for the plant. DOE plans to use the studies, which are expected to be completed by May 2007, to establish initial design parameters for the plant and to further guide R&D efforts.

DOE is planning to begin the second phase in fiscal year 2011 by issuing a request for proposal that will set forth the design parameters for the plant. If R&D results at that time do not support the decision to proceed, DOE may cancel the project. Assuming a request for proposal is issued, DOE is planning to choose a design by 2013 from among those submitted by reactor vendors. Construction is scheduled to begin in fiscal year 2016, and the plant is expected to be operational by 2021. In addition, DOE is planning for the appropriate licensing applications for the plant to be submitted for NRC review and approval during the second phase of the project. See figure 1 for the overall Next Generation Nuclear Plant project schedule.

Figure 1: Next Generation Nuclear Plant Project Schedule



Source: DOE.

As scheduled by DOE, the Next Generation Nuclear Plant project is expected to cost approximately $2.4 billion, part of which is to be funded by industry. According to DOE officials, the department budgeted about $120 million for the project from fiscal years 2003 through 2006. This amount includes about $80 million for R&D on the nuclear system of the plant and about $40 million for R&D on the hydrogen production system.

Initial research results since DOE initiated R&D on the Next Generation Nuclear Plant project in 2003 have been favorable, but the most important R&D has yet to be done. For example, DOE is planning a series of eight fuel tests in the Advanced Test Reactor at Idaho National Laboratory. Each test is a time-consuming process that requires first fabricating the fuel specimens, then irradiating the fuel for several years, and finally conducting the postirradiation examination and safety tests. DOE is at the beginning of the process. In particular, DOE officials said they have successfully fabricated the fuel for the first test and addressed previous manufacturing problems with U.S. fuel development efforts in which contaminants weakened the coated particle fuel. However, the irradiation testing of the fuel in the Advanced Test Reactor has not yet begun. The first test is scheduled to begin early in fiscal year 2007 and to be completed in fiscal year 2009. The eighth and final test is scheduled to begin in fiscal year 2015, and the fuel testing program is scheduled to conclude in fiscal year 2019. As a result, DOE will not have the final results from all of its fuel tests before both design and construction begin.[8] While DOE has carefully planned the fuel tests and expects favorable results, a DOE

[8]Under DOE's fuel R&D plan, the results from the first six tests would be available before construction begins, and the results from the final two tests would be available before completion of the plant.

official acknowledged that they do not know if the fuel tests will ultimately be successful.

DOE is also at the beginning stages of R&D on other key project areas such as the hydrogen production system for the plant and materials development and testing. For example, Idaho National Laboratory successfully completed a 1,000-hour laboratory-scale test of one of two potential hydrogen production systems in early 2006. DOE ultimately plans to complete a commercial-scale hydrogen production system for demonstration by fiscal year 2019, which will allow time to test the system before linking it to the very-high-temperature reactor. DOE also has selected and procured samples of graphite—the major structural component of the reactor core that will house the nuclear fuel and channel the flow of helium gas—and designed experiments for testing the safety and performance of the samples. Nevertheless, much of the required R&D for the graphite has not yet begun and is not scheduled to be completed until fiscal year 2015.

Regarding licensing of the plant, DOE and NRC are in the process of finalizing a memorandum of understanding that will establish a framework for developing a licensing strategy. As required by the Energy Policy Act of 2005, DOE and NRC are to jointly submit a licensing strategy by August 2008.[9] NRC has drafted a memorandum of understanding and submitted it to DOE, but its approval has been delayed by additional negotiations on details of the agreement. Nevertheless, NRC has already taken certain other actions to support licensing the Next Generation Nuclear Plant. In particular, NRC has been developing a licensing process that could be used for advanced nuclear reactor designs and that would provide an alternative to its current licensing framework, which is structured toward light water reactors.

In addition to developing a licensing strategy, NRC will need to enhance its technical capability to review a license application for a gas-cooled reactor, such as the Next Generation Nuclear Plant. In 2001, NRC completed an assessment of its readiness to review license applications for advanced reactors. The assessment identified skill gaps in areas such as accident analysis, fuel, and graphite, which apply to gas-cooled

[9]The act also directs DOE to seek NRC's active participation throughout the duration of the project—for example, to avoid design decisions that would compromise safety or impair the accessibility of safety-related components for inspection and maintenance.

reactors.[10] Furthermore, NRC identified a "critical" skill gap in inspecting the construction of a gas-cooled reactor. As a result of its 2001 assessment, NRC issued a detailed plan in 2003 to address the gaps in expertise and analytical tools needed to license advanced reactors, including gas-cooled reactors. However, NRC has since taken limited steps to enhance its technical capabilities related to gas-cooled reactors because, until recently, it had not anticipated receiving a license application for a gas-cooled reactor.

DOE Is Pursuing a More Technologically Advanced Approach Than Other Options in an Effort to Ensure the Plant's Commercial Viability

DOE is beginning to obtain input from potential industry participants that would help DOE determine its approach to ensuring the commercial viability of the Next Generation Nuclear Plant. In the interim, DOE is pursuing a more technologically advanced approach—with regard to size, fuel type, and the coupling of electricity generation and hydrogen production in one plant—compared with the recommendations of the Independent Technology Review Group and the Nuclear Energy Research Advisory Committee. These technological advances require substantial R&D on virtually every major component of the plant. For example, the advanced uranium fuel composition that DOE is researching is not proven and requires fundamental R&D.

The Independent Technology Review Group cautioned that attempting to achieve too many significant technological advances in the plant could result in it becoming an exercise in R&D that fails to achieve its overall objectives, including commercial viability. Another key factor likely to affect the plant's commercial viability is the time frame for its completion. For example, the plant's commercial attractiveness could be affected by competition with other high-temperature gas-cooled reactors under development and potentially available sooner, such as one in South Africa, although these other reactor designs would also need to be licensed by NRC before being deployed in the United States.

DOE acknowledges the risk of designing and building a plant that is not commercially viable and has taken initial steps to address this challenge. For example, DOE has established what it considers to be "aggressive but achievable" goals for the plant, such as producing hydrogen at a cost low

[10]As defined in the *Future Licensing and Inspection Readiness Assessment*, published by NRC in September 2001, skill gaps occur when individuals with technical expertise are working in other areas within the agency, are near retirement or are expected to leave the agency, or do not exist in the agency.

enough to be competitive with gasoline. Furthermore, DOE is beginning to obtain industry input to help the department develop an approach for ensuring the commercial viability of the plant. DOE initiated two efforts in July 2006 to obtain input from industry on the design of the plant and the business considerations of deploying the plant. Specifically, DOE announced its intent to fund multiple industry teams to develop designs (and associated cost estimates) for every aspect of the plant, including the reactor and hydrogen production technology, by May 2007. In addition, DOE began participating in meetings with representatives from reactor vendors, utilities, and potential end users in order to obtain their insight into the market conditions under which the plant would be commercially viable. Until DOE develops a better understanding of the business requirements for the Next Generation Nuclear Plant, DOE is conducting R&D to support two distinct designs of the very-high-temperature reactor—pebble bed and prismatic block—rather than focusing on one design that may ultimately be found to be less commercially attractive.[11]

As recommended by the Independent Technology Review Group, DOE revised its R&D plans to lessen the technological challenges of designing and building the Next Generation Nuclear Plant. Most importantly, it reduced the planned operating temperature of the reactor from 1,000 degrees Celsius to no more than 950 degrees Celsius. According to Idaho National Laboratory officials, this small reduction is significant because it enables DOE to use existing metals rather than develop completely new classes of materials.

DOE, however, has not adopted other recommendations—in particular to revise its R&D plans to focus on a uranium dioxide fuel kernel, which has been more widely used and researched than the advanced uranium oxycarbide fuel kernel DOE is currently researching.[12] The Independent Technology Review Group considered DOE's fuel R&D plan on an advanced uranium fuel composition more ambitious than necessary and concluded that focusing on the more mature fuel technology would reduce

[11]The pebble bed design uses fuel particles formed into billiard-ball-size graphite spheres that slowly move through the reactor core in a continuous refueling process. In the prismatic block design, fuel particles are formed into cylindrical rods that are loaded into large graphite blocks making up the reactor core, which is periodically refueled in a batch process.

[12]The fuel is composed of a small uranium kernel that is coated with several protective layers. Whereas the more widely researched fuel kernel is composed of uranium dioxide, the advanced composition incorporates both uranium dioxide and uranium oxycarbide.

the risk of not meeting the schedule for the plant. Nevertheless, DOE has continued to focus on the advanced uranium oxycarbide fuel because it has the potential for better performance. DOE officials also told us that the most significant challenge with regard to the fuel is not its composition but rather the coatings, which is independent of the fuel kernel composition. To respond to the recommendation, DOE decided to test the performance of the two types of fuel kernels side-by-side as part of its fuel R&D plan.

The Nuclear Energy Research Advisory Committee also recommended that DOE re-evaluate the project's dual mission of demonstrating both electricity and hydrogen production. Although the advisory committee did not recommend what the project's focus should be—electricity generation or hydrogen production—it wrote that the dual mission would be much more challenging and require more funding than either mission alone. Instead, DOE's R&D is currently supporting both missions, and DOE officials said they consider the ability to produce hydrogen (or to use process heat for other applications) key to convincing industry to invest in the Next Generation Nuclear Plant rather than advanced light water reactors similar to the current generation of nuclear power plants operating in the United States.

