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The Nexus of Power | Water | Data: The Foundations of American Prosperity & National Security

SWJ Staff

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More than two thousand years ago, the Qin Chinese developed a concept to emphasize the relationship of national prosperity to state power and a strong armed forces through the idiom *Fuguo Qiangbing*, which roughly translates into English as *Rich Nation, Strong Army*. Meiji Japan adopted this slogan in the 19th Century as its model to guide the transformation of Japanese society and to increase the power of the armed forces and the Empire. The People's Republic of China (PRC) has again adopted this model to build its national power. Instrumental to the Chinese model has been significant investments in infrastructure and a mercantilist approach to supporting their economy. As an example, the Chinese state is planning to add 150 nuclear reactors and up to 300 coal power plants to power its growing economy and are investing more than $169 billion annually in its water infrastructure to support current and future industrial, agricultural and residential needs. The Chinese leadership is laying the foundation for Made in China 2025 and primacy during the Fourth Industrial Revolution (Industry 4.0).

As China has aggressively industrialized, during the last several decades the United States has transitioned to a service-based economy,

with decreased support to American manufacturing industries, such as critical mineral mining and refinement, and the production of everything from medical supplies to plastics, to metals and chemicals, to machinery and electronics, etc. As American manufacturing was hollowed out through outsourcing, the nation significantly under-invested in its infrastructure ecosystem: Water (storage, treatment, distribution, and regeneration); Power (generation, storage, transmission and distribution); Transportation (roads, bridges, rail, and ports / waterways); and Communication (operational technology to support advances in information technology, data storage and processing, cyber defense, etc).

The generational infrastructure investments made in the 1950s and 1960s have in many cases reached "the end of their lifespan and are dangerously overstretched." Without a major program to rebuild and expand infrastructure to meet the demands of Industry 4.0, the United States' global standing, both economically and militarily, will erode. An America unable to compete in Industry 4.0 will lead to decreased domestic prosperity for future generations and the erosion of the U.S. dollar as the global reserve currency, which together will have compounding negative effects on the U.S. economy's ability to support a global military capable of defending the nation's vital national interests.

The long-overdue $2 trillion in capital investments made through the 2021 Infrastructure Investment and Jobs Act (IIJA) and the 2022 Inflation Reduction Act (IRA), with the IIJA serving as a positive example of bipartisan collaboration, while the IRA was not. Together, the IIJA and IRA only provided a temporary fix for immediate infrastructure challenges. To stay competitive beyond the 2030s, America will need several trillion dollars in additional investment beyond the IIJA and IRA.

The new Trump Administration, with support from the Republican-

controlled Senate and House, has a mandate to materially improve the lives of average Americans. President Trump is thus uniquely positioned to build upon the IIJA and IRA's infrastructure investments and lay the foundations for American prosperity into the 21st century. However, despite holding a favorable political position, President Trump and the Republicans should not attempt this alone. Instead, they should engage the loyal opposition to create a joint plan for investing in America's future, as was accomplished in 2021 with the passing of the IIJA.

Bipartisan consensus is essential to elevating infrastructure as a national priority, maintaining political focus as power transitions occur, and for the sustained resourcing of a multi-decade infrastructure strategy. American prosperity is built on a strong and modern infrastructure foundation. If the United States wants to remain economically and militarily competitive through the rest of the 21st Century, both leading political parties must work together to make infrastructure a priority and resource it accordingly.

While infrastructure investment is needed across all sectors – water, power, transportation, communication (data) – essential for economic prosperity, the next major infrastructure bill must simultaneously drive efficiencies and prioritize interconnected investments. One such area of opportunity is the nexus of power, water, and data, each a cornerstone for sustaining America's global power.

