The U.S. Should Demonstrate Synthetic Fuel Production using a High Temperature Gas-Cooled Reactor (HTGR)

The nation faces unprecedented challenges in the energy sector as a result of an aging fossil-fuel electricity generation system, significant dependence on imported oil for the transportation sector and the threat of global climate change. Compounding the problem is the recent collapse of the U.S. financial markets and political gridlock creating uncertainty regarding the future cost of carbon and amount of financial support (e.g. loan guarantees) for new energy projects.

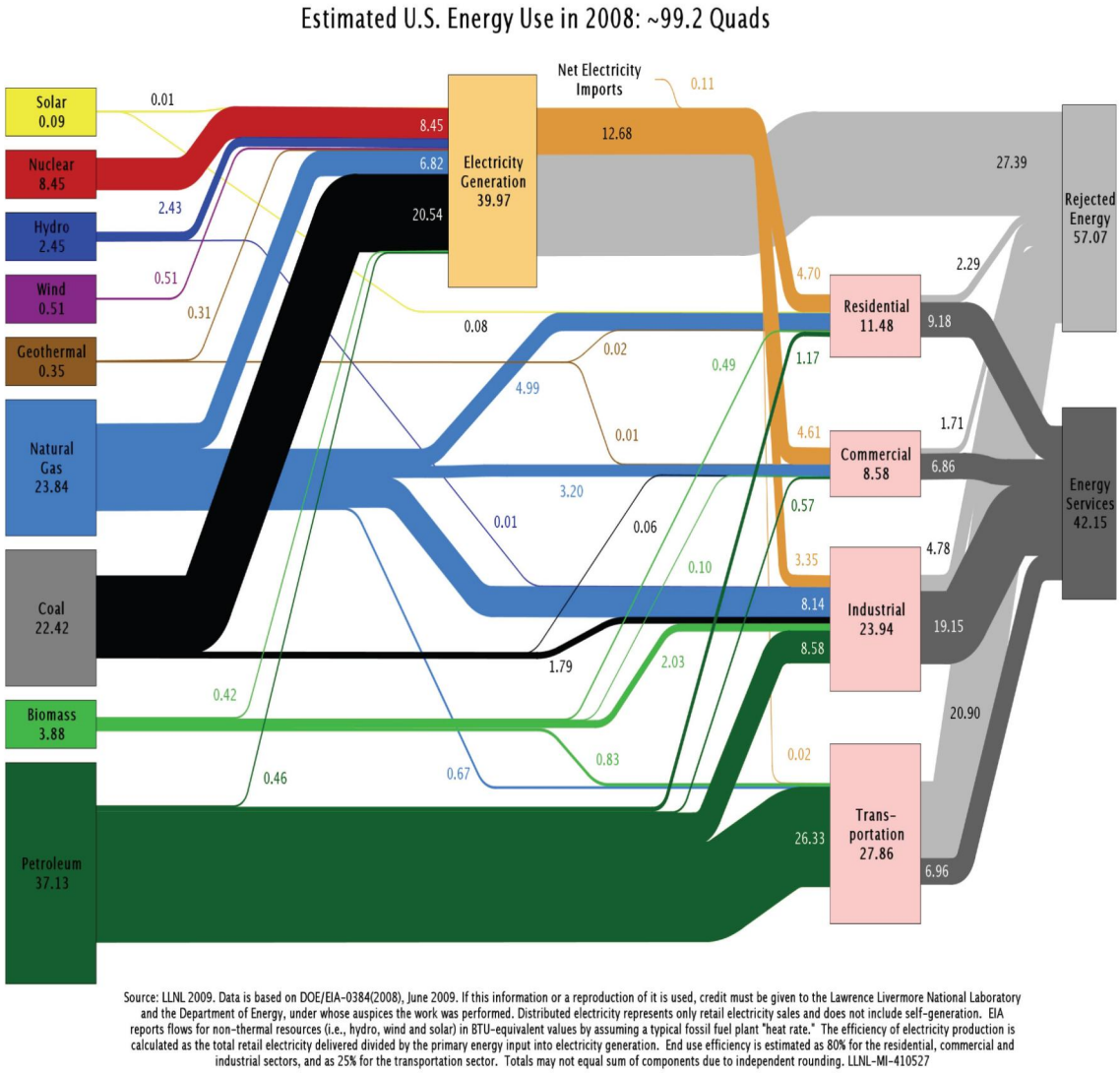
The "man on the street" understands that energy security is important and dependence on foreign oil imports can pose unacceptable risks. Historically, the United States has been somewhat slow to respond to impending danger. We tend to wait until a crisis occurs before our national resolve mobilizes and responds. We are near that point now.