Moreover, a key Nuclear Energy Research Advisory Committee recommendation was to accelerate the project and deploy the plant much earlier than planned by DOE in order to increase the likelihood of participation by industry and international partners. Representatives of the Nuclear Energy Institute, which represents utilities that operate nuclear power plants, also told us that accelerating the project would increase the probability of successfully commercializing the plant. As one possible approach to acceleration, the advisory committee further recommended that DOE design the Next Generation Nuclear Plant to be a smaller reactor that could be upgraded and modified as technology advances. However, DOE officials consider the advisory committee's schedule high risk and doubt that the degree of acceleration recommended could be achieved. Furthermore, according to DOE officials, a smaller reactor would require the same R&D as a larger reactor but would not support future NRC licensing of a full-scale plant, which is critical to the plant's commercial viability.

Idaho National Laboratory officials also consider the schedule proposed by the advisory committee to be high risk, potentially resulting in the need to redo design or construction work. Nevertheless, the laboratory has also proposed accelerating the schedule, though to a lesser extent than recommended by the advisory committee. According to laboratory officials, if DOE does not begin design sooner than currently planned, too much R&D and design work will be compressed into a short time frame after DOE begins design in fiscal year 2011, and the department will not be able to complete the plant by fiscal year 2021. Consequently, the laboratory has proposed beginning design earlier than planned by DOE, which would also reduce the scope of the R&D by focusing on fewer design alternatives. The laboratory's proposed schedule would result in completing the plant up to 3 years earlier than under DOE's schedule. While the laboratory's proposed schedule would slightly reduce the project's total cost estimate, it would require that DOE provide more funding in the near term. For example, in fiscal year 2007, Idaho National Laboratory estimates that R&D on the very-high-temperature reactor design would need to be increased from $23 million (the amount requested by DOE in its fiscal year 2007 budget submission) to $100 million.

DOE officials believe that the laboratory's current proposed schedule is the best option for the plant and stated that they would consider accelerating it if there were adequate funding and sufficient demand among industry end users to complete the project sooner. In addition, DOE officials said that even if the schedule is not accelerated, increasing the funding for the project would enable additional R&D to be conducted to increase the likelihood that the plant is completed by fiscal year 2021. For example, DOE officials stated that its current R&D plans for the very-high-temperature reactor design could support doubling the department's fiscal year 2007 budget request of $23 million. However, DOE has limited funding for nuclear energy R&D and has given other projects, such as developing the capability to recycle fuel from existing nuclear power plants, priority over the Next Generation Nuclear Plant.

Concluding Observations

While DOE is making progress in implementing its plans for the Next Generation Nuclear Plant, these efforts are at the beginning stages of a long project and it is too soon to determine how successful DOE will be in designing a technically and commercially viable plant. As we note in our report, it is also too soon, in our view, to support a decision to accelerate the project. Accelerating the schedule would require that DOE narrow the scope of its R&D and begin designing the plant before having initial research results on which to base its design decisions. This could result in having to redo work if future research results do not support DOE's design decisions. In addition, DOE has only recently begun to systematically involve industry in the project. Such input is critical to key decisions, such as whether DOE should design a less technologically advanced plant that is available sooner rather than a larger, more technologically advanced plant that requires more time to develop. Finally, DOE's history of problems managing large projects on budget and within schedule raises concerns about the department's ability to complete the Next Generation Nuclear Plant in the time frame set forth in the Energy Policy Act of 2005, and accelerating the schedule would only add to these concerns.

Mr. Chairman, this concludes my prepared statement. I would be happy to respond to any questions that you or other Members of the Subcommittee may have.

GAO Contact and Staff Acknowledgments

For further information about this testimony, please contact me at (202) 512-3841 or wellsj@gao.gov. Raymond H. Smith Jr. (Assistant Director), Joseph H. Cook, John Delicath, and Bart Fischer made key contributions to this testimony.

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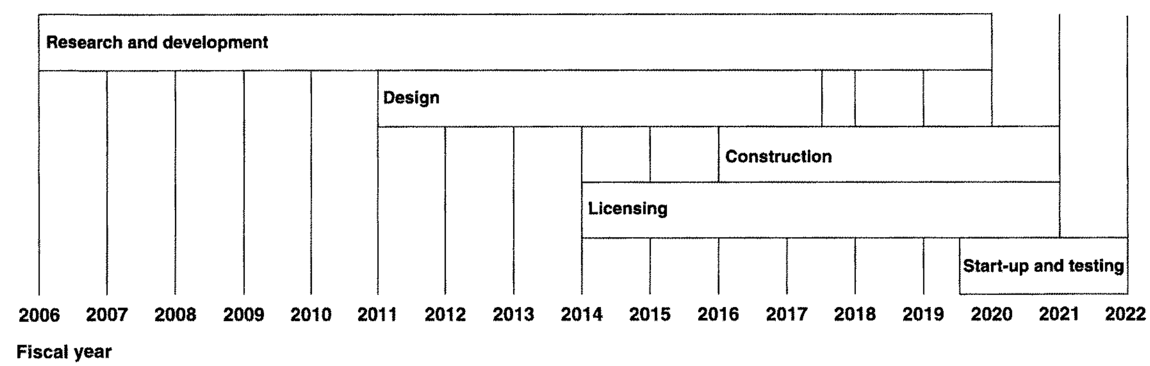
DOE's Schedule for Completing the Next Generation Nuclear Plant by Fiscal Year 2021



Source: DOE.

Mr. ISSA. Jim, I thought you were going to stay for a full career. It is just not right for a young guy like you to consider retirement. With your expertise, it is very likely to pay better than your work did, but congratulations on 37 years.

Mr. WELLS. Thank you, sir.

Mr. ISSA. That is a wonderful period of service.

Mr. WELLS. Thank you.

Mr. ISSA. Mr. Hildebrandt, I don't think you can equal that, but give it a try.

STATEMENT OF PHIL HILDEBRANDT

Mr. HILDEBRANDT. I can perhaps say I might be older.

Mr. ISSA. I understand that you and the Admiral——

Mr. HILDEBRANDT. Grossenbacher?

Mr. ISSA. Yes, you taught him everything he knew, right?

Mr. HILDEBRANDT. I would never admit to that.

Mr. ISSA. OK.

Mr. HILDEBRANDT. He would not, as well. Rickover did teach me much of what I know, however. I did work for him for many years.

Mr. Chairman and members of the subcommittee, it is an honor to present the views of the Idaho National Laboratory regarding progress being made on the schedule for the Next Generation Nuclear Plant and plans to ensure commercial viability of the project and participation of the private sector.

I am a consultant to Admiral John Grossenbacher at the laboratory. I have a title, which is in the formal testimony. It is a long one. I have worked for over 38 years in the nuclear industry, starting in the naval nuclear propulsion program for Admiral Rickover, as the chairman mentioned, subsequently in the commercial electric power generation industry, and most recently then within the Department of Energy, itself.

I am and we at the laboratory are encouraged by the recent resurgence of interest in nuclear technologies by the U.S. commercial power generating industry, as indicated by announced plans to seek licenses from the NRC to construct and operate new nuclear plants.

The Idaho National Laboratory, under the leadership of its director, John Grossenbacher, is playing a central role in this nuclear renaissance and in the future of nuclear energy, including the Next Generation Nuclear Plant, the subject of today's discussion, and the Global Nuclear Energy Partnership.

The subject of today's hearing, the Next Generation Nuclear Plant, is an essential part of the future of nuclear energy, in our opinion. The demonstrated success of the commercial nuclear industry in reliably producing electric power using nuclear technology in the United States and throughout the world provides the foundation upon which these improved nuclear technologies can be extended to other energy sectors, not just hydrogen.

I want to make sure we think of this perhaps more broadly. This is what we call in the engineering field a process heat machine. The importance is very high temperature, processed heat which can be used not only to produce hydrogen but to be used complementary with coal gassification and extracting petroleum products from oil and tar sands and for direct use in many chemical processes.

In doing so, we have the important contribution to reducing the carbon footprint, if I may, of the chemical industry that exists today. So this is a very broad application, hydrogen being one of the areas of focus; however, much broader than that in total.

The marketplace for the high-temperature processing and the hydrogen exists today. If we had a plant of this technology to provide to the commercial industry, they would be able to compete in an economic competition with hydrogen production by other means today, and by doing so reduce the extent of natural gas that we use for such purposes and better use the natural gas and other such products elsewhere for their unique capabilities.

The key aspect of initiating a project such as the Next Generation Nuclear Plant is to obtain the commercial energy industry interest because, in fact, it is in the end a commercial venture.

Rather than take the approach of asking government to bring this along to its completion, we are now taking the approach, with the facilitation of the Idaho National Lab, to bring together a public/private consortium. In doing so, that public/private consortium shares the risk with the government in the development of these technologies. This is consistent with the Energy Policy Act of 2005 and the requests within that act.

The steps that we are currently taking and have just completed—preparing a credible business strategy and project plan and beginning the development of the commercial alliance of major end users and technology developers—there is a core of those today which are traditional in the nuclear energy world in terms of equipment vendors, nuclear system suppliers, and end users. We are now going to broaden that into other sectors because this particular plant goes well beyond the use for, as I mentioned hydrogen, as well into other areas where the larger marketplace of the petroleum industry, such as the petroleum industry, fertilizer industries, and other uses for this type of energy.

