The AAPG Explorer - May 1, 2021

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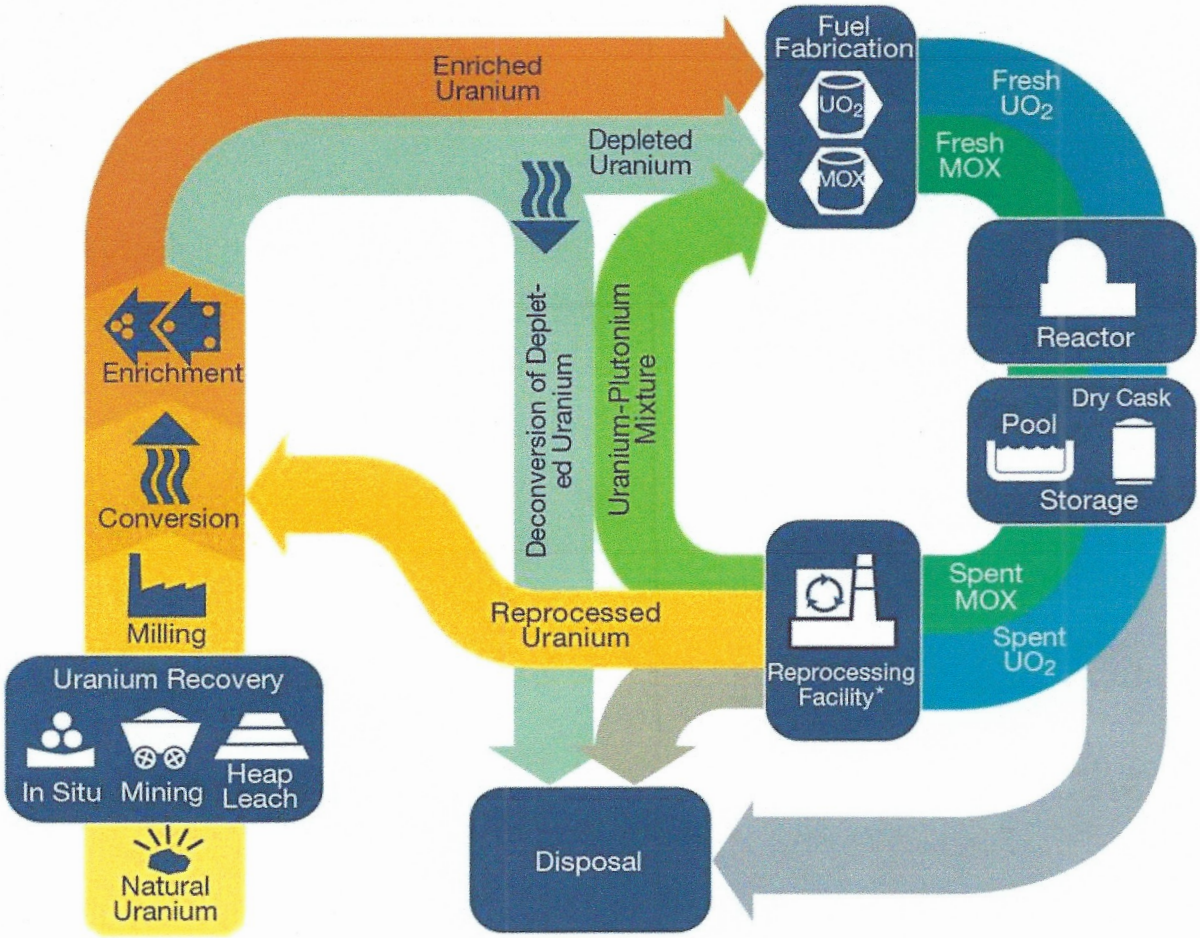
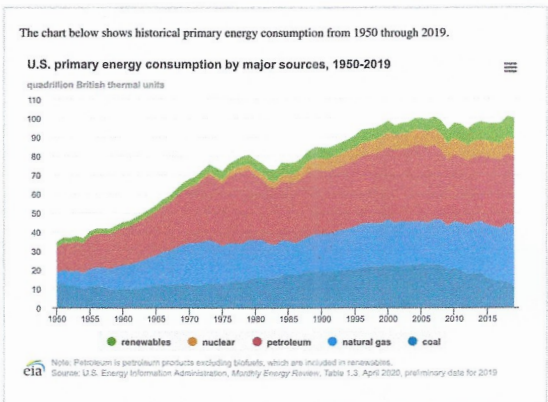


Net-Zero Emissions by 2050? Not Without Nuclear

Part 1 of 2

May 2021 | Heather Saucier, Explorer Correspondent

In the quest to reach net-zero emissions of energy-related carbon dioxide by 2050, a longtime goal of the United States, other world governments and energy agencies, no one is even close to achieving it.



