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Why Big Dams Are the Wrong Response to Climate Change

A Critique of the IPCC Special Report
on Renewable Energy Sources and Climate Change Mitigation
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June 14, 2011

Summary

The IPCC published its Special Report on Renewable Energy Sources and Climate Change Mitigation on June 14, 2011.[1] The report found that renewable energy "has a large potential to mitigate GHG emissions." Its most optimistic scenario concludes that renewable energy sources could contribute 43% of the world's primary energy supply by 2030, and 77% by 2050. Employing these energies can lead to cumulative greenhouse gas savings equivalent to 220-560 gigatonnes of carbon dioxide (Gt CO2eq) between 2010 and 2050. The biggest increases are expected to come from bioenergy, direct solar and wind energy.[2]

The technical potential of renewable energy is higher than all projections regarding future energy demand. The IPCC report estimates that for the four scenarios it analyzed in detail, investments of $2,850 to $12,280 billion will be needed between 2011 and 2030. While large, these sums amount to less than 1% of global GDP during this period. Investing them would allow stabilizing atmospheric concentration of CO2 at 450 ppm. It would have the added benefit of promoting energy access for the 1.4 billion people who currently live without access to electricity.[3]

The value of the IPCC report is weakened by the strongly biased treatment of hydropower, which the report included among renewable energy sources irrespective of project size and impacts. At least half of the lead authors of the hydropower chapter are not independent scientists, but have a vested interest in the promotion of hydropower. This creates a conflict of interest, which is reflected throughout the report. The hydropower chapter of the new report at time reads like a marketing brochure of the hydropower industry. It ignores or misrepresents the findings of the independent World Commission on Dams, and glosses over the findings of many scientific reports which came to conclusions that are not convenient for the hydropower industry.

International Rivers strongly supports policy measures that can promote a rapid expansion of renewable energy sources. But these measures need to be based on a holistic understanding of sustainability. Large hydropower projects are not a renewable source of energy, can produce significant amounts of greenhouse gas emissions, and as a recent World Bank report has warned,

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[1] See http://srren.ipcc-wg3.de/report

[2] See Ottmar Edenhofer et al. (2011), Summary for Policy Makers, IPCC Special Report on Renewable Energy Sources and Climate Change Mitigation, pp. 18, 20, 22.

[3] Ibid., pp. 16, 24.

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are not resilient to the vagaries of climate change. Unlike truly renewable energy sources, such projects also have massive social impacts. The scarce resources devoted to the promotion of renewable energy should not be squandered on technologically mature, environmentally destructive and non-renewable forms of energy such as large hydropower.

Conflict of interest

We have high respect for the scientific rigor and independence of the IPCC. We were surprised and dismayed to see that the preparation of the new report's chapter on hydropower was left to a group of authors of whom a majority has a vested interest in the promotion of hydropower. The nine lead authors include representatives of two of the world's largest hydropower developers, a hydropower consultancy, and three agencies promoting hydropower at the national level.

We recognize the need to have hydropower expertise on the panel and do not question the personal integrity of the authors. Yet it is not appropriate for IPCC to commission individuals with a business or institutional interest in the subject matter to prepare a report that is supposed to be unbiased and independent. The resulting conflict of interest weakens the quality of the report's hydropower section.

Inappropriate definition of renewable energy

The IPCC Special Report considers hydropower as a renewable form of energy irrespective of project size and impacts. This is not consistent with standard practice in international policy and debate. Across the world, policy tools – for example portfolio standards, feed-in tariffs, and tax credits – only tend to include *small* hydropower projects as a form of renewable energy. Small hydropower is generally defined as projects of less than 10 MW (with the exception of up to 25 MW in India, less than 30 MW in Brazil and the United States, and less than 50 MW in China).[4]

There are good reasons why large hydropower should not be considered a form of renewable energy. While the flow of water is renewable, the ecosystems that are destroyed by damming rivers are not. Dams change the chemistry, temperature, turbidity and nutrient load of rivers. As the World Commission on Dams, the Millennium Ecosystem Assessment and the 3rd Global Biodiversity Outlook have documented, they have serious and irreversible impacts on freshwater ecosystems. Dams are often rendered unviable by the silting up of their reservoirs, and starve deltas of sediments. Not least due to such changes, freshwater is affected by a much higher loss of species than terrestrial and marine ecosystems. Dams and reservoirs can also emit significant amounts of greenhouse gases. Their contribution to climate change has been estimated to be of similar size as the civil aviation industry (see below).