To address the item that Mr. Wells mentioned, which I share his concern with regards to past experience in the Department of Energy in managing such ventures. I think there is an unfortunate trail of problems in the past.

We are approaching this as a commercial venture. This public/private partnership that I have described in brief will have direct involvement of major commercial end users, technology developers, nuclear system suppliers, and equipment manufactures in what we are calling the Alliance; will implement commercial contracting vehicles between the Alliance and the national and international laboratories for the research and development; will use contemporary commercial project management practices for the design, licensing, and construction of the demonstration prototype.

So our emphasis is on the commercial sector, and then subsequently, upon building it, we will operate it by an experienced commercial nuclear operator. So we share the concern and we are addressing the concern from a commercial sector standpoint.

Addressing the item specifically of are we proceeding down a schedule which will achieve the result that we wish in a timeframe, the commercial sector, as has been consistent with other recommendations, would like to have this prototype demonstration that supports commercialization completed sooner than 2021. The target for the technology development would be in the timeframe of 2016 to 2018. In achieving that, it is a choice of a balance between the technologies that you choose to achieve the performance that is acceptable to the commercial sector to reduce the risk of completing it in the timeframe, so there is a choice—choice of technology, choice of schedule, choice of costs.

The commercial sector would drive this toward achieving success in the 2016 to 2018 timeframe. As you know, in the commercial sector such targets are not taken lightly. This is very important in the financial realities.

I will stop there since the red light has gone on. I thank you for your time and attention.

The Idaho National Laboratory fully supports the development of these technologies for the Next Generation Nuclear Plant, and the targeted energy needs in the United States and the world make these technologies an essential part of the overall development and strategy for nuclear energy.

I thank you.

[The prepared statement of Mr. Hildebrandt follows:]

TESTIMONY FOR THE RECORD

Philip C. Hildebrandt, P.E.
Special Assistant to the Laboratory Director
for Prototype Reactors & Major Projects
Idaho National Laboratory

U.S. House Committee on Government Reform
Subcommittee on Energy and Resources

Concerning the Next Generation Nuclear Plant and Hydrogen Production

September 20, 2006

Mr. Chairman and members of the Subcommittee, it is an honor to present the views of the Idaho National Laboratory regarding progress being made on the schedule for the Next Generation Nuclear Plant, and plans to ensure commercial viability of the project and the participation of the private sector. I have worked for over 38 years in several sectors of the nuclear energy industry including the Naval Nuclear Propulsion Program, commercial electric power generation and the Department of Energy. I am encouraged by the recent resurgence in interest in nuclear technologies by the US commercial power generating industry as indicated by announced plans to seek licenses from the Nuclear Regulatory Commission to construct and operate new nuclear plants. The Idaho National Laboratory, under the leadership of its Director, John Grossenbacher (Vice-Admiral US Navy, retired), is playing a central role in this nuclear renaissance and in the future of nuclear energy including the Next Generation Nuclear Plant and the Global Nuclear Energy Partnership.

Over the next ten years the Idaho National Laboratory is envisioned by the Department of Energy to become the preeminent, internationally-recognized nuclear energy research, development and demonstration laboratory. The Idaho National Laboratory will foster academic, industry, government and international collaborations to produce the investment, programs and expertise to ensure this vision. To this end, the Idaho National Laboratory is today forming collaborations with other US national laboratories and commercial industry for development and demonstration projects such as the Next Generation Nuclear Plant, drawing on the existing core of talented and experienced personnel and the capabilities of unique facilities such as the Advanced Test Reactor.

The subject of today's hearing, the Next Generation Nuclear Plant, is an essential part of the future of nuclear energy. The demonstrated success of the commercial power industry in reliably producing electric power using existing nuclear technology in the US and throughout the world provides the foundation upon which these improved nuclear technologies can be extended into energy sectors that were previously not directly served by nuclear energy.

The *Energy Policy Act of 2005* authorized the Next Generation Nuclear Plant project, including construction of a high temperature gas-cooled nuclear prototype to demonstrate production of hydrogen and electricity. This nuclear technology provides substantive improvements with regard to its potential uses in the energy industry beyond the traditional electric power generation mission and its more efficient use of natural resources. The reliability, safety, proliferation resistance and economy will be competitive with and in some cases exceed that achieved in existing commercial nuclear plants for the targeted applications. The Next Generation Nuclear Plant is envisioned to be a full scale prototype that will support the commercialization potential of high temperature gas-cooled reactors and associated technologies including economically competitive means of producing high temperature process heat for uses such as hydrogen production. These advanced nuclear plants can supply greenhouse gas emission-free high temperature process heat and hydrogen for use in enhanced oil recovery from oil shale and sands, refineries, coal-to-liquids and coal-to-gas plants, chemical plants and fertilizer plants. These nuclear process heat source plants can promote the utilization of indigenous coal and uranium resources and extend domestic oil and gas resources thereby reducing dependence and cost associated with imported petroleum and natural gas. Utilization of this high temperature nuclear process heat source will effectively improve the carbon efficiency of the chemical industry, significantly reduce carbon emissions and other air pollutants, produce electricity and other industrial products at lower overall cost with less impact on valuable natural resources and scarce water reserves than competing technologies.

The marketplace for use of the high temperature process heat and hydrogen exists today, for example, in petroleum refining and in fertilizer production. If these high temperature process heat and hydrogen technologies of the Next Generation Nuclear Plant were available today, it has been estimated that the hydrogen produced would be economically competitive for this large marketplace. Hence, the maturation of a broader so-called "hydrogen economy" is not a prerequisite to successful commercialization of these technologies.

A key aspect of initiating the project is obtaining demonstrated commercial energy industry interest. It is essential that the project attract the necessary private funding and value-in-kind contributions from end-users and technology developers for the duration of the project, i.e., research and development through construction and operation of the demonstration plant. These issues are being managed through:

- Preparing a credible business strategy and a project plan for managing this endeavor
- Developing a commercial alliance of major end-users and technology developers
- Forming a public-private partnership to share the development and demonstration costs for these advanced technologies.

A core of potential members of this commercial Alliance has prepared a summary-level business strategy and project plan that will be used for discussions with a broad spectrum of potential end-users and technology developers throughout the energy industry. These discussions will occur over the next several months. Once sufficient commercial support is ensured, the Department of Energy will be approached by the Alliance to form the cost-sharing partnership.

The longer term risks to completion of the project are associated with successful technology development (e.g., nuclear fuels, materials, analytical methods and hydrogen production) and design, construction and operation of the demonstration prototype. These longer term risks will be mitigated by managing the technology development and demonstration prototype as a commercial venture. This commercial venture approach would include:

- Direct involvement of major commercial end-users, technology developers, nuclear system suppliers and equipment manufacturers in the Alliance
- Implementing commercial contracting vehicles between the Alliance and national and international laboratories, other commercial technology developers and universities for the technology development
- Using contemporary commercial project management practices for the design, licensing and construction of the demonstration prototype
- Operation of the demonstration prototype by an experienced commercial nuclear operator.

As can be seen from the preceding discussion, commercial viability of the project is ensured by direct involvement of commercial end-users and technology developers at every step through its development. The configuration and functional capabilities of the demonstration prototype will be selected by the public-private partnership based on a balance between desired performance, technology development risk and the desired schedule for commercialization of the technologies. It is anticipated that the reference configuration will be based on providing process heat at conditions that fulfill the needs of prospective end-users in the production of hydrogen, for direct use in processes for the production of synthetic fuels and in chemical processing. The results of near-term pre-conceptual design work for the Idaho National Laboratory will better define the configuration and the functional capabilities for this demonstration. For planning purposes, the business strategy being prepared by the potential future members of the commercial industry Alliance anticipates initial operation of the demonstration prototype in the 2016 to 2018 timeframe to support commercial interests in these technologies. This operational timeframe is based on the earliest it is judged that the technology could be developed and the nuclear system licensed, based on leveraging applicable gas-cooled reactor development work being performed elsewhere, e.g., the Pebble Bed Modular Reactor in South Africa, the High Temperature Test Reactor in Japan. It is expected that certain commercialization activities will proceed in parallel with the demonstration prototype to support the earliest commercial application consistent with perceived commercialization risk.

For the Department of Energy, the Idaho National Laboratory is leading the planning, research & development, and design activities for the Next Generation Nuclear Plant project drawing on the capabilities of other national laboratories and the commercial nuclear industry. Currently, budget planning by the Department of Energy is based on fulfilling the phased approach described in the *Energy Policy Act of 2005*, with completion of the demonstration prototype by September 2021 as required therein. Funding to date has successfully initiated the project and provided some momentum. However, INL's planning estimates indicate that the project future is budget constrained if the operational date anticipated and desired by the commercial entities forming the Alliance is to be achieved.

The Idaho National Laboratory fully supports the development of the technologies for the Next Generation Nuclear Plant. The targeted energy needs in the US and the world make these technologies an essential part of the overall development strategy for nuclear energy. The INL appreciates the continued support of the Congress for this project.

I thank you for your time and attention.

Mr. ISSA. Thank you.

Dr. Kadak.

STATEMENT OF ANDREW KADAK

Mr. KADAK. I thank you for the invitation.

