

Thom Mason: Charting the path to carbon-free power

(As published in *The Oak Ridger's Historically Speaking* column on February 9, 2015)

Carolyn Krause brings us the conclusion of her interview with Thom Mason, Oak Ridge National Laboratory Director. In this final portion of the interview, he touches on a variety of potential world changing issues that ORNL scientists are researching. This interview reinforces the broad ranging impacts our own Oak Ridge laboratory has had and continues to have on large scale problems facing not just our state, the region, or the nation but the entire world.

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The proposal to build a small modular reactor to provide "green power" to Oak Ridge National Laboratory and the other plants is still alive. And the Tennessee Valley Authority is still planning to work on the old Clinch River Breeder Reactor site and get it certified for an SMR. So said Thom Mason, director of ORNL in a recent interview.

ORNL's interest in having a local SMR stems from President Obama's Federal Leadership in Environmental, Energy, and Economic Performance Executive Order of 2009, which must be complied with by 2020. Because TVA is focused on getting a new Watts Bar reactor on the grid, the TVA-B&W partnership has been less active.

However, the Department of Energy has funded two teams to work with the Nuclear Regulatory Commission on certifying two new SMR designs – the B&W mPower reactor and the NuScale Power Module. An SMR, Mason said, would meet 45 percent of ORNL's goal of reducing its use of electricity from sources that emit carbon dioxide in compliance with the executive order.

ORNL's new buildings are LEED-certified, partly meaning that they consume less energy than older buildings with equivalent space. "Johnson Controls has installed light fixtures that turn off when people leave their offices," he added.

ORNL receives power from the TVA mix, which is 40 percent carbon free. The mix is 30 percent nuclear, 10 percent hydroelectric, and 60 percent coal, although some coal units are being closed and replaced with gas turbines. Natural gas is currently cheaper than coal and, when burned, emits about half the carbon dioxide coal combustion gives off.

"We hope to have an agreement to buy clean electricity, or carbon-free power, from TVA, similar to the way you can buy renewable energy credits," Mason said.

The challenge is that to conduct the energy research that DOE will fund, ORNL will have to increase its large facilities' demands for electricity.

"There is not a lot of opportunity to reduce power use at our Spallation Neutron Source and the Oak Ridge Leadership Computing Facility," Mason said. "SNS already has a superconducting accelerator--you can't get more energy efficient than that. We are planning to increase power use at the SNS when we have a second target station.

IBM has a contract with ORNL to build Summit, a supercomputer that will have 1,000 times the computational capacity of ORLCF's petascale supercomputers Jaguar and Titan. Summit will be able to perform a billion billion calculations per second.

"We are demanding of our vendors tremendous improvements in energy efficiency in computation just to stay even," Mason said. Otherwise, Summit would need 1,000 times more electricity than Jaguar, which is equivalent to the output of 10 Watts Bar nuclear power stations.

Jaguar consumes 10 megawatts of electricity. ORNL's goal is to operate the exascale supercomputer Summit using 20 megawatts. Summit will be used partly for climate modeling.

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ORNL's Climate Change Science Institute, which combines the lab's environmental sciences and computing organizations, is involved in the Next Generation Ecosystem Experiment being performed on the North Slope near Barrow, Alaska. ORNL is collaborating with researchers from DOE's Lawrence Berkeley National Laboratory and the University of Fairbanks in Alaska.

They are trying to answer questions about the Arctic permafrost as it degrades and melts. Once a large carbon sink, the once-frozen tundra soil may be decomposed by microbes with global warming, leading to releases of carbon dioxide and even methane, another greenhouse gas. The goal of the NGEE Arctic project is to reduce uncertainty in climate prediction through improved representation in computer models of Arctic tundra processes.

"We are making measurements to better inform our computer models with hard physics, biogeochemistry and biology data before we run simulations," Mason said. "Titan focuses on climate modeling to understand the sensitivities and feedback mechanisms. Summit will eventually enable scientists to get down to the spatial resolution of clouds where weather happens, which is exceptionally demanding computationally."

Last year was the hottest on earth since recordkeeping began in 1880, even though temperatures in parts of the eastern U.S. were below average. Mason challenged the argument of climate deniers who insist the data show the global surface temperatures have not risen as much as expected since 1998 considering the human-induced increases in atmospheric carbon dioxide.

"One of the challenges in communicating climate science is that people don't experience climate," Mason said. "They experience weather. It's not the same thing. Weather is all about the fluctuations, which are substantial."

At the beginning of this year, TVA experienced its largest swing in electricity demand in its history over a five-day period, Mason said. The temperature on a Saturday was close to 60 degrees. Then the TVA region received a blast of cold air from the north. The demand for electricity from TVA that week was three times the total demand of New York City.

"Climate is a small temperature shift that can have big systematic effects on patterns of rainfall in the Southeast, the buildup and melting of the snow pack that supplies water to the Southwest, and the sea level around coastal cities, which has risen in the past 100 years," he explained. "There has been a systematic warming decade by decade since the 1950s. Parts of the U.S. had a very cold winter last year, but it was unusually warm in the Arctic and the West."

According to Mason, "Insurance companies will drive adaptation to climate change." They have been building actuarial models to predict the risks that houses rebuilt along coasts will be damaged or destroyed within a certain amount of time. They are deciding the size of reserves needed to cover the costs of catastrophic events.

Energy and water shortages are likely to be crises this century. Mason sees opportunities for ORNL to do research on the "energy-water nexus." Water is needed for energy production (think hydroelectric dams). Several years ago, TVA had to shut down a reactor during a very hot summer because the cooling water normally taken from the river was too hot to remove heat from the reactor.

Energy is needed for clean water production. Mason noted that the United Arab Emirates ordered four nuclear reactors from a South Korean consortium that will be used to supply power and heat for desalinating seawater to produce clean drinking water.

During his seven years as director, Mason experienced the peaks and valleys of U.S. government funding. ORNL received \$500,000 in American Reinvestment and Recovery Act funds. "We were

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quite successful at making good use of the stimulus,” he said. “We deliberately made sure we didn’t do anything that was not sustainable.”

Most of the money accelerated the construction of planned new buildings, such as the Chemical and Materials Sciences building. Only 100 new staff members were hired, but at least 150 people got temporary jobs doing construction under contract.

By 2010 ORNL had 5,000 staff. “Then sequestration and the associated austerity changed the federal funding climate, and the number of ORNL employees dropped to 4400,” Mason said. “Most left through the voluntary separation program.” Whether ORNL grows again depends on future funding.

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Now I hope you appreciate what you have just read! Readers of this *Historically Speaking* column have just been given privileged insight into the thoughts, plans and accomplishments of the scientists in one of the world’s most comprehensive and effective research facilities as presented by its leader. Where else in the world could you find such information shared with the public in a way that is clear and understandable?

We in Oak Ridge, the Science City, truly have exciting things happening routinely. Be proud of ORNL, it is a center of research with truly worldwide implications.



Thom Mason, Secretary of Energy, Ernest Moniz, Michelle Buchanan and Johnny Moore of DOE Office of Science (courtesy of ORNL photo by Jason Richards)

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Congressman, Chuck Fleischmann, DOE Deputy Secretary of Energy (at the time of the photograph), Daniel Poneman, Secretary of Energy Ernest Moniz and Thom Mason (courtesy of ORNL photo by Jason Richards)