Some obvious changes are already underway. Automakers are retooling factories to produce smaller, more fuel efficient cars. And they are racing to roll out plug-in hybrid automobiles, a move that will bring use of electricity for personal transportation into the mainstream. The increased substitution of electricity for fossil fuels is a step in the right direction, in fact key to many aspects of our energy transformation, but it will never be complete. For example, the airline industry will remain dependent on liquid fuels for many decades to come.

From a climate change perspective, it is important to replace aging fossil plants with new sources of clean energy; from hydro, wind, solar, geothermal and nuclear. Natural gas plants will be used to supply peak demand during daily power fluctuations and as baseload generation if natural gas costs are very low. Economical improvements are needed in energy storage in order to make wind and solar more viable as large components of the electricity generation sector. Changes in the transportation sector from gas guzzlers to plug-in electric cars increase the demand for electricity and increase the importance of building new clean electricity plants.

Much has been written about the electricity sector, but less has been written about the role that nuclear energy can play in reducing dependence on foreign oil imports. In my opinion, this is the primary driver for the NGNP project, the reason the U.S. should build and demonstrate a high-temperature gas-cooled reactor.

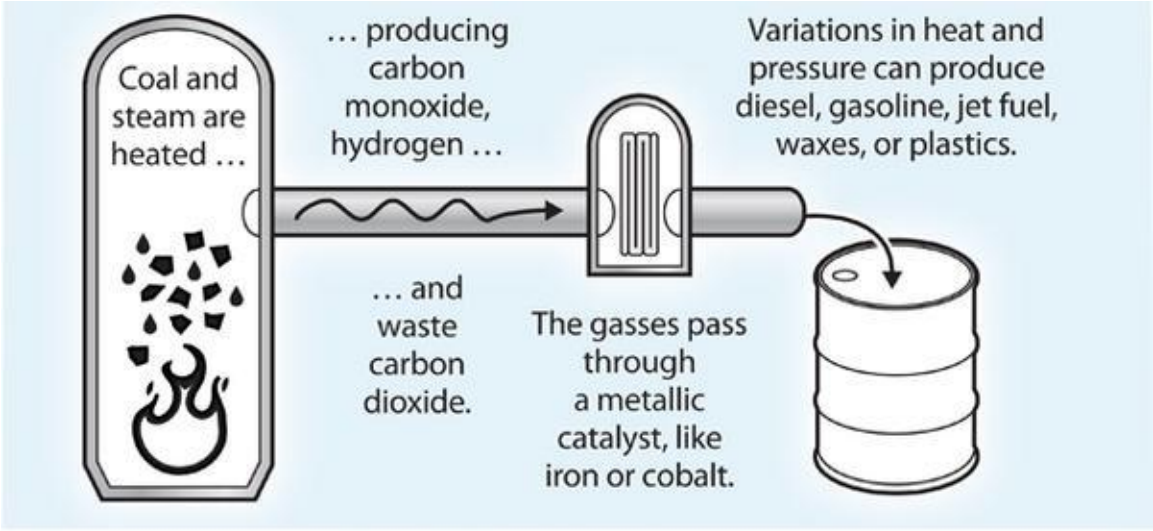
As can be seen in the following chart on U.S. energy usage, transportation makes up roughly 27% of U.S. energy use, which is supplied almost entirely by petroleum. Petroleum also fuels a significant amount of industrial and some commercial and residential applications, totaling an additional 10% of U.S. energy. To put this in perspective, nuclear energy supplies less than 9% of U.S. energy use.



What can be transformational is how we combine our various energy resources for the greatest good. We have traditionally looked at coal and nuclear as being competitors for the production of electricity. We have not focused on the hybrid use of proven coal and nuclear technologies to produce liquid fuels and other hydrocarbon products without generating greenhouse gasses in the conversion process. The technology to convert coal-to-liquid fuels has been around for almost a century. Germany used it to power its military in WWII.