First of all, I want to make sure that you understand that I am speaking here as an individual, not representing MIT or the nuclear engineering department.

You have already mentioned my background relative to being a past nuclear utility operator and servicing of the light water nuclear industry as we know it, but, in case I run out of time, I would like to answer your questions.

First, I agree with you that we are way too far in the future with 2021. I think it can be done much earlier. Countries such as South Africa and China are doing it. There is no reason why we cannot. I agree with your moon analogy.

Second, are the goals being met? Clearly not. As you saw in my testimony, the budget requests by the DOE for the NGNP are woefully inadequate, even for their 2021 date. I think they can be accelerated. I also believe that there is a way to accelerate not only the project but also the amount of R&D necessary to bring this project to fruition.

As you may remember, this project was started as a Generation IV project called a very high-temperature reactor. The commercial industry and Mr. Hildebrandt headed up a commitment called the International Technical Review Team, and they had several recommendations. The technical goals set for the VHTR were way too excessive, the timing was far too in the future, and what we have done independently is look at what do we really need to do to bring the Next Generation plant to fruition, not the very-high temperature reactor to fruition. A thousand degrees centigrade is a lot different than 850 and 900 centigrade, and that is sufficient to make hydrogen, certainly on a demonstration scale.

So what you will see in my testimony is, I took a thorough look at what the DOE was estimating for their cost, their R&D program, had that reviewed by people who are actually building their pebble bed reactors, and this could also apply to the General Atomics prismatic reactor, and we scrubbed those numbers and said, “what would it cost to build this particular plant on a schedule that looks like 2015, 2017.” We were able to cut about $1 billion off that number. It is a huge amount. For that amount of money, which basically is for NGNP and hydrogen at $1.2 billion total cost, we could get an operating plant, probably get it licensed by the NRC as a test facility that could be commercialized once demonstrated.

Those are, I think, the two questions that you had.

In terms of oversight, absolutely. I think what you will see in the funding profiles is it is desperately needed to make sure that the funds are provided.

Relative to Mr. Kucinich’s comments about renewables, I strongly suggest there is a book that just came out by William Sweet entitled, “Kicking the Carbon Habit.” It is a very informative, very helpful book that takes a very practical look at our energy technologies and the imminent crisis that we are facing in terms of global climate change. That has changed my opinion about the timing of projects such as this.

So I think I got pretty much everybody's main concerns identified. Now to my testimony, which hopefully you all will read.

The key issues I think for us is the process of getting the industry involved. Mr. Hildebrandt is working on trying to get an alliance together, which I think is a very important goal. Some time ago I proposed with industry a recommended approach, which was a funded competition to develop conceptual designs for the NGNP and also the hydrogen plant. Competing teams would participate, with ultimately a down-selection that would be based on the mission goals, the costs and schedules, and their capability to deliver the product. Then that team, whether it be a General Atomics team or Westinghouse team or AREVA team, would then be charged with building this plant, consider it an engineering project, not a science project.

Clearly there is going to be some R&D that is going to be needed to get this thing done. The Idaho National Lab will play a key role, and hopefully universities, as well. But, there is a lot of R&D being done internationally in China and in South Africa that was very helpful and supportive of the kind of thing we want to try to do here.

So we believe, at least I believe, that we can get this project done within 2015—let's just say within 2017, within the same time lines as Mr. Hildebrandt is talking about—but an approached that is focused and phased.

I would like also to address what I could call the chicken or the egg question. Where is this industry that is supposed to rise up and support this particular NGNP? Well, the industry is very fragmented, as you know. If you start saying let's make it the utilities, utilities don't care. All they want to do is buy power stations or buy hydrogen plants and run them, so they are not going to be developers, and they are not developers.

If you go to the nuclear steam suppliers like Westinghouse, General Electric, where they used to invent new technologies, but they haven't had an order in 30 years. Their resources and capabilities to put something like this together, put $1 billion on the table, is just not going to happen. Then, as you mentioned, the hydrogen producers, you know, they are quite fine with making hydrogen with steam methane reforming, but the price is very high, the supply is going to get very tight, and they don't want to do anything with nuclear. Then you get the hydrogen users and they say, I just want to buy the product. I don't want to get involved with all of this nuclear stuff or even more complicated technologies.

So there is no industry there, which is why I think this Next Generation Nuclear Plant, with not only the hydrogen mission but the process heat mission, oil recovery—we have done a lot of oil sands work—ought to be a national strategic project. Stop playing the games about who is going to put up the money first. It is a national strategic project, and if you read that "Kicking the Carbon Habit" book, you are going to be convinced that it is vitally important for this Nation and perhaps for the world.

I think I am done. Thank you very much for your time.

[The prepared statement of Mr. Kadak follows:]

The Next Generation Nuclear Plant
Timing is Critical

Andrew C. Kadak, Ph.D.
Professor of the Practice
Nuclear Science and Engineering Department
Massachusetts Institute of Technology

September 20, 2006

Testimony Before the Committee on Government Reform
Subcommittee on Energy and Resources

My name is Andrew C. Kadak. I'm a Professor of the Practice at the Massachusetts Institute of Technology, Nuclear Science and Engineering Department. My testimony today focuses on the Next Generation Nuclear Plant. It will identify NGNP's national strategic importance and describe how best to see this project to completion in a manner that will be suited for ultimate deployment in the commercial sector. My background is not a strictly an academic one. Most of my life has been spent in private nuclear utility industry, most recently as President and Chief Executive Officer of Yankee Atomic Electric Company. This company, at one point, operated three nuclear power plants in New England: Yankee Rowe, Vermont Yankee and Maine Yankee. Yankee Atomic also was the owner's engineer for the Seabrook Nuclear Power Station in New Hampshire. Yankee also provided engineering, safety analysis and environmental support services for most of the New England nuclear power stations. Today, I come to you as an academic with industry experience to discuss the Next Generation Nuclear Plant.

The comments and views expressed are my own and do not reflect those of MIT or the Nuclear Science and Engineering Department. In the interest of full disclosure, I have advised the committee staff that I am a member of one of the teams competing for the pre-conceptual design of the NGNP. I can assure the committee that my role on the team, which is to propose a sensible research and development plan for near term implementation, does not affect my testimony since much of what I am about to present are positions and suggestions made to the Department of Energy in the past. My experience with the DOE on high temperature gas reactors began as a technical expert on the high temperature gas reactor group for the Generation IV Technology Roadmap.

As many of you may remember, the Next Generation Nuclear Power Plant was conceived out of the Generation IV initiative of the Department of Energy. The Generation IV initiative was designed to identify promising new technologies that could be deployed in 20 or 30 years. The outcome of that study was that the Department of Energy selected high temperature gas reactors as the technology that they would develop as their top priority since it would coincide with President Bush's hydrogen initiative. This initiative, which continues, was judged to be important since it is designed to find a clean alternative to replace depleting and expensive fossil fuels for the transportation sector.

The Next Generation Nuclear Plant was accelerated from the 20-30 year time frame to the next 10-15 years largely because of the need to begin development of clean hydrogen production alternatives that would not be dependent upon another valuable fossil fuel, namely natural gas, and to reduce CO_2 emissions that affect global climate change. Originally the Generation IV high temperature gas reactor was called the Very High Temperature Reactor (VHTR) because there was a desire to attain temperatures of 1000 C or higher. Responding to technical community criticism that this extremely high temperature was unrealistic, the Department of Energy convened an International Technical Review Group (ITRG) to assess the realism of the VHTR. Their conclusion, as documented in their report, were that the design objectives of the VHTR were not materially possible. In addition, the proposed carbide fuel would unnecessarily delay deployment since the existing uranium dioxide fuel was already demonstrated and was quite adequate. And most importantly relative to the purpose of this committee hearing, that to gain industry interest and support, it was important to move to an early deployment strategy and not wait 20-30 years.

This early deployment strategy resulted in the Next Generation Nuclear Plant, which was aimed at a 2015-2020 time frame. While the program started off quite well in the sense that the Department of Energy was committed to it, it was set aside because they could not agree on a deployment strategy and the Department of Energy internal plans were judged to be far too expensive. At the time, numerous suggestions were made to the department about an alternate strategy for deployment that would engage private industry. However, the Department of Energy chose to use what is called a "Project Integrator" approach, which was not supported and ultimately resulted in the demise of the program for all practical purposes. Had it not been for the Energy Bill of 2005 and the support of key senators, the Next Generation Nuclear Plant would have remained as a low- if not zero-priority for the Department. The Energy Bill called for having a demonstration plant online and operational no later than 2021. The key word is "operational".

In May of 2005, the DOE published an implementation plan for the NGNP. This plan had an extensive research and development element and a design, engineering, licensing plan and schedule with a cost estimate. Shown on Figure 1 is the cost of the NGNP for a 2017 operational date. This estimate includes a significant research and development effort for the NGNP and the hydrogen plant and design and construction costs for both. Also shown on this graph is the NP 2010 spending profile. The importance of this addition is that many in the utility industry are concerned that their top priority of getting new light water reactors deployed will be affected by the NGNP program. As the funding profile shows, the heavy NGNP expenditures will occur after the NP 2010 program is over in the next two years. This should alleviate the utility industry's concern.