United States will face an energy crisis within the next ten years. Unlike the petroleum energy crisis in the 1970s, the energy crisis of 2030-2035 will be electrical. Current forecasts predict the United States will require at least 38 gigawatts of more electricity in the next five years. Other estimates project that electricity demand in 2050 will be 27% higher than today. These assessments, however, underestimate the impact of growing energy demands and the implications of replacing aging fossil

fuel power plants and nuclear reactors slated to go offline over the next decade. For example, the World Nuclear Association asserts that if "today's nuclear plants retire after 60 years of operation, 22 GWe [gigawatt electric] of new nuclear capacity would be needed by 2030, and 55 GWe by 2035 to maintain a 20% nuclear share." Furthermore, over 28% of the nation's coal-fired power plants, which currently provide 20% of the country's electricity, are scheduled to be retired by 2035.

The U.S. is facing a severe electricity shortage, endangering both economic growth and national security. Energy conservation measures and power management efficiencies are a part of the solution, but any savings gained over the coming years cannot off-set the expected increased energy demand. Likewise, there is no comprehensive plan to replace retiring coal plants and nuclear reactors in the coming decade. Even if these retiring capacities are replaced, the growing residential, industrial and digital economy demands driven by Industry 4.0 will remain unmet.

Wells Fargo predicts the power demand from artificial intelligence alone is expected to grow 8,050% by 2030, consuming over 652 terawatt hours of energy or "more than 16% of the current total electricity demand in the US." Renewable energy resources, such as wind and solar, cannot offset current demands nor meet future requirements. Natural gas plants currently provide 40% of America's electricity, but with rising global demand for LNG, the U.S. is uniquely positioned to leverage its considerable fossil fuel resources to increase the use of modern nuclear power alternatives. Fission and fusion nuclear power are the only viable options available to replace coal, meet future energy needs, and to establish the power foundations for a Fifth Industrial Revolution.

While the U.S. is naturally rich in freshwater resources, the water infrastructure is old and reaching a breaking point. To repair and upgrade

the nation's water pipes, treatment plants, and wastewater facilities, an additional $744 billion to $1 trillion is needed beyond what the IIJA and IRA have already allocated. Currently, half of the nation's freshwater is too polluted for swimming, fishing, or drinking. Although U.S. households consume over 13 trillion gallons of water annually, this amount pales in comparison to the 47 trillion gallons used by the electric power sector. The Union of Concerned Scientists reports that 65 percent of U.S. electricity generation requires these large amounts of water to cool the power generators, accounting for "almost 40 percent of freshwater withdrawals in the United States". Additionally, the rapid growth of data centers is depleting water tables, consuming over 175 billion gallons of water today, though as of 2021, only 51 percent of data center operators even tracked their water consumption. Total data center growth in the U.S. is forecasted at more than 9 percent compound annual growth rate through 2030, while during this same period hyperscale data center growth is expected to triple in the next five years, placing a significant added water table strain from data center water use by the end of this decade.

Today, 96 of the 204 water basins across the U.S. are under stress, and the system within a few decades will be unable to support residential, agricultural, and industrial demands. Water is symbiotically linked to the electric grid, and is essential for economic prosperity. To address this, the U.S. needs to augment and reinforce its freshwater supply, leveraging Industry 4.0 technologies to innovate water access methods. While conservation can help, it will only go so far. Industrial demands for water to support growing power generation capabilities, manufacturing, data center needs, if left unaddressed, will exacerbate the fragile state of the U.S. water system by depleting and further polluting fresh water sources essential to the agricultural economy and the residential sector.

Desalination is a potential solution, but is both costly and challenging to scale on a continental level.

In addition to desalination, advances in atmospheric water generation (AWG), if stacked and industrially scaled, offers a promising approach to harvesting water from atmospheric rivers in the troposphere. Rising temperatures increase atmospheric water content by seven percent for every one degree Celsius increase in air temperature, which AWG technology can capture and deliver as clean, vector-free water to areas in need. This approach could help sustain the nation's natural and artificial water basins, and if scaled, could support the filling of currently depleted basins or creating additional micro water basins across the United States to support local Industry 4.0 demands. Together, desalination and AWG present the U.S. with a modern opportunity akin to the North American Water and Power Alliance (NAWAPA) envisioned six decades ago.