See Figure 1

Despite 2020's largest decline in emissions as a result of less energy usage during the COVID-19 pandemic, the U.S. Energy Information Administration anticipates "a rapid rebound in energy demand and emissions" this year.

Furthermore, the EIA projects that by 2050, U.S. energy-related emissions will be 5-percent higher than 2020 levels.

Globally, emissions also are expected to increase by at least 0.6 percent each year through 2050.

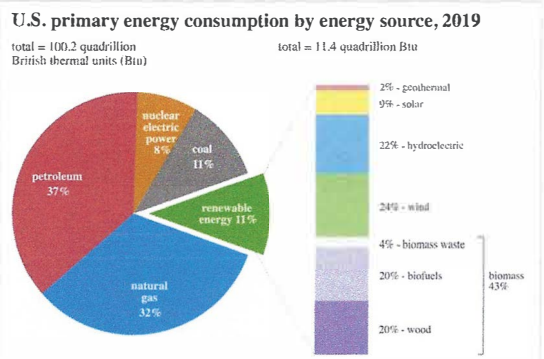
"What happens to energy demand and emissions in 2021 and beyond will depend on how much emphasis governments put on clean energy transitions in their efforts to boost their economies in the coming months," the agency stated in a March 2 report titled, "Global Energy Review: Global Emissions in 2020."

In an effort to turn the emissions curve downward more quickly, President Joe Biden announced at the April 22 Leaders Summit on Climate that the United States should aim to cut 2005 level emissions (which peaked at just under 6 billion tons of carbon dioxide) by half by 2030.

It's a lofty goal, leaving many to question whether or not it's doable.

Fossil Fuel Dominance

Figure 2 (Enlarge)



Note: Sum of components may not equal 100 percent because of independent rounding. Source: U.S. Energy Information Administration, Monthly Energy Review, Table 1.3 and 10.1, April 2020, preliminary data

Fossil fuels currently dominate the global grid because the world needs energy and its population continues to grow toward a projected 10 billion, said AAPG Member James Conca, Ph. D., a 33-year Earth and environmental scientist and consultant for federal and state environmental and energy agencies as well as industry.

While it might seem ironic, access to energy will be the world's best environmental protection. Studies, such as the United Nation's Human Development Index, have shown that 3,000 kilowatt hours per person, per year, results in lower birthrates.

"People become prosperous enough to not depend on their children to feed them in their old age," Conca said. "You can't save people and the planet without energy."

Yet that energy must be clean, sustainable and – at this point – include a significant presence of nuclear power, said Conca, who is also a member of the Uranium Committee of AAPG's Energy Minerals Division .

See: EMD's UCOM

Moving backward in its goal to reach net-zero emissions by 2050 and 3 billion tons by 2030, the United States must play a major game of catch-up.

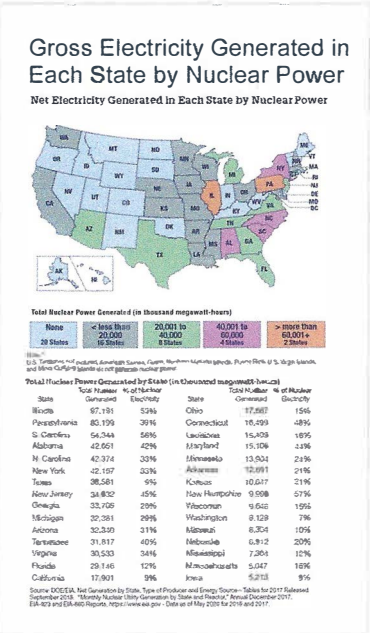
The Intergovernmental Panel on Climate Change, the International Energy Agency, the U.N. Sustainable Development Solutions Networks and the Global Commission on the Economy and Climate are encouraging tripling the amount of nuclear energy in the world to stabilize global carbon emissions.