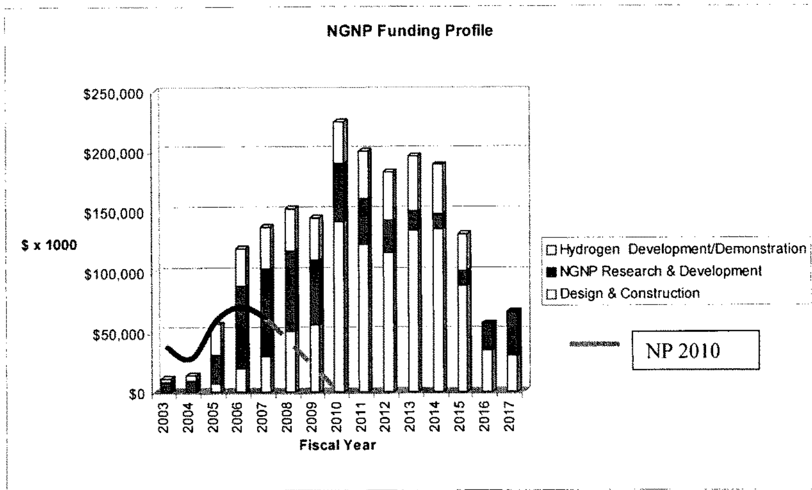


Figure 1: NGNP Cost Estimate

Unfortunately, the Department of Energy has not supported the funding levels required to complete the NGNP on the either schedule. The actual funding requests by DOE are shown below with a comparison to the program needs.

Table 1

Comparison of DOE NGNP Budget Requests vs. Program Plan Needs (including Hydrogen Demonstration)

Fiscal Year	DOE Budget Request	Program Plan Need	Underfunding
2003	2.97	11.23	- 8.26
2004	18.39	13.78	+ 4.61
2005	28.00	56.37	- 8.37
2006	63.75	119.60	- 55.85
2007	42.10	137.40	- 95.30
2008	??	152.36	??

The actual funding level for 2006 for example is less than half of what is needed. Much of the early effort is focused on R&D. This data is somewhat misleading on NGNP progress since a significant percentage of the appropriations were to support the nuclear hydrogen element and not the NGNP design process.

With the pressures of the Global Nuclear Energy Partnership, it is even harder to acquire the resources needed for the Next Generation Nuclear Plant unless DOE renews its commitment to its development. In the past, I have proposed an approach that I and others in the industry believe would bring this project to fruition with a clearly focused plan and schedule at a cost that can be supported within federal budget limitations. I will summarize that briefly for you

A Framework for the Successful Near-Term Demonstration for NGNP

In order for such a project to be successfully undertaken, gain support from the commercial industry, and be completed given the current fiscal constraints of the DOE budget, the project must be structured to strike the appropriate balance between advancing the state of the art of technology, cost and risk sharing between the public and private sectors, and the need to provide a performance-based disciplined approach to project execution. The objective is to build an advanced gas cooled research/demonstration plant in the near term that can be used as a demonstration plant for electricity and hydrogen production to gain commercial acceptance and research platform for developing even more advanced concepts such as the Very High Temperature Reactor. Such a project would have the following characteristics:

1. The project would be contracted and executed in 5 tightly coupled phases: 1) Conceptual Design, 2) Concept Evaluation and Selection, 3) Detailed Design, Component Development and Construction License, 4) Facility Construction and Operating License, and 5) Testing and Operation.

2. Competing teams would be funded by DOE for 1 year during the Conceptual Design Phase to develop a conceptual design and cost estimate. The winning team would be selected during the second phase if their design, schedule, and cost met pre-determined DOE targets. Each succeeding phase would have performance-based contracts between DOE and the successful team to execute the deliverable of the phase. Major capital for construction would only be committed if pre-determined performance and cost targets were achieved in the detailed design phase. The second place team would be available should the primary team not meet desired targets.

3. Clear evaluation criteria would be established prior to the Conceptual Design phase so that the competing teams would understand the important factors to DOE and the industry in subsequent phases. Cost sharing between the winning team and DOE would be an important factor in the evaluation criteria.

4. The down-selection of the chosen team and design would be conducted by an independent international team of experts with expertise in the technology, construction, operations and finance. They will make a recommendation to DOE of the best choice consistent with the design, schedule and funding objectives of the project. This team will act in place of the traditional DOE contractor selection team.

5. There would be no Project Integrator. The prospective contractors for the project would need to bring an integrated team to the project with all of the capabilities needed for its successful execution including fuel design and manufacturing.

6. The objective of this approach is to demonstrate ***to*** the utility industry that the plant can be built at a reasonable cost without the DOE process burden using a commercial procurement strategy. It is hoped that the industry will gain sufficient confidence in the technology upon completion of construction, testing and operation that they would order future plants.

7. The nuclear reactor and interfacing systems would be owned by DOE or a government special purpose entity (SPE). The electricity portions of the plant would be owned by a private SPE. The hydrogen plant(s), since it is very experimental would be owned by DOE (possibly a 50/50 partnership if feasible) since commercial production of hydrogen is not expected. Revenue generated from post-construction electricity and hydrogen generation would be used to first offset private investment and then DOE investment. Revenue generated from use of the reactor and the generation facilities for advanced technology testing by third parties would be apportioned between DOE and the private SPE, thereby reducing the overall cost of the project to the government.

8. The project would be targeted for completion in the 2017 or earlier time frame which ***is achievable*** by leveraging the work currently being done internationally on advanced reactors (Generation IV nations and China) and hydrogen generation.

9. The Idaho National Laboratory's role for this project is one which leverages its expertise and capabilities. As the owner of the reactor and the test facility, it would provide, in conjunction with industry needs, the general specifications that would form the bases for the conceptual design and identify specific areas for research needs. INL would be a key part of the selection process of the supply team in the second phase, particularly in assessing the design's ability to contribute to subsequent advanced high temperature gas reactor and hydrogen generation technology R&D. It would also be a major participant in the R&D activities associated with fuel qualification, materials evaluation and hydrogen technology evaluation as well as the licensing process. It will establish and conduct the R&D for developing the VHTR using the NGNP as a research platform. It is likely also to be the plant operator in a similar capacity as they now operate the Advanced Test Reactor (ATR).

10. This project will also be used to receive an NRC certification for future construction of similar plants. This should attract the commercial industry in this project since with this NRC certification, utilities can proceed expeditiously with deployment much like the NP 2010 program goals. It is envisioned that the nuclear plant could be certified by NRC for both electric and process heat applications in a "license by test" process.

11. A preliminary cost estimate shown on Table 2 based on the previous NGNP estimates is shown below which focuses on the construction of this project as an NGNP not a Generation IV VHTR. The DOE NGNP cost and schedule was reviewed in some detail with particular emphasis on the R&D that could be reduced or eliminated for the NGNP to get the plant built. The research that remains is judged to be needed for NGNP and hydrogen plant deployment. In addition, research and technical development work being done in South Africa and China can be applied to this project to make it more cost effective.

    This estimate has been reviewed by industry people currently involved in detailed design of high temperature gas reactors and hydrogen production plants. What this demonstrates is that this first of a kind plant can be built at about $ 1.2 billion which is about $ 1 billion lower than DOE cost estimates. The cost sharing agreement reflects an appropriate demarcation between industry and government for this advanced research and demonstration project.

    Shown on Figure 2 is the proposed reduction in R&D from the DOE program plan to focus on the lower temperature (900 C versus 1000 C) and build on existing international R&D programs needed to deploy the NGNP early. Shown on Figure 3 is the expected cost to develop and deploy a hydrogen demonstration plant based on industry input compared to the DOE program plan. The intent of these charts is not to predict costs but to point out that with industry leadership and experience that the design, cost and schedule can be improved over DOE long term plans.

12. The cost of the NGNP could be balanced against the cost of Nuclear Power 2010 in terms of OMB scoring. As the NP 2010 costs go down, the costs of the NGNP would scale up. In this way both programs can be executed with minimal budget impact during this period as shown on Figure 1.

NGNP Total Cost Estimate
(Results Based on Independent Review)

Key Assumption - NGNP is not VHTR
VHTR R&D Follows NGNP Development

Summary

NGNP Plant Construction:

Construction	**$ 560**
R&D	**60**
Design	**251**
Licensing	**40**
Total	**$ 911**
Contingency	**84**
Total NGNP	**$ 995**
DOE share:	**$ 868**
Private Share:	**$ 122**

Research and Development:

Fuel	$ 0 Use existing technology - Continue VHTR research
Design Methods	$10 Use existing tools developed elsewhere
Materials	$ 0 Use existing qualified graphite and steels
Power Conversion	$ 50 Intermediate Heat Exchanger

Total DOE contribution $ 60 million

Hydrogen Plant:

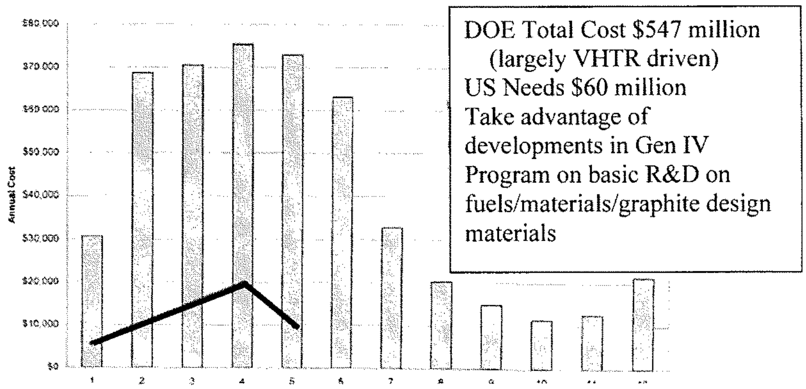
$ 265 million. Based on Westinghouse hybrid sulfur water splitting technology

