HEALTHY WATERS IN CANADA'S LOW CARBON ECONOMY

The future of hydropower may be one of the most perplexing challenges Canada faces, at the nexus of climate change, energy and water policy. WWF-Canada seeks to ensure renewable energy is developed in tandem with safeguarding healthy waters in Canada.

The Government of Canada is committed to meeting the climate targets set out in the Paris Accord. We know that to achieve this goal, we need to change the way our energy is produced and used. Canada needs reliable sources of low-carbon energy to fuel our economy and support our quality of life. The real debate lies in how much energy is needed and in what form that energy should take. It is critical that the development of clean renewable energy does not come at the expense of healthy ecosystems and communities.

Water and energy have a tightly linked relationship, often called the water-energy nexus. Water is required to generate energy; it is necessary for hydropower production, oil and gas extraction, and as a coolant in power plants, for example.[1] In fact, energy generation, transmission and distribution uses more water than any other industries in Canada. Conversely, energy is required to extract, treat and distribute water.[3] As the impacts of climate change become more and more apparent, and the demands for both energy and water continue to increase, the relationship between energy and water will be felt more acutely.[4] As water expert Peter Gleick points out, "Energy constraints are beginning to affect water policy, and water policy is beginning to affect our energy choices. And yet, almost never do we integrate these two policies."[5]

Energy development is a cornerstone of Canada's economy, but so is water. In fact, water is the basis for all economic activity – no industry can operate without directly or indirectly using some amount of water.[6] Water can also be responsible for significant economic losses in the form of droughts and flooding. Yet, Canadians have a very poor understanding of the role of water in our economy. A 2011 estimate determined the contribution of water to the Canadian economy was about $7.8 billion to $22.9 billion; however, the authors of this assessment indicate that number is likely significantly lower than the actual contribution.[6]

Canadians are facing a great opportunity. As we re-think the ways we produce energy, we must take advantage of this chance to fully consider water and energy together. In doing so, we can ensure that water is healthy and available to power our ecosystems, communities, and economy now and into the future.

It is critical that the development of clean renewable energy does not come at the expense of healthy ecosystems and communities.

ELECTRIC RIVERS: THE FUTURE OF HYDROPOWER IN CANADA

An important example of where water and energy collide in Canada is the generation of hydropower. Hydroelectricity is at the heart of our energy supply and where many countries left the big dam era in the 1960's and 1970's, Canada has forged ahead.

Canada is the second largest hydroelectricity generator in the world with roughly 60 per cent of our current national electricity supply coming from harnessing the energy of our rivers.[7] Hydropower is also an important export commodity for many provinces including Quebec, New Brunswick and Ontario, generating billions of dollars in profit annually for Canadian provinces.[8] For example, Hydro-Quebec reported revenue of $803 million from exports, 99% of which comes from hydropower.[9] As Canadians imagine a low-carbon future, hydropower is the major player in the renewable energy mix.

All of the scenarios outlined in the Government of Canada's mid-century long-term low-greenhouse gas development strategy[7] involve the addition of significant hydro capacity. Done right, hydropower can be a green, sustainable source of electricity. Yet often hydropower's development comes at a cost to river health by disrupting the river's natural flow, acting as a physical barrier to species, and preventing nutrient and sediment movement. If we fail to consider river health when planning of hydropower development, we risk the loss of native biodiversity and the ecosystem services on which society relies. The future of hydropower needs to recognize the trade-offs and seek to balance the benefits of renewable energy supply with the need for healthy rivers.

Instead of focusing on the costs and benefits of individual projects and evaluating hydropower on a case-by-case basis, it's time to look at the bigger picture and ask how we can do things better.

TOWARDS RESPONSIBLE HYDROPOWER: WWF-CANADA'S TOOLS

Because hydropower will continue be a major part of Canada's renewable energy portfolio, tools are required to ensure appropriate integration between energy decisions and water management.

To help facilitate this integration, WWF-Canada has a suite of tools that can help hydropower stakeholders ensure that infrastructure is not being constructed at the expense of the health of our rivers. Our Watershed Reports paint a pictures of freshwater ecosystem health across the country that is already at risk, our Renewables for Nature work details ways to ensure that high conservation values aren't sacrificed while siting renewable energy projects, and our Wild Rivers report identifies free flowing rivers in Canada, and highlights those that remain free from significant threats. Combined, these tools can be used to ensure that dams are built at the right time, in the right place, and at the right scale.