Finally, dams have massive social impacts. According to the World Commission on Dams (WCD), such projects have displaced an estimated 40-80 million people, and have impoverished most of them in the process. As the WCD notes, "for millions of them displacement has

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[4] REN 21, Renewables 2010 Global Status Report, pp. 68f.

essentially occurred through official coercion."[5] According to another recent study, dams have likely impacted 472 million people downstream of their reservoirs.[6]

The hydropower chapter of the IPCC report largely ignores the findings of the World Commission on Dams and the Millennium Ecosystem Assessment on the social and environmental impacts on dams. It focuses on the mitigation of environmental impacts, even though the WCD found that "efforts to mitigate the impacts on fauna have met with little success," and that efforts to avoid or minimize impacts were "more successful."[7] The IPCC report in turn summarizes (or rather, misrepresents) the WCD's findings on the large-scale displacement and impoverishment caused by dams as follows: "Restoration and improvement of living standards of affected communities is a long-term and challenging task that has been managed with variable success in the past (WCD, 2000)."[8]

Greenhouse gas emissions from reservoirs

Because of decomposing vegetation in the reservoir area, the detritus washed down from their watersheds, and the seasonal flooding of the reservoir fringes, hydropower projects emit greenhouse gases (CO_2 and, particularly, methane) when reservoirs are first created and throughout their lifetimes. These emissions are largest for shallow tropical reservoirs.

The IPCC report correctly states that the uncertainty in the quantification of reservoir emissions is high, but then goes on to largely ignore this significant source of greenhouse gases (GHG). By excluding the emissions from land-use changes – including the impoundment of reservoirs – the report claims that the lifecycle GHG emissions from hydropower are lower than those of wind, solar, geothermal and all other renewable energy sources.[9] It states that the majority of the estimates for the lifecycle GHG emissions for hydropower projects that it considered "cluster between about 4 and 14 g CO_2eq/kWh," but admits that "reservoir hydropower has been shown to potentially emit over 150 g CO_2eq/kWh."[10]

The IPCC report ignores important empirical research on reservoir emissions. According to research by Philip Fearnside of the Brazilian National Institute for Research on the Amazon, the reservoirs of the Tucurui, Carua Una and Samuel hydropower projects in Brazil emit greenhouse gases of 1751-2704 g CO_2eq per kWh.[11] These emissions are approximately twice as high as the GHG emissions of modern coal-fired power plants with the same electricity output. Fearnside

[5] Dams and Development (2000), the Report of the World Commission on Dams, p. 106.
[6] Brian Richter et al. (2010), Lost in development's shadow: The downstream human consequences of dams, in: Water Alternatives, Vol. 3, Issue 2.
[7] Dams and Development, pp. 75, 90.
[8] Arun Kumar et al. (2011), Hydropower. In: IPCC Special Report on Renewable Energy Sources and Climate Change Mitigation, 2011, p. 32.
[9] Ottmar Edenhofer et al., p. 17
[10] Arun Kumar et al., p. 44
[11] See Philip M. Fearnside, (2004), Hydroelectric dams in Amazonia as contributors to global warming: The controversy heats up. In: Anais: III Conferência Científica do LBA Experimento de Grande Escala da Biosfera-Atmosfera na Amazônia, Academia de Tênis Resort, Brasília, p. 88; and ibid. (2005), Brazil's Samuel Dam: Lessons for Hydroelectric Development Policy and the Environment in Amazonia, Environmental Management 35:1

calculated the GHG emissions from Brazil's Balbina reservoir to be about ten times as high as the emissions of coal-fired power plants, but excluded this project from his research as an outlier.

While GHG emissions from shallow tropical reservoirs such as Balbina are highest, emissions from reservoirs in temperate zones can also be significant. Researchers of the Swiss Federal Institute of Aquatic Science and Technology (EAWAG) measured the emissions from Wohlensee, a run-of-the-river hydropower project in Switzerland, at 119 g CO2eq per kWh.[12] Both Fearnside's and EAWAG's measurements are conservative in that they include neither the initial spike of emissions when the reservoirs were flooded nor the emissions caused by the construction of the hydropower plants and their auxiliary infrastructure.

A team of researchers coordinated by Ivan Lima of Brazil's National Institute for Space Research estimated the total methane emissions from large dams in a peer-reviewed article in 2007 at 104 million tons per year.[13] This amounts to more than 4% of the total warming impact of human activities. Lima's research included reservoirs that were built for non-hydropower purposes, but does not include the emissions generated by dam construction. If Ivan Lima's research is correct, reservoirs emit about the same amount of greenhouse gases as the civil aviation industry, which the IPCC has estimated is responsible for around 4% of anthropogenic climate change.[14] The Scientific and Technical Advisory Panel of the Global Environment Facility, which is administered by the World Bank, has also confirmed that "GHG emission from reservoirs is an important source of GHG emissions globally."[15]

In a significant omission, the IPCC's hydropower chapter does not reference the research by Ivan Lima or EAWAG, or Philip Fearnside's paper from 2004.

