Exhibit 49

The Washington Post

Capital Weather Gang

Save the climate and protect America: Build an 'underground energy interstate' now

By Alexander MacDonald June 2

Guest commentary

The two greatest threats the United States (and other nations) face could be solved by a single infrastructure project that could be done now with existing technology.

The threat the Democrats see is climate change. The threat the Republicans see is terrorism on a massive scale. There are weapons, called Electromagnetic Pulse (EMP) nuclear bombs, currently in the hands of nations such as North Korea that could be in the hands of terrorists in 15 years. An EMP bomb placed high above Kansas City, Kan., could wipe out the U.S. electric system and much of our digital electronics.

A year without electricity (no food, no running water, no gasoline) could kill 100 million Americans or more. Even our friendly, life-giving sun could generate a solar storm that would have a similar devastating effect.

The core solution to both of these problems is a technology that was not fully ready five years ago but is ready now: an *underground* high voltage direct current (HVDC) electric transmission network. I have called it an "underground energy interstate."

There are now commercial HVDC cables that can carry billions of watts of energy that could be buried beside interstate highways, along railroad rights-of-way or underneath existing electric transmission lines.

Underground transmission is better than overhead because it can be protected from EMP and solar storms and because the opposition to very large above-ground transmission is formidable and would likely stop progress for many years if not decades.

In a recent paper published in Nature Climate Change, my co-authors and I showed that an HVDC network would make large-scale use of wind and solar energy cheap and reliable enough that the United States could reduce its carbon dioxide (CO_2) emissions by up to 80 percent without an increase in electricity costs.

Similar studies show that this would also work for China and Europe and other areas of the world.

We have a short window of time to act — action to create large reductions in CO_2 after 2030 is too late.

In installing the HVDC lines underground, the cables can be surrounded by a copper sheath and grounded every couple of miles. This and other protections would safeguard the underground network; the sheath adds too much weight for overhead lines, which, in addition, are more directly exposed to destructive intent.

The nature of alternating current (AC) dictates that power production and usage generally operate in small geographic areas of a few hundred miles across. I have studied weather my whole life and concluded about 10 years ago that the intermittency problem of wind and solar energy would go away if power could be moved in real time over an area big enough to encompass large weather energy scales. An area big enough that the wind is always blowing *somewhere* is needed.

Our paper showed that an HVDC power network could provide reliable, low-cost, low-carbon electricity across a 48-state area. Creating such a market would turn America's geographic size into an advantage, allowing production and delivery of electric power over a large market instead of the current patchwork of small monopolies.

In the 1950s, President Dwight D. Eisenhower led the creation of the National Interstate and Defense Highways Act, which was important to both the commercial and military well-being of the United States. A properly planned, multiply connected electric network can be designed to be highly robust; power produced anywhere over the contiguous United States can reach anywhere it is needed, moment by moment, using numerous different paths.

A protected underground HVDC network would be the core that allows power to get anywhere in the United States after an EMP attack or solar storm. Since the HVDC network is an overlay upon the existing AC transmission and distribution system, there would have to be efforts to harden selected parts of the existing electric system.

A nationally planned integrated HVDC transmission network should be built and maintained privately, in contrast to the publicly built U.S. interstate that took 35 years to complete. Individual segments could be open to private bidders, paid for by usage fees. The existing AC power distribution and retail systems, investor owned utilities, independent system operators and much of the regulatory structure could remain in place, making a smooth transition likely.

Our paper shows that the implementation cost, including new generation and transmission, would be low enough that it would not increase electricity costs to consumers. Investment at this level should be reasonably accommodated by private capital markets.

The threat of greenhouse gases to both the global ocean and atmosphere is real and will continue to ratchet up in coming years. A national electricity market is crucial to address this problem without causing economic harm. Nuclear plants could be placed far from cities to enhance safety and along with wind and solar generators would have continuous access to the full national market. Fossil fuel plants with CO_2 sequestration could compete on a level playing field. A low carbon electric system would enable other energy segments, such as autos and space heating, to use electricity to decrease their carbon footprint. The market would ultimately decide on the best mix of generators as energy consumers and their technologies change through time.

Recent history shows that big things can happen, even in today's legal environment.

Since the 1990s, an entire national network of fiber-optic cables was put in place. It used existing rights-of-way such as roads and had significant segments underground. The proposed primary HVDC network is also similar to the fiber-optic network in that it would *not be funded by tax dollars* — it is an infrastructure project that could start now, create millions of jobs, and leave the United States much less dependent on foreign oil.

There are HVDC cable manufacturing plants in the United States, and much of the project would be done by local contractors across the country — similar in scope to the building of the interstate highway system. The need to coordinate an integrated network design and sufficient legal authority for fast track implementation (i.e., built by 2030) requires robust enabling legislation.

Since solar and security threats, weather scales and the benefits of large markets are similar the world over, it is likely that such a system would work in Europe, China, India and other areas. The United States could lead the world in electric-system transformation, creating increased energy self-sufficiency, stabilizing long-term energy cost and supply, and lessening the likelihood of catastrophic power disruptions. The security, environmental, and economic primacy of those countries that take action soon will be enhanced for decades.

Alexander MacDonald recently retired as director of NOAA's Earth System Research Laboratory. He was president of the American Meteorological Society in 2015. He is currently director of Numerical Weather Prediction at Spire Global.