Watershed Report

Renewables for Nature

Wild Rivers

WATERSHED REPORTS

All development decisions, not only hydropower, must be evaluated at a scale larger than the individual project. A river system can be impacted by multiple developments, intakes for industry, cities and agriculture, sources of point-source and nonpoint-source pollution, climate change, and many other threats. The cumulative impact of development, in it's many forms, can be devastating on freshwater systems. For this reason, water management should be conducted at the watershed or basin level. WWF-Canada's Watershed Reports provide the information about how different stressors add up to overall threat level, while also providing information about the current health of their watershed.

The Watershed Reports identify the status of freshwater in Canada through a rigorous analysis based on health and threat. Each of Canada's 25 major watersheds and 167 sub-watersheds has been analyzed, providing Canadians with the first ever national picture of the status of their water. The health score is based on four indicators: flow, benthic invertebrates, fish, and water quality. The threat score is made up of seven indicators: fragmentation, alteration of flows, climate change, invasive species, pollution and water use.

Presently, the Watershed Reports indicate that many of Canada's watersheds and sub-watersheds are facing significant threats. More troubling, is that we don't have enough monitoring data to understand how those threats are impacting water health. This is a disturbing trend. Proceeding with large scale developments, such as hydro projects, while lacking the data necessary to understand the health of the watershed is simply irresponsible. Impacts to water are expected to increase with continuing development pressures and climate change. In fact, 21 out of 25 watersheds in Canada are already facing high or very high threats from climate change. We must consider the health of our watersheds as we strive to mitigate climate change through renewable energy development.

When planning a hydropower development, basin managers can drill down at the Watershed Reports scores and look at individual health and threat metrics, specifically the flow health indicator, and the alteration of flows and fragmentation threat metrics. These metrics indicate watersheds and sub-watersheds that already have impacted flow regimes, in some cases by dams, and conversely those watersheds that are not impacted. Ten out of twenty-five watersheds receive a flow score below the "good" threshold. Fourteen watersheds received high or very high habitat fragmentation threat scores, and five watersheds receive high alteration of flows threat scores. Understanding the existing impacts to the region will help determine the cumulative impact in a watershed and if it acceptable for additional impact of hydropower infrastructure.

WATER HEALTH INDICATORS

Fish

Benthic invertebrates

Water quality

Water flow

RENEWABLES FOR NATURE

Traditionally, hydropower sites have been chosen based on technical considerations and on their potential to generate revenue. To protect river health, we need to add high conservation values (HCVs) to that mix. Fortunately, WWF-Canada has created a tool called Renewables for Nature which will help stakeholders do just that. HCVs are unique or outstanding values and/or the areas that support those outstanding values. Based on a scientifically robust framework that cross-references information about renewable energy capacity with important environmental considerations, our data-driven, habitat-friendly renewable energy siting tool will help project proponents balance energy production with ecosystem needs. In addition, using this tool will reduce negative and time-consuming nature-related conflicts over renewable energy development. Currently the Renewables for Nature tool does not consider large-scale hydro projects, but can be an effective tool for siting small-scale hydro projects. Once identified, HCVs can be protected either through project siting decisions, through dam operation protocols, or both.

WILD RIVERS

In some cases, protecting HCVs could mean making a specific site, stretch of river or the entire watercourse off-limits to hydropower development. WWF-Canada's Wild Rivers report helps to identify high value rivers which should remain free flowing.

All rivers in Canada were systematically assessed to determine if they are presently impacted by dams or not. Where Watershed Reports identifies impact from dam at the watershed scale, this analysis looked at the individual river level. The relative location of dams within the river networks were used to identify river sections where upstream and downstream river flows could be influenced by in-stream infrastructure, as dams impact rivers beyond their immediate vicinity. River segments where no dams were located were identified as "free flowing". The ten longest free flowing rivers which were contained within sub-watersheds that received "low" or "very low" threats scores from the Watershed Reports' Freshwater Threats Assessment were identified as Canada's wild rivers.

These rivers should be considered "no-go" zones for any dam construction, including hydropower development.

Aside from the identification of Wild Rivers, this analysis produced the first systematic classification of free flowing rivers in continental Canada. Hydropower project proponents can use the results of this analysis to apply the principles of The Nature Conservancy (TNC)'s Hydropower by Design, which advocates for a systems scale approach to maximize energy development while minimizing impacts to rivers.[11] These principles are applied by conducting spatial analyses to examine various dam arrangement scenarios, providing the information necessary to maximize length of connected river segments during dam siting processes. For example, placing a dam upstream may result in a more highly fragmented river system than placing a comparably sized dam further downstream.[11] The results of our free flowing rivers analysis provide the necessary tools to run these optimization scenarios in Canada.