DOE Contribution: 50/50 or $ 132 million
Private Share **$ 132 million** (if market can be found locally)

TOTAL PROJECT COST: **$ 1,254 MILLION (completion in 2015)**

DOE Share **$ 1,000 million**
Private Share: **$ 254**

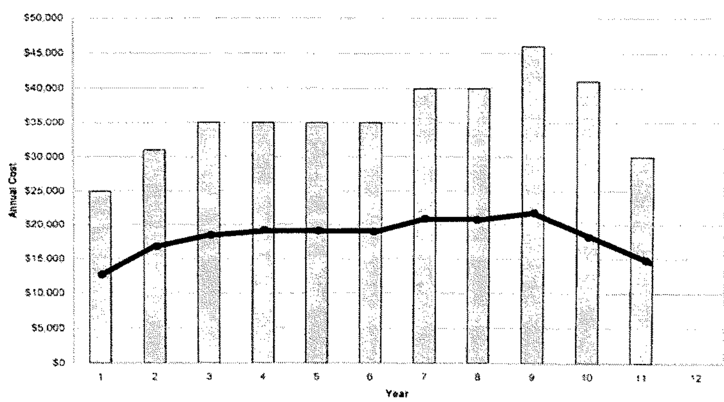
NGNP Research and Development Proposal (DOE)



US Research Needs for NGNP—Design Methods and Intermediate Heat Exchanger

Figure 2

NGNP Hydrogen Demonstration Cost



Industry Estimate for Single Demonstration Plant $265 million (versus $400 million)

Figure 3

What this plan essentially calls for is a funded competition by the department whereby interested developers would be allowed one year to develop a conceptual design, cost and schedule for their version of the Next Generation Nuclear Plant. As you may know, there are two competing concepts for high temperature gas reactors; one is a pebble bed reactor proposed by Westinghouse and the other is a more conventional prismatic reactor proposed by General Atomics and AREVA. Prior to DOE's Project Integrator approach, teams had been organizing to put proposals together for such a conceptual design effort. These teams included developers such as Westinghouse, architect engineers, hydrogen users and producers to be sure that the collective wisdom of the industry was applied to developing a reactor concept that was best suited for meeting the mission requirements of electricity and hydrogen production.

The plan was to have a funded competition whereby these groups would present their design, cost and schedule for this technology, after which an independent review team would evaluate the concepts and down select one for the next phase, which would be detailed design engineering and cost estimation, followed by yet another decision to actually build the plant.

As noted on Table 1, this project was estimated to cost approximately $1 billion spread over five to seven years in terms of actual construction. On an annualized basis this would not be a large amount of money in terms of the overall DOE budget that would end up with a real operational full-scale demonstration plant instead of endless paper studies and analyses.

Chicken or the Egg ?

Much has been said about whether the industry supports NGNP and what role should the government play in its deployment. To answer this question, one needs to identify the "industry". Is it the utilities? The nuclear reactor vendors ? Hydrogen users ? Hydrogen Producers ? Putting the questions this way, one can see whatever industry there is, it is fragmented and not integrated enough to produce a nuclear hydrogen plant. The utilities are generators of electricity. They buy power plants and do not design or develop new reactor technologies.

The nuclear reactor vendors are best described as "nuclear steam suppliers" which is how they sold reactors in the past and that is the business that they know. They do not know high temperature gas reactors. The nuclear reactor vendors of the past, which included Westinghouse, General Electric, Combustion Engineering that were able to invest in new technologies simply don't exist as we knew them anymore. Today most of these companies are service providers to the existing fleet of nuclear power stations and are only now seeking to license advanced light water reactors with resources provided in part by the Department of Energy.

Hydrogen users want only to buy the product. Hydrogen producers are quite comfortable with the use of natural gas in methane steam reforming. Were it not for the cost and supply of natural gas and CO_2 emissions, they are quite content with business as usual.

They clearly are not nuclear people who would put forth such a project. It is likely, if asked, they would want to steer quite far from nuclear operations despite its obvious advantage in their business because they are not familiar with it. So which "industry is going to fund the development of a new, potentially economically risky project such as this? How does one show "industry interest" in the absence of a product they can buy or sell and to ask them to invest in project that the DOE says won't be ready until 2021? Whoever thinks this is a metric for moving forward on this type of project does not understand the commercial world.

The question still remains about the level of industry support that should be provided to make this project realizable. To introduce a new technology as called for by the President and the Department of Energy to support a hydrogen mission is simply not possible by the commercial nuclear industry sector. Efforts are being made to create a coalition of reactor vendors, utilities, hydrogen users and producers to provide a focal point for the development of NGNP. It should not be assumed however, that they will be major financial contributors for the building of this demonstration plant since their interests are far too diverse for the construction of a viable business model for each. The plan outlined earlier does form such a basis with the financial apportionment strategy that justifies the investment by each of the interested industry segments.

In the past I have proposed a roughly 80-20 split between government and industry respectively, which would be very roughly apportioned by the degree of research and development needed to provide a demonstration reactor and to provide the confidence to the commercial sector that this technology does work and can be cost effective. The overall proposal calls for building a full-size Next Generation Nuclear Plant to provide the commercial sector with that level of confidence that it could provide cost-effective power and hydrogen.

US Way Behind

Much of the technology development for this project is underway in other nations. South Africa is proposing to build a pebble bed reactor and is now in detailed design and licensing for commercial operation of their demonstration plant by 2011 or 2012. This project is largely supported by their government. In China, a pebble bed reactor is also being designed and licensed using a somewhat different power conversion system for electric generation. They, too, plan on having this plant operational in the same time frame. Thus, two, what we would consider less developed nations, have taken the lead in high temperature gas reactor technology. Japan has had an experimental high temperature gas reactor in operation since approximately 1998, and China has had an experimental small pebble bed reactor producing power in operation since 2000. The United State has nothing currently operating to produce high temperature heat, either for hydrogen, electricity or process heat applications. Thus, the United States is quite far behind in high temperature reactor technology.

One way to jumpstart our effort and catch up to less developed nations is to build this Next Generation Nuclear Plant as a **strategic national project** which is what it was a few years ago. High temperature gas reactors have been so designated by China and South Africa. Next Generation Nuclear Plant has the potential for putting us back in the lead for high temperature gas reactor technology for hydrogen production. One of the more difficult technical questions is demonstrating and then commercializing thermo chemical production of hydrogen. Hydrogen can also be produced by electrolysis, which is more conventional. We, at MIT, are exploring the process of high temperature steam electrolysis that would allow the high temperature reactor to not only provide the heat but also electricity for this process.

As a researcher who's been exploring high temperature gas reactors since 1998 and one who originally was not convinced that we needed such a technology due to my past light water reactor experience, I've come to believe that the high temperature gas reactor with its higher thermal efficiencies, more efficient utilization of uranium and the possibility of many process heat applications in a generally smaller reactor size, paves the way for the next generation of nuclear power stations. I will not review all the advantages of high temperature gas reactors since they are generally well known. The most significant advantage is that these reactors cannot melt down. There are technical challenges that need to be overcome and the reactor and hydrogen technologies need to be demonstrated for utilities and other energy producers for future purchase.

Recommendations

My recommendation for this committee is to carefully oversee the Department of Energy's plan for the Next Generation Nuclear Plant in terms of funding to allow the demonstration reactor to come online by no later than 2017. Since other nations are already proceeding with operational dates of 2011, we can build on the experience and knowledge gained by these nations to allow for an efficient, cost effective design to be produced to show the industry and the utilities that this is a very viable form of energy production for hydrogen and that it can be quite economical for electricity as well.

Consider adopting the deployment strategy outlined earlier as practical path forward to engage the commercial industry to produce a reactor that will have commercial interest. Without a near term deployment strategy, industry will not be interested and the program may actually die. Unfortunately, I can not find such a comprehensive path forward at DOE for deployment of the NGNP. While a request for proposal was surprisingly issued by DOE in the summer for a pre-conceptual design for the NGNP, it is not clear what will happen after May of 2007 when the pre-conceptual designs are due.

Summary

The payback for this technology could be enormous in the sense that for approximately $1 billion we can develop a clean form of hydrogen production which does not now exist. We cannot continue to dump massive amounts of carbon dioxide into the environment by use of fossil fuels, and we need to start now to prepare for an economy that is not dependent on oil for its transportation needs. Hydrogen, with its potential for fuel cells in power stations, in transportation, and for chemical processing needs, is our transition fuel until we can find alternatives for transportation. The Next Generation Plant can become the heat source for oil extraction from tar sands, enhanced oil recovery, gasification of coal without the use of fossil fuel emitting greenhouse gases. Thus, the NGNP could become our heat engine that could be an extremely valuable asset in our future energy production options.

