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Include the fossil-free transition in the next Water Action Agenda

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IMAGE (ABOVE): Vattenfall combines wind solar and batteries in new hybrid energy park © VATTENFALL

The next Water Action Agenda must seriously consider the role and future of water in the transition to fossil-free energy – both as an agent for change and as a sensitive system to be impacted with serious negative consequences. Producing more energy, even if "fossil-free", will affect the achievement of water quality, biodiversity and climate goals. Leaders need to rethink the "optimal" equation to account not only for energy security but also climate, ecosystem and social benefits and trade-offs. These considerations should focus on hydropower and how it fits into other renewable energy sources, and how water use will shape these decisions.

Water energy ups and downs

Hydropower is increasingly hailed as the single most important source of renewable energy with a crucial role in accelerating clean energy transitions to achieve countries' climate ambitions securely (IEA, 2021). Furthermore, offshore renewable energy is expected to produce more than the current global electricity consumption (IEA, 2019).

Increasing renewable energy sources does not come without a cost, and water is part of that trade-off. Hydropower dams have serious impacts on water systems, from the ecology of the downstream river network to the changed land use upstream. Offshore renewable energy will have impacts on habitats, water quality and noise pollution and could lead to a range of conflicts over the use of marine space (Lloret et al., 2022). As both freshwater and the ocean play crucial roles in regulating the planet's climate – through heat transfer, the water cycle, the carbon cycle, and sea level – the effects on water and the ocean from renewables will have far-reaching implications on ecosystems and societies.

For example, Sweden, hailed for its environmental leadership and transformation of its industries, leans heavily on hydropower for decarbonizing its electricity mix to reach the country's 2050 net-zero emissions target (Klimatpolitiska rådet, 2022). That mix will be challenged with the expansion of industrial activity for battery, fossil-free steel, and hydrogen production in the north of the country (Svenska Kraftnät, 2022a). Further challenges to the electricity grid will be posed by urbanization, because of industry expansion, and subsequent population growth with increased energy consumption for economic developments (Energimyndigheten, 2020).

Relying on hydropower cannot address these issues, and Sweden is not alone in this development, with implications for other energy sources. For example, hydrogen production, promoted by the EU (European Commission, 2021), in many countries requires hydroelectric energy for its production (Karayel et al., 2022). This is part of the reason why globally, the International Energy Agency (IEA) calls for increased investments in hydropower, with particular untapped potential in emerging and developing economies (IEA, 2021).

However, the vulnerability of hydropower production to climate change has become apparent in the past few years. Due to droughts, hydropower generation decreased in 2021 for the first time in two decades, despite relatively high-capacity growth (IEA, 2022).

Increasing the energy mix to ensure a reliable electricity network will become paramount – with water-based resources playing a major role (see sidebar). Marine areas are expected to host most of the energy expansion in the coming years. The IEA estimates that the global potential for offshore wind power alone is over 18 000 terawatt-hours (TWh) per year, which is more than the world's current electricity consumption. Additionally, the IEA notes that wave and tidal energy could potentially generate up to 337 TWh per year globally (IEA, 2019). A mix tailored to local resources could meet demands, with solar platforms riding wave and tidal energy harvesting systems, for example.

Even nuclear power relies on water. Sweden and other countries continue to use nuclear power and are considering building new plants – of the 450 currently active nuclear power plants worldwide, 100 use seawater for cooling and the rest, freshwater, such as lakes and rivers or humanmade lakes (World Nuclear Association, 2021). New and old plants will face difficulties with shifting weather patterns and climate change, related to freshwater and sea temperature increases, water availability and the cost of other expensive replacement cooling capacity (Vattenfall, 2018; Westlén, 2018).

WATER-DEPENDENT RENEWABLE TECHNOLOGIES LIKELY TO INCREASE IN THE FOSSIL-FREE TRANSITION

- Pumped-hydro storage: During periods of high wind output, excess electricity generated by offshore wind farms can be used to pump water uphill to a reservoir. Then, during periods of high electricity demand, the water can be released from the reservoir to generate hydropower.
- Co-located wind and hydropower facilities: An example is an offshore wind farm built near an existing hydropower plant, with the two facilities connected through a shared transmission line. This would allow for more efficient use of the transmission infrastructure and increase the overall capacity of the renewable energy system. Maintenance activities could be shared to some extent as well.
- Offshore floating solar: Solar panels can be integrated with offshore wind and hydropower systems, for example, on the same offshore platform as wind turbines or hydropower turbines. The same marine space can generate more renewable energy in this way.
- Co-located wave and offshore wind: Wind turbines and wave energy devices can share the same offshore site, in a few different ways: share infrastructure such as mooring systems and undersea cables; develop hybrid devices that can capture both wind and wave energy; or deploy separate wind turbines and wave energy devices in close proximity to each other.