In the past, the coal-to-liquids conversion process used lots of water and two-thirds of the coal "went up the stack into the air", as coal was used as both the feedstock for producing the liquid product via the Fischer-Tropsch process, and the feed stock for generating the hydrogen and heat that is required by the process.

Modern coal-to-liquids facilities use natural gas to provide the heat to the coal feedstock and steam used to drive the process.



SOURCES: Dr. Anthony Stranges, Texas A&M University; Syntroleum AP

If we were to use electricity from commercially available nuclear reactors to produce the heat and hydrogen via proven electrolysis processes, we could produce the liquid fuels without emitting greenhouse gasses in the conversion process. However, high temperature gas-cooled reactors could be used to produce the heat and hydrogen with even greater efficiency.

Let's dream big for a moment. What if the U.S. built a coal-to-liquid energy system to significantly displace foreign oil imports? This would obviously take decades to implement, but it could be done, providing true energy security. Additionally, the energy and hydrogen required to convert the coal-to-liquid could come from nuclear energy resulting in a much greener use of coal than a traditional coal-to-liquids system using natural gas as an energy source.

In its August 2010 report titled *High Temperature Gas-Cooled Reactor Projected Markets and Preliminary Economics*, the Idaho National Laboratory (INL) calculates that displacing 25% of the current U.S. demand of 9.12 million barrels of crude oil per day would utilize 415 HTGR modules of 600MWt each. Although eliminating 25% of oil imports is far from becoming independent, it is significant enough to change the supply and demand balance, likely resulting in the lowering of oil prices. Deployment of 415 reactors, even though these reactors are small compared to current operational reactors, would be a significant undertaking and take decades.

As of January 1, 2009, the Energy Information Agency (EIA) estimated that the remaining U.S. recoverable coal reserves totaled over 261 billion short tons (a unit of

weight equal to 2,000 pounds), comprising 27% of the world's coal reserves. According to EIA the U.S. consumed 1 billion short tons of coal in 2009, therefore the recoverable coal reserves in the U.S. could support the U.S. for more than two centuries at the current usage rate. Given the abundance of coal reserves in the U.S., it is appropriate to seek approaches to use this resource in a manner that minimizes adverse climate impacts.

Coal-to-liquids facilities will be built if the price of oil is expected to stay high (e.g. above $60 per barrel). The point of this paper is to encourage the U.S. to demonstrate the ability to drive the coal-to-liquids process with nuclear energy rather than natural gas for two reasons; to allow our valuable natural gas resources to be used for other, more ideal purposes and to reduce the amount of CO2 emissions from the coal-to-liquids process. According to INL, a conventional coal-to-liquids plant using HTGR technology would reduce CO2 emissions by ~410 million metric tons per annum with a carbon conversion efficiency of more than 90% compared with a ~35% carbon efficiency of the conventional process.

The greatest transformational effect of bringing U.S. energy supply and demand into equilibrium will be the effect on the U.S. economy. Building all of the capital intensive nuclear, synthetic fuels, wind, solar and other related facilities together with improving the energy efficiency of our factories and buildings required to achieve energy equilibrium means we will have created millions of high paying jobs and reestablished a strong domestic manufacturing capability. We will have strengthened the engineering education programs at our universities and expanded trade schools to supply the skilled workforce. At the same time we will have put a tourniquet on our bleeding of cash by eliminating the expenditure of hundreds of billions of dollars per year for oil imports.

It is time for the nuclear industry to meet with big oil companies and big coal companies and their respective trade organizations to explore the possibility of a partnership in the demonstration of an HTGR-powered coal-to-liquids process to make synthetic fuels for the transportation sector. The coal industry should appreciate penetrating the transportation sector, especially given the outlook for coal in the electricity generation sector. The oil industry possesses the knowledge and skills to refine the liquid fuels to meet customer requirements.

At today’s oil prices wide-scale deployment of HTGRs and synthetic fuel manufacturing may not be justified, but it would be foolish to wait for price alone to justify taking action. It will take decades to put in place such a system to wean the U.S. off of foreign oil. If we wait for price alone to justify proceeding, the rest of the world will have passed us by. With the appropriate vision, a national policy and leadership, the U.S. can take the steps now to enable global leadership in the future.