CANADA'S WILD RIVERS

- Liard River
- Kazan River
- Dubawnt River
- Thelon River
- Horton River
- Anderson River
- Taltson River*
- Stikine River
- Ekwan River
- Birch River

*The Taltson River does have a hydro dam near where it flows into Great Slave Lake. However, the free-flowing portion of this river is still one of the longest in Canada, therefore we included it as a Wild River.

THE VALUE OF HEALTHY RIVERS

Healthy river ecosystems, like all freshwater environments – including lakes, streams, marshes, swamps, other wetlands, aquifers, estuaries and deltas – provide the habitat and resources needed by fish, birds, plants and other wildlife, as well as the vital good and services on which humans depend. Benefits of healthy rivers include:

ECOLOGICAL BENEFITS

Biodiversity

Freshwater systems support ecosystem viability for both land and terrestrial based species. Free-flowing, or undammed, rivers provide intact habitats, which support native species diversity.[13]

Unhindered transportation of nutrients

As sediments and nutrients are carried along the river's course, some are deposited along the banks and some are carried out to sea where they contribute to the health of coastal ecosystems.[14] Intact rivers can also facilitate the transportation of nutrients upstream in the bodies of anadromous fish, such as salmon, when they migrate upstream to spawn.[19]

Pollution control

Rivers transport and remove pollutants which can build up in a watershed. When the river flow is altered, pollutants can become trapped in the sediments behind dams leading to areas of high pollutant concentration.[16] Additionally, free-flowing rivers support populations of species which improve water quality such as freshwater mussels.[17]

Climate change adaptation

When rivers are barrier free, they work as natural corridors for fish and other species, allowing them to relocate to conditions more suitable for their survival.[14] Furthermore, large free-flowing rivers with healthy surrounding ecosystems are better able to temper increasing changes in flow regimes expected to occur with climate change.[15]

THE VALUE OF HEALTHY RIVERS CONT'D

Healthy food supply

Healthy river ecosystems provide the necessary habitat for freshwater fisheries. Healthy fish populations support communities as well as water and land-based wildlife (e.g. brown and grizzly bears) reliant on the fish as a food source.

Ecosystem Services

Many of the benefits derived from healthy rivers and freshwater ecosystems provide services to society that would otherwise be very costly to replicate. These services provided are commonly known as ecosystem services.[23] The value provided by the provision of non-market goods is harder to quantify, but must be considered when development projects are proposed.

Cultural values

Rivers play an important role in Canadian national identity, having created a sense of place and "deeply seated symbolic connections that set out the defining characteristics" of the country.[22] The religious, spiritual, aesthetic and poetic values of rivers are best maintained when they remain wild and unthreatened by human activities.

Vibrant industries

Healthy rivers support tourism such as recreational fisheries, wildlife viewing and paddling industries.[17] Additionally, these rivers can support high value commercial fisheries, providing livelihoods for the people who live around them.[21]

DOES SIZE MATTER?

When it comes to environmental questions, the distinction between "large" and "small" hydropower projects may be misleading. While "small hydro" is often seen as a more sustainable form of energy production than large storage facilities, these hydropower projects are not necessarily benign.[25] Ultimately, the sustainability of a hydropower project is not merely a question of its size but how much it alters the surrounding environment. This depends on where the project is situated, how it is operated and what other facilities exist on the river.

CONCLUSIONS

Because of the Government of Canada's commitment to meeting the Paris accord and the reliance on hydro development to transition to a low carbon economy, responsible development of Canada's freshwater resources for generation of electricity will become one of the most contentious environmental issues in the next decade.

The urgent need to move away from carbon-intensive fossil-fuels has rapidly increased the demand for green, renewable sources of energy. Due to our relative wealth of freshwater resources but at risk watersheds, Canada has a unique opportunity to provide hydropower to meet this energy demand in North America. Renewable energy must be developed in such a way as to ensure Canada's watersheds aren't further threatened or where significant free-flowing river systems are intact, we maintain.

Using the tools produced by WWF-Canada, hydropower development can occur in ways that are less damaging to our freshwater ecosystems. Our Watershed Reports paint a picture of the overall health of the watershed, and the current level of impact from dams. Our Renewables for Nature tool allows project proponents to identify areas of high renewable energy potential while avoiding areas of high conservation value. And our Wild Rivers report identifies ten magnificent rivers that should remain free from hydropower development, as well as lays the groundwork for spatial analyses to identify the scenarios which maximize energy production while minimizing impacts to river health.

Canada is already one of the world's leading producers of hydroelectricity, yet significant potential remains to expand our generating capacity to meet both domestic and international demands for renewable energy. Canada must ensure that our precious freshwater ecosystems are not casualties of our hydropower industry. However, if done correctly, our hydropower industry could help transition North America to the low carbon future we all desire.