NAWAPA aimed to redirect "the excess water of the high yield watersheds of the far northwestern land masses by distributing it to the water deficient areas of Canada, the United States, and northern Mexico" through a network of "369 individual dams, canals, pipelines, tunnels, and pumping stations." While its scale is likely infeasible today due to environmental and community impact concerns, the U.S. could adopt selective engineering elements of NAWAPA to deliver water where it will be most needed and help power America into the future.

The United States will continue to invest in its infrastructure. However the ultimate question for the nation and its future prosperity will be, does the nation continue the variable funding practice it has used since 1969, underinvesting across time with periodic surges as tools to prop up the economy in times of financial distress or to rebuild damaged infrastructure in response to natural disasters. The United States, in real

per capita spending using 2009 cost figures, spent less on infrastructure in 2013 ($776) than it did in 1960 ($793), despite a trebling in gross domestic product (GDP) over this same period.

If America wants to remain competitive economically, it can't keep spending 2.3 percent of its GDP on infrastructure. European nations spend 5 percent, while China is spending 8 percent. The nation needs an enduring, multi-decade infrastructure program that is funded above 4 percent of GDP annually to both repair and strategically build out the nation's infrastructure to be more resilient and to meet future Industry 4.0 demands. Committing more than 4 percent is sustainable; the nation resourced more than 2.8 percent of its GDP for water and transportation infrastructure alone in the years 1959-1965.

There is a growing recognition within the United States that infrastructure is not just in a state of disrepair from under-investment, but that it is inherently fragile to severe disruption by natural and/or human generated threat vectors. The U.S. military has started working on making its military bases more resilient through assured energy projects such as large scale micro-grids and the implementation of the Defense Department's Operational Energy Strategy. Industry is similarly getting on board to modernize the power grid by implementing virtual power plants (VPP), which are aggregations of distributed energy resources to better balance electricity demand and supply. While the above efforts are indeed commendable and heading in the right cardinal direction, they fall short of the mark. They are insufficient, because they continue to perpetuate the antiquated approach to infrastructure by concentrating too narrowly, focusing either on individual, stand-alone projects (i.e. Georgia's Vogtle Nuclear Power Plant expansion) or as a single infrastructure category (i.e. power, water, transportation, etc).

The next infrastructure program put forward should be designed to

maximize the investments made and focus on the larger strategic picture, such as where infrastructure investments may interconnect. Designing an infrastructure program that harnesses the nexus of power, water and data, if approached together, could provide a synergistic effect and ensure one leg of the nexus doesn't outpace the others. For instance, if the power infrastructure category is built out to support big data growth, without commensurate investments in the water infrastructure, then the energy grid and data networks will irreparably damage the water supply and its ability to support residential and agricultural demands.

Therefore, in order to avoid the mono-infrastructure trap of past infrastructure programs, the United States should consider a more comprehensive approach that expands VPP efforts beyond the power domain. VPPs can be expanded by connecting and integrating AWG water generation and production with artificial intelligence capabilities to establish transformative virtual utility (VU) network ecosystems. VUs offer the assured capacity to deliver essential power, water and data resources for Industry 4.0. A United States, equipped with infrastructure that can support Industry 4.0 demands, provides the nation the economic foundation to equip and sustain a globally dominant military. Without the right infrastructure foundation, the American economy will be increasingly challenged to adequately and sustainably resource a military sized and capable of deterring aggression and defending its interests against rivals that have invested more wisely.

The United States must invest sustainably and substantially in its national infrastructure to stay competitive. Without rebuilding and expanding its infrastructure, the U.S. is essentially choosing to cede its standing in Industry 4.0, and over time will increasingly be challenged to develop, produce, and resource an Armed Forces that can defend its

global interests against the likes of the PRC. Two hundred years ago the United States completed the Erie Canal, a geoengineering project that harnessed water with transportation. It was the first of many infrastructure projects over the last two centuries that built America. Today, the nexus of power, water and data represents a similar transformative opportunity – not just for competition, but for ensuring enduring American economic and military dominance well into the future.