The "electrification revolution" is moving high carbon intensity activities to electric-powered processes and increasing demand for power. *Photo: Adobe Stock*

Emerging energy issues and impacts on water

by Aaron Atcheson and Karen Hakim

As the world increasingly turns to renewable energy sources, the ripple effects of this transition extend beyond the realm of energy production. One often-overlooked aspect is the significant impact renewable energy advancements may have on our water resources. Advances in the use of renewable power resources present unique challenges in managing water usage and quality.

The intersection of energy and water is marked by promising innovations and pressing concerns. Among the foremost challenges is the escalating demand for water and the potential for water contamination due to further development of water resources to meet energy demands.

The "electrification revolution" is moving high carbon intensity activities to electric-powered processes and increasing demand for power. The rise of new electricity "loads" such as cryptocurrency mining and data farms also presents unique challenges for water resources. This and the rise of the "hydrogen economy" could increase demand for clean water.

Canada has three orders of government as well as Indigenous groups. Federal regulations govern international waters and fish habitats, while provinces have broader responsibilities, some of which are delegated to municipalities. This is especially true in the areas of drinking water and wastewater management.

The federal government is forcing carbon emission reductions. Individuals and corporations are adjusting, but provincial water protection legislation is generally not keeping up with the added risks to water resources and waterways.

Electrification and New "Loads"

The push to reduce greenhouse gas emissions by promoting electric vehicles (EVs) and electrifying industries will heighten power demand in the coming years.

Ontario has not seen material generation added to the grid recently. Although, there has been a surge in storage installations, facilitating additional generation capacity and higher utilization of resources.

The push for renewable energy and other low-carbon power options has also spurred diverse project developments. The rise in geothermal energy, also known as heat pumps, is one example. Simultaneously, the development of large data centres and cryptocurrency mining adds significant power demand to our economy.

This expansion means more power projects, some potentially posing risks to water resources. An intriguing trend is the repurposing of old dams from pulp and paper operations for new ventures like cryptocurrency mining.

Rebirth of Nuclear

While it has been decades since Canada has seen new nuclear projects, there is a recent buzz surrounding small modular reactors (SMRs). These versatile projects can be deployed in both urban centres and remote areas, though they attract attention on potential safety risks and radiation contamination.

With new nuclear endeavours comes the challenge of managing additional nuclear waste. This includes spent fuel rods and pellets, which could potentially threaten water sources depending on storage methods. Legacy concerns persist in this regard.

SMRs also entail water usage in various processes, introducing further risks. The Nuclear Waste Management Organization has made progress in planning and development of a deep geological repository, but physical work at their sites remains limited. From a water perspective, the focus is on keeping water separate from nuclear waste throughout the encapsulation and storage process.

Hydrogen and Ammonia

Green hydrogen also presents implications for water resources. Green hydrogen is generated through electrolysis using renewable electricity to split water into hydrogen and oxygen. The production process increases overall water consumption, with electrolyzers requiring high-purity water. This leads to significant waste generation.

Varied water usage regulations across Canada necessitate approvals from multiple governing bodies, introducing a permit application process with associated risk assessments. For instance, Ontario requires permits for daily water usage exceeding 50,000 litres, while Manitoba mandates licenses for over 25,000 litres per day. Additionally, obtaining approvals may involve other government ministries, municipalities, and electric system operators.

Hydrogen (once it is created) can theoretically be transported by land, ship, or pipeline. However, there are significant transportation challenges due to its low volumetric energy density and corrosive properties, leading to costly storage and shipping as well as a preference to use ammonia as the transportation and storage medium. In turn, increased use of ammonia raises concerns regarding potential environmental contamination, and its toxic effects on aquatic life and human health, at high concentrations.

Geothermal, Aquifer Storage, Deep Water Cooling

Geothermal systems are gaining popularity in both urban and rural settings, including as part of district energy initiatives. In urban areas, deep drilling may pose challenges, potentially impacting perched groundwater and creating contamination risk. Meanwhile, aquifer storage entails storing thermal energy in self-contained groundwater resources.

With increasing adoption of these energy solutions, drilling-related contamination incidents may rise. Regulation of geothermal systems in Canadian jurisdictions remains minimal, and aquifer storage is still in the early stages of development.

Another category of related systems involves deep water cooling. A leading example is Toronto's deep lake water cooling system. Toronto's system utilizes water from Lake Ontario to cool more than 100 buildings in the city, including city hall and Scotiabank Arena. This system has garnered global recognition. Similar systems are being explored in other communities with significant water bodies, aiming to leverage temperature differentials for cooling.

Permitting for such systems needs to involve considerations like fish habitat protection and ecosystem impact assessment.

Wastewater Energy Transfer

A promising renewable energy innovation with minimal water-related risks is wastewater energy transfer (WET), which captures waste heat from wastewater headed for sanitary sewers. This technology targets facilities like hotels

and hospitals, where significant hot wastewater is generated, particularly from laundry operations.

The Toronto Western Hospital WET system, with a capacity of 19 megawatts equivalent, exemplifies this advancement. Since WET projects recapture heat from wastewater already bound for treatment, it poses minimal risk to water supplies while contributing to carbon reduction efforts in energy production.

Decarbonization as a Driver

Corporations are increasingly committing to decarbonization efforts, driven by regulatory mandates, financial considerations, shareholder activism, and public perception. While these commitments hold the promise of positive changes, the full implications are often realized later.

Decarbonization initiatives are expected to drive significant changes in water and wastewater management practices. Meeting carbon reduction targets will require a massive increase in projects. Many of these will impact water resources or pose risks to water supplies. These projects could have wide-ranging effects across the country.

One unexpected impact of decarbonization involves revisiting older energy projects and looking at water and waterways in different ways. For example, mothballed hydro projects – either unfinished or requiring repowering – are being reconsidered alongside greenfield projects.

Notable water-based storage projects, such as the Meaford, Ont., pumped energy storage project, are being planned. But despite advancements, concerns related to security of supply and grid integrity overshadow considerations related to water resources. It seems unlikely that we will completely change course in the coming years, although there may be adjustments to compliance options, timelines, and accommodations.

The overall trend is clearly toward reducing carbon emissions, and so we can anticipate more projects in the pipeline leading to increased interactions with water resources and greater water demand. It is essential for the water sector to proactively manage risks associated with energy innovations, rather than reacting retroactively. Simultaneously, we should explore ways to leverage this energy momentum to move essential water and wastewater projects forward.

It is imperative that we urge our governments to address the risks associated with advancements in energy technology, particularly those affecting water resources. The current patchwork of regulations often fails to adequately address the unique circumstances of each project. Ultimately, our governments bear the responsibility of ensuring that energy advancements do not harm our water resources.

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