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Sources

1. Mass, C. 2010. Ontario's water-energy nexus: will we find ourselves in hot water…or tap into opportunity? *POLIS Project on Ecological Governance*. Retrieved from https://dspace.library.uvic.ca:8443/bitstream/handle/1828/7967/Ontario's%20Water%20Energy%20Nexus_final.pdf?sequence=1&isAllowed=y

2. Statistic Canada. 2017. Human activity and the environment 2016. Retrieved from http://www.statcan.gc.ca/pub/16-201-x/16-201-x2017000-eng.pdf

3. Siddiqi, A. and Diaz Anadon, L. 2011. The water-energy nexus in Middle East and North Africa. *Energy Policy*, 39: 4529-4540.

4. Mimoune Hamiche, A., Boudghene Stambouli, A. and Samir Flazi. 2016. A review of the water-energy nexus. *Renewable and Sustainable Energy Reviews*, 65: 319-331.

5. Hoyle, B. 2008. The Energy-Water Nexus: Deja-Vu All Over Again? *Nature Reports Climate Change*, 2: 46-48. Retrieved From Http://Www.Nature.Com/Climate/2008/0804/Full/Climate.2008.22.Html

6. Renzetti, S., Dupont, D. P. and Wood, C., 2011. Running through our fingers: how Canada fails to capture the value of its top asset. *Blue Economy Initiative*. Retrieved from http://www.gordonfoundation.ca/blue-economy.ca/sites/default/files/reports/64331%20BEI%20Report%20E%20V4.pdf

7. Environment and Climate Change Canada. 2016. Canada's mid-century long-term low-greenhouse gas development strategy. Retrieved from http://unfccc.int/files/focus/long-term_strategies/application/pdf/canadas_mid-century_long-term_strategy.pdf

8. Bordeleau, S. 2011. Where Canada's surplus energy goes. CBC News. Retrieved from http://www.cbc.ca/news/canada/where-canada-s-surplus-energy-goes-1.1109321

9. Hydro Quebec. 2016. Annual Report 2016. Retrieved from http://www.hydroquebec.com/publications/en/docs/annual-report/annual-report-2016.pdf

11. Opperman, J., Grill, G., Hartmann, J., 2015. The power of rivers. Finding the balance between energy and conservation in hydropower development. The Nature Conservancy. Retrieved from https://thought-leadership-production.s3.amazonaws.com/2015/11/02/15/49/08/13e98158-02ce-4fcc-bd61-ce1ba924424d/power-of-rivers-report.pdf

13. Reidy Liermann, C., Nilsson, C., Robertson, J., Ng, R.Y. 2012. Implications of dam obstruction for global freshwater wish diversity. *BioScience* 62(6): 539-548

14. WWF, 2006. Free-flowing rivers: economic luxury or ecological necessity? Retrieved from http://www.wwf.se/source.php/1120326/free

15. Chezik, K. A., S. C. Anderson, and J. W. Moore .2017. River networks dampen long-term hydrological signals of climate change. *Geophysical Research. Letters*. 44, doi:10.1002/2017GL074376.

16. Stanley, E.H., Doyle, M.W. 2003. Trading off: the ecological effects of dam removal. *Frontiers in Ecology and Environment.* 1(1):15-22.

17. Auerbach, D.A., Deisenroth, D.B., McShane, R.R., McCluney, K.E., LeRoy Poff, N. 2014. Beyond the concrete: Accounting for ecosystem services from free-flowing rivers. *Ecosystem Services* 10:1-5.

19. Nilsson, C., & Svedmark, M. 2002. Basic principles and ecological consequences of changing water regimes: riparian plant communities. *Environmental Management* 30: 468-480.

21. Hoeinghaus, D.., Agostinho,A.A., Gomes,L.C., Pelicice,F.M., Okada,E.K., Latini,J.D., Kashiwaqui,E.A.L., Winemiller,K.O. 2009. Effects of river impoundment on ecosystem services of large tropical rivers: embodied energy and market value of artisanal fisheries. *Conservation Biology* 23:1222–1231.

22. Noel, Lynn E. (Ed.) 1995. Voyages: Canada's Heritage Rivers. Breakwater Books.

23. Millennium Ecosystem Assessment, 2005. Ecosystems and human well-being: Synthesis. Island Press, Washington, DC.

25. Islam, M., Fartaj, A., D. S.-K. Ting, 2004. Current utilization and future prospects of emerging renewable energy applications in Canada. *Renewable and Sustainable Energy Reviews*, 8: 493-519.