After five decades of significant strides in safety, efficiency and cost, nuclear is a major key to making net-zero emissions more than "a pie in the sky" idea, said Conca, who specializes in geologic disposal of nuclear waste, energy-related research, planetary surface processes and radiobiology.

Although wind and solar have dominated mainstream discussions about clean energy, nuclear has been quietly advancing to become a power fuel that can most effectively serve large and growing populations while simultaneously lowering emissions.

Catching Up

Figure 3 (Enlarge)



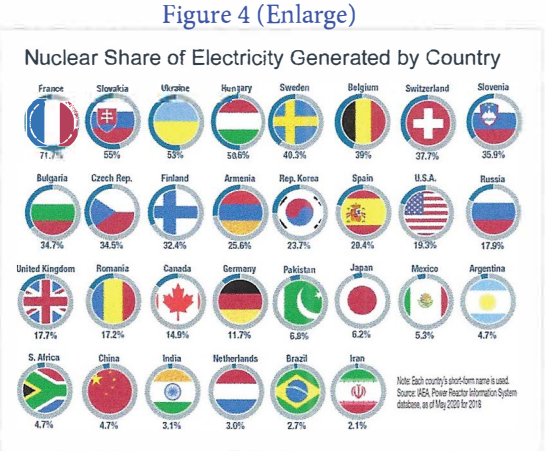
The United States' primary energy mix relies on 37 percent petroleum, 32 percent natural gas and 11 percent coal – a total of 80 percent dependence on fossil fuels, according to the EIA.

While fuel for electricity generation varies more, coal produces roughly 30 percent; natural gas, 34 percent; nuclear, 20 percent; hydropower, 7 percent; wind, 6 percent; and others, 3 percent.

To get even remotely close to net-zero emissions and Biden's 2030 goal, Conca calculated that the United States must immediately:

- Stop building new fossil fuel plants.
- Stop closing existing nuclear power plants that have been deemed safe by the Nuclear Regulatory Commission.
- Build wind turbines to generate an additional 500,000 megawatts.
- Install rooftop solar panels on all new buildings to generate an additional 800 billion kilowatt hours.
- Double hydroelectric power using existing dams to reach 600 billion kilowatt hours.
- Secure sources of lithium, cobalt, iron and other metals needed to build batteries for fully electric vehicles.
- Produce a fleet of 150 million fully electric vehicles and 100,000 charging stations along all roadways.
- Streamline the process to site and approve high-voltage transmission lines to support this abundance of renewables.

Figure 4 (Enlarge)



Even if the United States could attain these high-reaching goals, neither Biden's 2030 proposal nor net-zero emissions can be achieved without a significant nuclear energy component, Conca said.

Currently, the United States has 94 operating nuclear power reactors in 28 states, according to the EIA. These reactors generate approximately 20 percent of the country's electricity.

The United States would need to build an additional 100 standard reactors (1,000 megawatts) to generate 40 percent of the nation's power and, combined with existing operating reactors, support approximately 132 million people, Conca said.

In lieu of large commercial reactors, the United States could build 2,000 small modular reactors – a type of advanced nuclear reactor designed to operate with accident-tolerant fuels that won't melt down, explained Paul Goranson, CEO of Encore Energy Corp, a U.S. uranium company.

Private companies are currently testing the country's first commercial SMRs, and many expect them to become an accepted and pervasive form of electricity generation throughout the country and the world.

SMRs are ideal for small markets, Goranson said, pointing to states with small populations, such as Wyoming and Alaska, that would need just a handful to generate 1,000 megawatts of power. Underserved markets in California would also benefit from SMRs.

SMRs are considered by those in the industry to be "small, safe and manageable," and they require minimal waste handling, Goranson said.

Two thousand SMRs would provide electricity for an estimated 132 million people.

Conca said both options would cost about $1.6 trillion – "pretty much the same as installing windfarms to produce the same amount of energy."

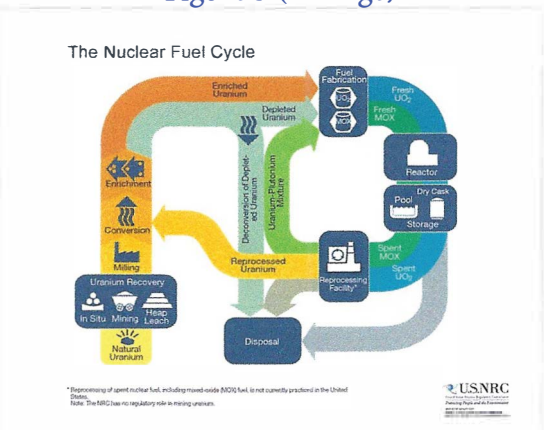
"When you get to these numbers, whatever the energy source, material availability becomes critical," Conca said. "Whether it's steel or neodymium, replacing our 4 trillion kilowatt-hours per year will take a lot of materials, and the amount differs widely between renewables and thermal."

