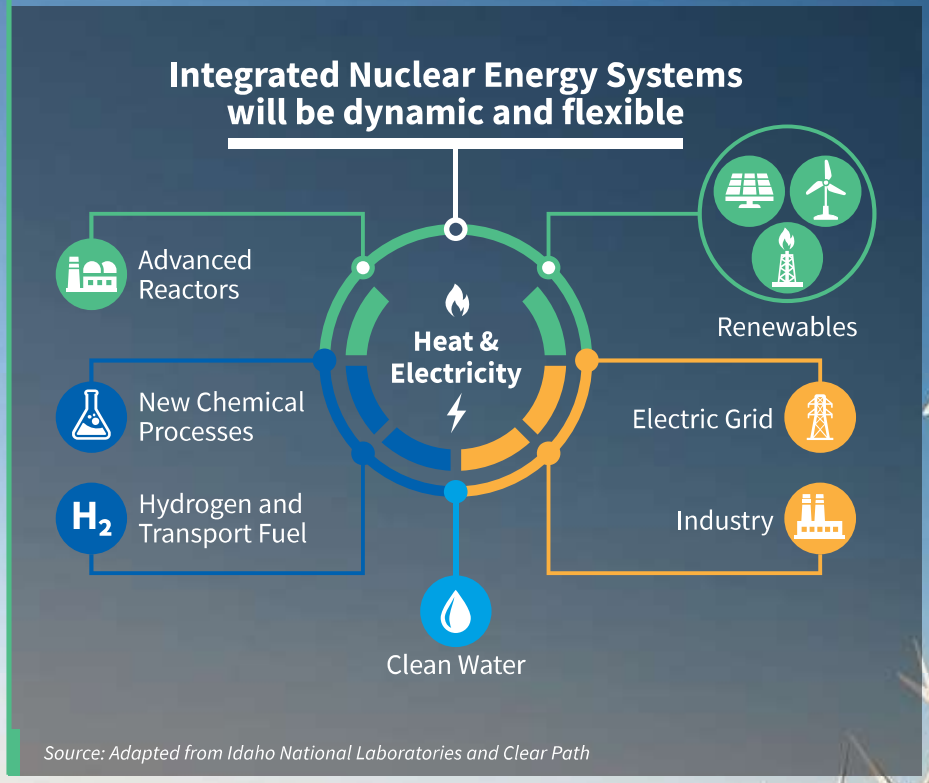
Innovative nuclear energy technologies are being developed to complement the deployment of wind and other renewables in integrated energy systems.




*Source: Adapted from Idaho National Laboratories and Clear Path*

Apart from not causing air pollution, nuclear energy and renewable energy have little in common. This may make them one of the best clean energy duos in the world.

## NUCLEAR-RENEWABLE ENERGY SYSTEMS

# Clean energy allies

In the summer of 2005, the Canadian province of Ontario set a dubious record, logging 53 days of smog advisories. At the time, Ontarians faced a terrible trade-off between air conditioning and air quality: keeping people cool required fossil-fueled electricity that led to greater air pollution, jeopardizing the health of elderly persons and people with respiratory problems.

Today, Ontario has eliminated the worst effects of smog from its cities (there were no smog advisories in 2018, and only one in 2017). This is thanks, in large part, to the restart of three nuclear reactors as well as growth in wind power, which together allowed the province to shutter a number of older, coal-fired power plants.

Cleaning up a large-scale grid doesn't need to be hard, expensive or far off in the future. Ontario's $600-billion economy has done it with nuclear and renewables, mainly hydroelectricity and wind.

You might think Ontario's approach is an outlier. After all, the traditional roles of nuclear energy and renewables have almost nothing in common. Nuclear energy is large, centralized, and (for the most part) always "on", whereas wind and solar are decentralized and dynamic.

But together, these features make nuclear and renewables a formidable pair. In fact, the handful of large economies in the world that have mostly or completely decarbonized their grid all enjoy a mix of nuclear and renewables (see next page), unless they have the fortune of a geography that allows for large-scale hydroelectricity or geothermal.

The secret is a balanced portfolio of "always available" energy sources (like nuclear and hydro) paired with variable, weather-dependent renewables like wind and solar.

This works well on big grids with a variety of energy sources. For example, Denmark—a pioneer in the development of wind power—generated 44 percent of its electricity from wind in 2018 thanks to an interconnected grid that lets it trade with its hydro- and nuclear-powered neighbors of Norway, Sweden and Finland. When the wind is up, Denmark exports its excess power; electricity is imported when it doesn't have enough.

And nuclear is also finding new ways of working with renewables. In France, nuclear power plants are tailor-made to follow fluctuations in electricity demand, a feature that makes them well-suited to a dynamic grid with larger shares of wind and solar.

In the U.S., some nuclear operators are looking at options to make their plants more flexible by producing hydrogen, desalinating water, or heating industrial processes—in addition to producing electricity. This gives nuclear plants other places to send their energy when wind and solar are powering the grid.

Innovations promise to make this kind of integration even easier. Small Modular Reactors could enable new applications for nuclear to contribute to smaller grids with decentralized energy sources. And many advanced reactor designs are better at dynamically following the demand for electricity, storing energy when it's not needed, or sending energy to other industrial processes.

For those looking to follow Ontario's lead, the good news is that new solutions are coming that could make this powerful clean energy duo widely available around the world.