The timing is important. We cannot afford to wait until 2021 with a program that does not have the committed support of the Department of Energy to see it through to completion. The best chance for the Next Generation Nuclear Plant is to allow the initiative and ingenuity of the private sector combined with a targeted research plan implemented by our national labs in cooperation with interested Generation IV nations to design and build this plant. This plant would also become the test bed to prove its commercial viability such that the utilities or other energy providers can purchase it with confidence. We need to start to move away from a fossil fuel economy that we are so grossly dependent upon and which is having a demonstratively negative affect on our environment and the economy.

Thank you for your attention.

Andrew C. Kadak

Mr. ISSA. Thank you.

Dr. Kadak, I will kick off a little bit of the questioning.

Mr. KADAK. Yes.

Mr. ISSA. The figures I was given that come from the Nuclear Energy Institute, existing nuclear plants cost about $0.168 cents—call it 1.7 cents—per kilowatt hour of electricity. Coal costs about 1.9. Existing nuclear plants pay 1/10th of 1 percent for the construction and maintenance of Yucca. Coal plants don't pay anything for the acid rain. They don't pay anything for any of the other damage to the environment, and certainly they don't pay for the carbon footprint. Natural gas, my favorite fuel in California—every new plant is natural gas can cost up to 5 to 7 cents, depending on the market for natural gas. Yes. We pay that in California for a big chunk of what we have, and I am very thankful that we have both nuclear and hydro to offset that, along with some of our renewables.

The estimate for III-plus, what we are clearly going to be making before we make Next Gen, is that they are going to run about 4.6 cents per kilowatt hour; however, clean coal is estimated at 5.1 cents, and natural gas 10 years from now clearly ain't going to be cheaper.

If the Federal Government takes the number of kilowatt hours that we expect to produce with nuclear and puts $5 billion on the table and says we want to recover at a rate of 2/10 or 3/10 of a cent on our investment, from a practical standpoint by the time that you have seven or eight reactors, aren't you going to recover that in a relatively short period of time and still be supplying for less than the cost of coal with all of its inherent damage to the environment and less than the cost of natural gas, a resource that we are presently importing at great risk because of where it comes from?

Mr. KADAK. It is hard to do those numbers quickly, but I think the bottom line——

Mr. ISSA. We will settle for nuclear, even if Next Gen is as expensive as III-plus, has a cost savings over fossil fuels today in our estimates. Unfortunately, you don't have the $5 billion to get to market.

Mr. KADAK. Don't have the money, but part of this proposal would be a payback to the government for whatever they have put on the table for the NGNP through revenues generated by electric production or hydrogen production. So the idea is not to just make it a complete subsidy, as Mr. Kucinich suggests, but it is an investment that you have to make and can make and get paid back for.

Mr. ISSA. So your position, for the record, is that——

Mr. KADAK. Yes.

Mr. ISSA [continuing]. If the Federal Government invests it can recover its investment, either based on your assessment or based on the numbers that I flashed around hoping that you could keep them all in your head?

Mr. KADAK. Yes. The investment in this technology will have a payback that the government ought to be able to get back from that particular number.

Mr. ISSA. Last for you, Mr. Kadak, the difference, the compromise between, let's say, an 850°C and a 1,000°C reactor, do we yet have an appreciation for, one, the efficiency, the 50 percent efficient utilization of the source material. And, two, how that would affect the sort of Yucca deposits, because I, for one, have been very supportive of Next Gen because of the anticipation that we are going to be dramatically reducing what we have to put into long-term storage and particularly, I know with General Atomics' system and some others, their ability to burn plutonium—actually burn it not for disposal but burn it for fuel—both of which reduce what I feel we would have to leave in for a very long period of time in, as Mr. Kucinich said, the million-year-water-will-happen situation.

Mr. KADAK. Clearly the efficiency advantage of high-temperature reactors over, say, light water reactors is about 50 percent, so just on that basis, alone, you would see advantages in the repository performance.

But I think the key point is really from the standpoint of, "Can we make this thing work?" The answer is we believe we can because there is a pebble bed reactor, as an example, operating now in China. There is a pebble bed reactor in licensing and final design in South Africa. They are not doing this without any understanding of its cost and its schedules. The thermal efficiencies that people are now talking about in terms of between 850 and 1,000 degrees relative to the hydrogen production efficiency is very small, and the material challenges are huge to be able to get materials that can withstand those temperatures, and not needed, in my opinion and the ITRG's opinion.

Mr. ISSA. OK. I see a head shaking, so you would say the sweet spot may very well be at 850°C, not 1,000°C, from a standpoint of cost/benefit?

Mr. HILDEBRANDT. Yes, sir, that is correct. I would expect the difference in those temperatures, in terms of overall efficiencies Dr. Kadak was mentioning, was about 3 percent. That is the difference.

Mr. ISSA. So we are buying a moon shot instead of the X-craft?

Mr. HILDEBRANDT. Yes, sir.

Mr. ISSA. I can certainly relate to the difference between Burt Rutan's cost versus benefit. He got into space for a whole lot less than we did.

Mr. HILDEBRANDT. That is right. I think that is a good analogy for this discussion. How do we do it from a practical standpoint with the least technology development risk and yet get as close to our performance goals as we desire?

Mr. KADAK. And the other advantage would be, once built, it becomes the research platform for going to more advanced fuels, higher temperatures. You can't, as you said, pick 1,000°C and say if we can't build it because we can't find the materials we should stop. We should build what we can do and then develop it further.

Mr. ISSA. Jim, you are not getting a freebie on this.

Mr. WELLS. Let me jump in here and say we are talking about the DOE mission and goal as to design and construct a reactor that was tailored to develop a maximum efficiency production facility that could produce hydrogen that could make the difference for commercializing the success of the hydrogen. If they were to lower their standards and lower temperatures and reduce the efficiency gains, you may end up having to try and compete in a marketplace at $3 equivalent gallon of gasoline. If they continued at the high temperature and gained the efficiency gains that they believe the R&D would support and they are able to develop the materials that can withstand the heat for 60 years, you may be in a situation where you are developing hydrogen at $1.50 equivalent, which in turn makes it that much more attractive to the commercial industry to compete in a marketplace that everybody is trying to bring the lowest-cost product to the table.

So philosophically you are looking at what they are trying to do in terms of designing high-end versus somewhere in the middle that may jeopardize commercialization in the future.

Mr. ISSA. So, to paraphrase you, Mr. Wells, you are totally supportive of their position if they can make it pencil out in a way that supports that position, and you are not supportive of it if they simply would like to do it but it may jeopardize the viability of replacing natural gas as a source material for hydrogen, either for petroleum cracking or for a hydrogen-based economy?

Mr. WELLS. That is right. That is what they are competing against.

Mr. ISSA. OK. Gentlemen, I am going to wrap up by asking you to tell me when and how you are going to give me the penciled numbers in a way that this committee could participate in perhaps asking for a near-Earth orbit rather than the moon shot if that is all we need.

Mr. HILDEBRANDT. Let me suggest how we are doing that, if I may.

Mr. ISSA. Please.

Mr. HILDEBRANDT. In this commercial alliance that I mentioned, at every step the test is by the commercial world. Is it competitive and will it remain competitive into the marketplace? Approximately a year downstream, perhaps by about this time next year, the Alliance will have two things. One, presumably an agreement amongst several commercial end users that allows us to work with the government for its development; two, from a technical standpoint, as we just had this discussion, and a business standpoint, we will have chosen the design, to answer your question, that would be commercially viable, commercially competitive, and the lower-risk alternative, if I may. We already have projections of that. Over this next year there is preconceptual design work that is going on, about to be started here in the month of October, where we will be able to put the numbers on the table in a more confirmed manner than we can today. We are doing it on an estimate basis, best judgment today.

Mr. ISSA. OK. So you estimate, and I have to get re-elected and come back if I want to see it in proof form?

Mr. HILDEBRANDT. Yes, sir, you certainly would.

Mr. ISSA. You have given me a goal.

Mr. Kadak.

Mr. KADAK. Yes. Could I just modify your analogy just a tad? It is like going to the moon or going to Mars. We can go to the moon. We have gone to the moon. The Chinese are going to the moon shortly. Relative to the differential inefficiency versus the thousand——

Mr. ISSA. But they have been celebrating the moon for a long time, so for them it is old hat.

Mr. KADAK. But, relative to the differential inefficiency between 1,000 and 900 degrees, as Mr. Hildebrandt said, it is 1 to 3 percent. That is not going to be the driver for cost differential between $3 and $1 a gallon.

Thank you.

Mr. ISSA. Very good. I could do this all day, but the ranking lady has been very patient, so with that I yield for her questions.

Ms. WATSON. I think my question was just answered by Mr. Kadak. The difference between efficiency with the degrees is making the difference in the time it takes, and then this goes to Mr. Wells. You are nodding your head, so that is the answer. If we don't meet the deadlines, what will the cost be? Mr. Kadak says, you know, we just don't have the resources. So what would you say, Mr. Wells? You will probably be retired. When are you retiring?

Mr. WELLS. Maybe before I answer this question.

Ms. WATSON. No, after you answer the question.

Mr. ISSA. Do you want to take advantage of the congressional ability to hold people on active duty indefinitely? We have done that in the past, you know.

Ms. WATSON. What do you think, because what I am hearing, if I can just sum it up, is that yes, we can do it. We got to the moon, we can go on to Pluto maybe, whatever it is. And the difference in the time would mean resources, money. What is your estimation?