Impacts on biodiversity

Water-dependent renewable electricity projects are set to grow. Mitigating their future impacts requires assessing the full range of potential trade-offs, such as those affecting habitats and ecosystems. Understanding the dynamics between water and energy is also important for achieving good water quality and ensuring sustainability of biodiversity.

For example, discharged water from hydropower plants changes natural flow patterns, water quality and temperature, affecting habitat for various aquatic species. Further pressures to habitat will come with industry expansion in places like northern Sweden, with increased urbanization and energy requirements that could result in higher pressures on river networks and their ecosystems.

When it comes to offshore wind, larger wind turbines that will be installed at greater depths will lead to as-yet unknown consequences for offshore habitats. In Sweden, current depths range between 5 and 40 m, but new installations are expected in depths of 40 to 60 m (Bergström et al., 2022). Ocean-based wind energy affects local fauna and flora at every phase of production, not only due to physical changes in the seabed required to set up the structures (Petruny et al., 2016), but also due to the noise pollution generated during construction and operation (Bergström et al., 2022).

Social justice implications cannot be overlooked

Renewable energy projects can lead to a number of social injustices, including land use conflicts, unequal distribution of costs and benefits, and ignored communities. Dams and reservoirs flood large areas of land, forcing people to move away from their homes and livelihoods. In Sweden, the construction of hydropower projects has led to the displacement of Sami communities from their traditional lands and territories (Inga & Kløcker Larsen, 2022).

The benefits of renewable energy projects, such as jobs and energy access, as well as the impacts to ecosystems and water quality, are often not evenly distributed across communities. In Sweden, for example, hydropower is the largest source of renewable energy, accounting for around 45% of the country's total electricity production (Energimyndigheten, 2022). Most of Sweden's hydropower is located in the northern part of the country, while most electricity consumption is in the south (Energimarknadsinspektionen, 2021). As wind power (including offshore) has not expanded in the south due to local opposition, electricity prices continue to be highest in the south (Svensk Vindenergi, 2022). Grid capacity bottlenecks between the north and south further exacerbate price differences (Svenska Kraftnät, 2022b). The social and environmental impacts from hydropower and wind installations are in the north, but lowering energy cost would be most beneficial to the south.

Lack of consultation can lead to projects that do not reflect the needs and priorities of a community. In particular, Indigenous communities, including Sami peoples, have often been excluded from decision-making processes related to hydropower development in their traditional territories (Biancardi Aleu et al., 2022). In Sweden, Sami communities have had little say in how their lands are used and how benefits from hydropower projects are distributed. Recently, to address these issues, the Swedish government implemented regulations requiring thorough environmental and social impact assessments in consultation with Sami communities.

A fossil-free Water Action Agenda

Renewable energy requires consideration in the next Water Action Agenda. Hydropower will play a critical role in a fossil-free transition, increasingly functioning as a load-balancing source of energy, filling the intermittency gaps of other renewable energy sources like offshore wind power and other freshwater and ocean-related forms of energy. But vulnerabilities will emerge. Land use conflicts, unequal distribution of costs and benefits, and lack of community participation are among the challenges to address.

In addition to social justice issues, water and biodiversity goals must be integrated with energy planning. Investments, regulatory changes and impact assessments should take into account climate changes, synergies and trade-offs between sustainability goals. This integration will enhance efficient and coherent planning for infrastructure operation, energy generation and industrial output, while also addressing synergies and trade-offs between sustainability goals, environmental targets, economic policies and social development that may evolve based on various scenarios, hydrology and climate conditions, and socioeconomic development pathways.

The implementation of the Sustainable Development Goals (SDGs) and targets related to water (SDG 6), particularly those concerning sustainable water use, water governance and water-related infrastructure, should be accelerated. Thus, the Water Action Agenda should address the urgent need to manage water on hydropower-regulated rivers in a more sustainable and equitable manner.

Smartly designed environmental flows and mitigation measures can help reduce the environmental impact of hydropower, but they cannot replace nature conservation and free-flowing river protection. The Water Action Agenda should also recognize and trigger action concerning the crucial role of integrated, holistic and transformative solutions in achieving sustainable development, including the SDGs. This further necessitates the adoption of integrated water resource management that considers the interdependencies between water, food, energy and ecosystems, as well as social and economic aspects of sustainable development.