As it stands, natural gas plants require the least amount of concrete and steel (with wind farms requiring the most), making them financially attractive, but a step backward in reducing emissions, he said.

A Case for Nuclear

Over the past four decades, the operation of nuclear reactors in the United States has been "a safer source of energy by far than in generating oil and gas, coal and renewables," said AAPG Member Michael D. Campbell, chair of the EMD's Uranium Committee and senior principal and chief geologist/chief hydrogeologist at I2M Consulting, LLC, in Houston and Seattle.

Figure 5 (Enlarge)



Reprocessing of spent nuclear fuel, including mixed-oxide (MOX) fuel, is not currently practiced in the United States. Note: The NRC has no regulatory role in mining uranium.

More than 8 million people died in 2018 from fossil fuel pollution, according to research from Harvard University, in collaboration with the University of Birmingham, the University of Leicester and University College London, published in the April 2021 issue of the journal Environmental Research. Researchers estimated that exposure to particulate matter from fossil fuel emissions accounted for 18 percent of total global deaths in 2018 – just shy of one in five people. See Reference (here)

Deaths from non-fossil fuels tend to be accident-related and much lower, with nuclear power holding the lowest death rate, Conca said.

Unlike wind and solar, which provide only intermittent power, nuclear energy is a consistent power source that can easily be turned on and off, Campbell said.

Many renewables rely on natural gas as a back-up fuel when nuclear would better serve that function. "Natural gas has long been touted as a bridge fuel to a non-fossil future beyond this century. But that is nonsense," Conca said. "We don't have a century. And if a lot of new gas plants are built, especially to load-follow wind and solar, then we lock ourselves into gas for a long, long time."

Furthermore, as recently constructed wind and solar projects mature, it's been discovered that the cost of electricity they are producing increases rapidly, Campbell said. This is because of low conversion production efficiencies and the fact that operation and maintenance costs were either overlooked or underestimated, he said. See Campbell (2020).

Figure 6 (Enlarge)

A quick glance at California underscores this fact, as consumers struggle with rising electricity costs, blackouts and power interruptions because the renewable systems cannot produce sufficient power.

Uranium fuel costs represent just 5 percent of the operating cost of a nuclear power plant, while fuel costs for power plants using natural gas are much higher. The volume of fuel needed is the principal difference in that 1 uranium fuel pellet contains the energy equivalent of about 17,000 cubic feet of natural gas, Campbell said.

"Not only is nuclear power climate-friendly," he added, "it has the potential to create thousands of high-paying jobs."

More reactors are operating in the world today, so there is growth in nuclear power, Goranson said. But there is no new production in the United States.

"The point of the Cold War was to scare people, and it worked," Conca said, acknowledging that incidents at Three Mile Island, Chernobyl and Fukushima Daiichi exacerbated a longtime fear of nuclear energy. "But it was supposed to scare people about nuclear weapons and not nuclear power."

People need to get beyond negative perceptions of nuclear power, Campbell added, emphasizing that scientists have learned how to prevent such incidents from reoccurring.

In the race to slow the rate of warming, and with nuclear energy rising as a viable, indispensable option, will the United States and other countries be able to get on board?

"Companies are spending huge amounts of money trying to hit the market first" as the dominant provider of green energy, Campbell said. "Like any capitalist venture, if you can produce a product and service that is good, safe and cost effective, you will win. Nuclear is starting on a new track in the United States."

Excerpt for Part 2:

Nuclear scientists have learned how to build nuclear reactors for power generation that won't cause meltdowns experienced at Three Mile Island, Chernobyl and Fukushima, said AAPG Member Michael D. Campbell, chair of the Energy Minerals Division's Uranium Committee and senior principal and chief geologist/chief hydrogeologist at I2M Consulting, see Campbell (2020).

"Small module reactors are coming on strong," he said. "That's the new nuclear industry that's approaching. They are built not to fail and not to produce radiation. I foresee them all over."

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