Mr. WELLS. Our position and why we were not supportive of acceleration, the dangers of acceleration to us was that you increase the project risk for success. There is potential for cost overruns. Rework has been huge in previous projects where we tried to start construction and start design faster before the research was actually done to come to the right decisions about whether it was going to work or not. Even DOE still believes that the technical challenges that exist to even build this type of reactor is going to take the entire time to 2021, and they are concerned about the technical challenges. I think if you do try to accelerate, the Congress has the responsibility to hold DOE accountable for delivering what they say they can deliver and good oversight.

Ms. WATSON. And I think the Congress then would have the responsibility for allocating the funds, and in a period where we have reduced——

Mr. WELLS. Absolutely.

Ms. WATSON [continuing]. The income to government by all these tax cuts, can we be realistic in our thinking that we can accomplish it within a meaningful amount of time? I heard you, Mr. Kadak, say that we don't have the money and we could do it, but it is going to take the resources. I don't see us providing that kind of priority on DOE and on the way we expend the taxpayers' funds any time soon because we have other priorities.

Mr. Chairman, to you, it just kind of looks really dim for the future, at least for the tenure of Mr. Wells and probably for our tenure.

Mr. ISSA. I am not going to get into a malaise here, if that is what you are looking for.

Ms. WATSON. No, no, no. I am just making an observation because the problem is with the resources. Mr. Wells says we don't need to speed up and accelerate until we are sure it is safe, and that is going to take resources, a dedication of resources to be able to meet those goals, and I am just saying we have other priorities that we are dealing with within this era. I don't think any of us will be here by the time this project—I won't be here by the time this project reaches fruition. That is my observation.

Thank you. I am going to have to leave. I have another committee going on right now. You can carry it from here.

Mr. ISSA. OK. I thank the gentlelady.

I will just wrap up with one or two questions. I probably won't get into the 37 percent revenue increase we have experienced—no, spending increases over discretionary spending or the fact that we have a 30 percent reduction in the projected shortfall as a result of the huge rising revenues as a result of the tax cut. I will not get into that. I think that is important to stay away from for this committee. I won't mention it if you don't.

You know, the one thing Republicans tend to do is they quote Kennedy on his tax cuts, and I won't do that today, either.

In conclusion, I am very interested in followup and I would like the staff to be able to use the next few days to go back and forth over a couple of these items. One of them is as much base material for your projections of comparative hydrogen production cost and comparative electricity cost based on moon two versus Mars or other—yes, I am returning to the moon for less, or return to the moon for half the fuel, so to speak, versus Mars.

I do also want as much new material as you can make available on where you see the technology challenges. I am a layman on this, but the difference between materials that hold up at 800-plus-C and those that hold up at 1,000C, it does not surprise me that we don't have materials to do that available for any length of time and that we need to develop those and that the thresholds could be hugely different. I would like to understand that difference.

Last, the one that really gets me, is a rhetorical question, but, Mr. Wells, it includes you particularly. What if we get to 2015 and the French, the South Africans, and the Chinese are selling something that does the job and they are able to essentially take the market, the potential market, which is a 30 year or 40 year renewing market, away from us prior to that occurring, because today we are hoping to be putting in III-plus plants around the world, but, in fact, in 2016, if they have an 800C product that can acceptably produce, let's say, hydrogen to be close to our Louisiana or other ports where we do refining, will they, in fact, eclipse us in those source locations?

That is a rhetorical question of, "is there a risk?" I know this is a difficult risk for people to assess, but I want you to go down this road if you could for a few minutes here if you have time, but then further in writing, of what is the risk to not being on a path toward that product, even if that product is not the same product we are presently funding. And I might say we are spending $8 billion a month in Iraq today, so the idea that it is $1 billion dual path a Next Gen and a high-temperature as two separate, distinct potential but parallel goals doesn't scare this particular chairman, even if the idea of writing the check would petrify me.

I will give you each a chance to respond briefly, and then I would very much encourage you to respond at length.

Mr. WELLS. I am glad to jump in. It is clear. It is true that DOE is designing a unique product and they have set parameters and lowered the parameters from 1,000°C to 950°C and their goal is to generate, design, and have the capabilities to produce hydrogen at a very, very high temperature in a reactor that will allow commercialization at a price that the marketplace will pay, and it is going to take 20 years to get there. I mean, that is their stated goal and that is what they are moving forward on. There is no question about that.

It is true that if the existing reactors that are available, whether it be in South Africa or China, pebble bed, or the prismatic in Japan or France, they are smaller scale. They are not of the full scale that the DOE is proceeding upon. And if they do bring to market something that would be 800°C, there is that competitive environment where they will eat our lunch, so to speak, and question what are we going to do with the plant that we are bringing online 10 years later. No question about that.

However, I would hang our hat a little bit on the fact that in Gen IV the stated goal is these are international partners and the United States will be a player in all the international development in terms of whatever future reactor comes online, so I am not so sure that competition is the word here if we, in fact, see the world more internationally as opposed to just within our borders.

That would be a quick response to you.

Mr. ISSA. Thank you.

Mr. Kadak.

Mr. KADAK. I will always be happy to weigh in on that one.

Let me just tell you a few words about China. MIT and Tsinghua University have a collaborative arrangement on the pebble bed reactor development. They have a commercial project. It is called a demonstration plan. With their demonstration plan as successful, and their scheduled commercial operation by 2011 or 2012—and this is 190 megawatts of electric, which is smaller than the 600mw reference thermal or 300mw electric of the DOE—but this plant, if it is successful, will have a site of 3,600 megawatts of power, electric power—they are not looking at hydrogen yet—with 19 modules. That is real.

Mr. ISSA. That is three reactors of a typical size in America today?

Mr. KADAK. Exactly. Three per building, if you will. In South Africa, again, they are going to a commercial demonstration fronted by the government, in large part, but for the utility, which is about 165 megawatts electric, certainly smaller than the 1,500mw French reactors or the 1,200mw or 1,300mw American high water reactors. But the market may be such that smaller units added when the capacity is needed is better than building one big one which, if you lose, you have some serious problems.

I was just in Finland looking at the EPR reactor being built there. They have to build a gas-fired power station to provide power should that reactor shut down. Think about that. It got perhaps a little bit too big for a particular nation to absorb that kind of capacity.

Mr. ISSA. That is a lot of peak power if you have to replace an entire nuclear plant.

Mr. KADAK. But it is not the entire plant, but it is enough to keep the grid from collapsing when they lose it.

So we have some very interesting issues. I do believe we are already behind. This schedule will make us further behind. Although our emphasis is on hydrogen and process heat applications, it doesn't take them long to figure out how to do that, either.

Mr. ISSA. You know, I don't want to add to your testimony—I am not qualified to—but it is always interesting when Mr. Kucinich and I come to a common agreement on something. When he talks about wind-to-hydrogen, he is talking about electricity we produce and then use it with water to create hydrogen, so he is, in fact, doing what we would certainly be able to do with Next Gen nuclear equally well. I always remind that, that I believe in how we get to hydrogen with high temperature nuclear, but I also recognize that his proposal and why we get to hydrogen, if we simply get an unlimited supply of affordable electricity we still get to zero emissions hydrogen without cracking natural gas.

Mr. Hildebrandt, you get the closing remark.

Mr. HILDEBRANDT. Yes, sir. Just as an overall observation of the comments that were made earlier, nuclear power isn't the answer, alone. Coal gassification, carbon sequestration, renewables—all of it needs to be together because no one of them can handle our huge appetite for energy in the United States. These are complementary efforts that need to be part of a large, overall nuclear strategy—nuclear strategy, energy strategy more importantly.

With regard to your specific questions on such things as costs, electricity, hydrogen, materials considerations, temperatures, I will refer you to a report and I will also provide it to your staff if you wish. It is called "Design Features and Technology Uncertainties for the Next Generation Nuclear Plant." It was work that is referenced in the Energy Policy Act. It is the group that, as Andy mentioned, I chaired back 2 years ago. It answers most of those questions, but we will also update it for you and provide updated information based on what we know today.

Regarding the risk of others getting ahead of us, if I may, in the simplest term, that is a very real risk. This is an international effort. However, at the same time we are emphasizing the need to rebuild the industrial infrastructure in the United States to handle such things as building large industrial facilities such as a nuclear power plant—not that solely, but such as that. We have lost much of that. It has gone overseas. Part of the intent of the Next Generation Nuclear Plant is to go after rebuilding those capabilities, even though it is in the international marketplace.

The leveraging of the other gas-cooled reactor demonstration projects that have occurred is very important. Dr. Kadak mentioned a couple of those. He mentioned the current one with the pebble bed modular reactor in South Africa. We have also built two gas-cooled reactors here in the United States which approach the temperatures we are talking about here in Colorado and Peach Bottom. Is that Pennsylvania? I believe it is Pennsylvania.

The work that has been done in Germany, as well, with a reactor called ADR, which I won't try to say the German name, and THTR, each of these demonstrations have been an important contributor to our understanding of gas-cooled reactor technology and allows us to take steps with confidence as to where we are going and how big the risk is. So our choices here are fairly well understood based on previous work that has been done and current work that is being done.

I thank you.

Mr. ISSA. I thank you, and I would like to thank all of the witnesses for being here today.

I will hold the record open for 2 weeks from this date so that you may forward your submissions and you may expand on your responses.

With that, this hearing is adjourned.

[Whereupon, at 2:30 p.m., the subcommittee was adjourned.]

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