References

Bergström, L., Öhman, M. C., Berkström, C., Is, M., Kautsky, L., Koehler, B., Sandman, A. N., Ohlsson, H., Ottvall, R., Schack, H., & Wahlberg, M. (2022). *Effekter av havsbaserad vindkraft på marint liv.* Naturvårdsverket. https://www.aquabiota.se/wp-content/uploads/bergstrom-l.-ohman-m.-c.-berkstrom-c.-isaeus-m.-kautsky-l.-koehler-b.-nystrom-sandman-a.-ohlsson-h.-ottvall-r.-schack-h.-wahlberg-m.-effekter-av-havsbaserad-vindkraft-pa-marint-liv.-isbn-978-.pdf

Biancardi Aleu, R., Kløcker Larsen, R., & Methner, N. (2022). Participation and marginalization in water governance: Probing the agency of powerholders. *Ecology and Society*, *27*(4), art33. https://doi.org/10.5751/ES-13680-270433

Energimarknadsinspektionen. (2021). *Elområde* [Text]. https://ei.se/konsument/el/sa-har-fungerar-elmarknaden/elomrade

Energimyndigheten. (2020). *En studie av elanvändningens utveckling per län till år 2030*. Statens Energimyndighet. https://www.energimyndigheten.se/nyhetsarkiv/2020/norra-sverige-och-storstadsregionerna-kan-fa-storst-okning-av-elanvandningen/

Energimyndigheten. (2022). *Energy in Sweden 2022 – An Overview.* Statens Energimyndighet. https://www.energimyndigheten.se/en/news/2022/an-overview-of-energy-in-sweden-2022-now-available/

European Commission. (2021). Understanding the climate-water-energy-food nexus and streamlining water-related policies. *Directorate-General for Research and Innovation.* https://research-and-innovation.ec.europa.eu/news/all-research-and-innovation-news/understanding-climate-water-energy-food-nexus-and-streamlining-water-related-policies-2021-03-19_en

IEA. (2019). *Offshore Wind Outlook 2019: World Energy Outlook Special Report*. International Energy Agency. https://www.iea.org/reports/offshore-wind-outlook-2019

IEA. (2021). Hydropower has a crucial role in accelerating clean energy transitions to achieve countries' climate ambitions securely. IEA. https://www.iea.org/news/hydropower-has-a-crucial-role-in-accelerating-clean-energy-transitions-to-achieve-countries-climate-ambitions-securely

IEA. (2022). *Hydroelectricity – Analysis*. IEA. https://www.iea.org/reports/hydroelectricity

Inga, K., & Kløcker Larsen, R. (2022). *Samers förtroende för förvaltningen av vattenkraft: En enkätstudie*. Stockholm Environment Institute. https://doi.org/10.51414/sei2022.015

Karayel, G. K., Javani, N., & Dincer, I. (2022). Hydropower for green hydrogen production in Turkey. *International Journal of Hydrogen Energy*, S0360319922015956. https://doi.org/10.1016/j.ijhydene.2022.04.084

Klimatpolitiska rådet. (2022). *2022-Klimatpolitiska Rådets Rapport*. https://www.klimatpolitiskaradet.se/wp-content/uploads/2022/03/klimatpolitiskaradetrapport2022.pdf

Lloret, J., Turiel, A., Solé, J., Berdalet, E., Sabatés, A., Olivares, A., Gili, J.-M., Vila-Subirós, J., & Sardá, R. (2022). Unravelling the ecological impacts of large-scale offshore wind farms in the Mediterranean Sea. *Science of The Total Environment*, *824*, 153803. https://doi.org/10.1016/j.scitotenv.2022.153803

Petruny, L., Wright, A., Smith, C., Popper, A., & Hawkins, A. (2016). Renewables, shipping, and protected species: a vanishing opportunity for effective marine spatial planning? *Effects of Noise on Aquatic Life II*, *875*, 815–820.

Svensk Vindenergi. (2022, March 13). Allt fler kommunala nej till vindkraft – nu behövs ökade incitament—Svensk Vindenergi. https://svenskvindenergi.org/pressmeddelanden/allt-fler-kommunala-nej-till-vindkraft-nu-behovs-okade-incitament

Svenska Kraftnät. (2022a). *Program Fossilfritt övre Norrland*. https://www.svk.se/utveckling-av-kraftsystemet/transmissionsnatet/transmissionsnatsprojekt/program-fossilfritt-ovre-norrland/

Svenska Kraftnät. (2022b, May 2). *Elområden och prisskillnader*. https://www.svk.se/om-kraftsystemet/om-elmarknaden/elomraden/elomraden-och-prisskillnader/

Vattenfall. (2018). Warm cooling water forces Swedish nuclear reactor Ringhals 2 out of operation. Vattenfall. https://group.vattenfall.com/press-and-media/newsroom/2018/warm-cooling-water-forces-swedish-nuclear-reactor-ringhals-2-out-of-operation

Westlén, D. (2018). Nuclear power and high sea water temperatures. *Analysgruppen*. https://www.analys.se/engelska/publications/nuclear-power-high-sea-water-temperatures/

World Nuclear Association. (2021). *Nuclear Power Today | Nuclear Energy—World Nuclear Association*. https://www.world-nuclear.org/information-library/current-and-future-generation/nuclear-power-in-the-world-today.aspx

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