Not resilient to climate change

The mandate of the IPCC Special Report was confined to assessing the contribution of renewable energy to the *mitigation* of climate change. It largely neglected the reverse impacts of climate change on hydropower and other sources of energy, and what role these technologies can play in the *adaptation* to climate change.

The assumption that future streamflow patterns will mirror those of the past no longer holds true. River flows will change significantly as temperatures increase, glaciers and snow packs melt, and precipitation patterns are drastically altered. More frequent droughts will make many hydropower projects uneconomic, while more extreme weather events will make many dams

[12] Tonya Del Sontro et al. (2008), Wohlensee: Lake Flatulence and Global Warming, Eawag – Annual Report 2007
[13] Ivan B.T. Lima et al. (2007), Methane Emissions from Large Dams as Renewable Energy Resources: A Developing Nation Perspective, Mitigation and Adaptation Strategies for Global Change, published on-line March 2007
[14] See IPCC, Aviation and the Global Atmosphere, www.ipcc.ch/ipccreports/sres/aviation/index.php?idp=64, viewed on June 1, 2011.
[15] STAP Scientific and Technical screening of the Project Identification Form (PIF), GEF Project ID: 4144, February 9, 2010, p. 1.

unsafe. Extreme weather events will also increase siltation and reduce the useful lifetime of many dams.[16]

Large hydropower projects are potentially highly vulnerable to changes in precipitation and streamflows. A recent World Bank ESMAP report states: "Heavy reliance on hydropower creates significant vulnerability to climate change and is a feature that many low- and middle-income countries have in common."[17] The report summarizes the impacts on the hydropower sector as "reduced firm energy, increased variability, increased uncertainty."[18] It warns that "long-lifespan infrastructure, such as hydropower plants, is generally less adaptable to changes in actual facilities whereas short-lifespan infrastructure can be replaced in the long term as the climate changes."[19] And in order to "increase the flexibility of the system and its resilience to more variable climatic conditions," the report recommends: "An adaptation response may require a policy decision to diversify away from hydropower." – The World Bank ESMAP report was ignored by the authors of the IPCC's hydropower chapter.

Recent research has also produced conclusive evidence that reservoirs can alter local climates and change rainfall patterns. US researchers showed that reservoirs can for example intensify storms in their basins. Faisal Hossain et al. found that "for southern Africa and southern Europe, dams appeared to have increased extreme precipitation (P99 events) by as much as 20% during the last century."[20]

The uncertainties of climate change call for a nimble, decentralized and flexible adaptation of global energy and water sectors.[21] Slow, lumpy investments in large dams are not resilient to the vagaries of climate change. The drastic impacts of the current droughts in large parts of China, Western Europe and East Africa on hydropower generation are a stark reminder that building large hydropower plants, and increasing hydro-dependency, are not an appropriate adaptation to the uncertainties of climate change.

The IPCC report's hydropower chapter takes a birds' eye view of the hydrological impacts of climate change at the global and regional level, but glosses over the serious uncertainties on the level of individual watersheds. It points to climate projections which show "increases in globally averaged mean water vapour, evaporation and precipitation over the 21st century," and concludes that "the overall impacts of climate change on the existing global hydropower generation may be expected to be small, or even slightly positive."[22]

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[16] For more information, see www.internationalrivers.org/en/node/1579.

[17] World Bank ESMAP, Climate Impacts on Energy Systems, Key Issues for Energy Sector Adaptation, Jane Ebinger and Walter Vergara, 2011, p. 93.

[18] Ibid., p. 48.

[19] Ibid., p. 58

[20] Faisal Hossain, I. Jeyachandran and R. Pielke Sr. (2010). Dam Safety Effects due to Human Alteration of Extreme Precipitation, Water Resources Research, 46, W03301, p. 3.

[21] See Zbigniew W. Kundzewicz et al. (2007), Freshwater resources and their management. Climate Change 2007: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change, pp. 173-210

[22] Arun Kumar et al., pp. 11, 14.

The report does note that "results also indicated substantial variations in changes in energy production across regions and even within countries."[23] And it states that "an increase in climate variability, even with no change in average runoff, can lead to reduced hydropower production unless more reservoir capacity is built and operations are modified to account for the new hydrology that may result from climate change."[24]

The IPCC report's recommendation to build more hydropower capacity in response to increased hydrological uncertainty may reflect wishful thinking of the hydropower operators. It ignores the economic costs of hydrological uncertainty, the risks such an approach would entail for countries that may already be over-dependent on hydropower, and the environmental impacts on freshwater ecosystems that are reeling under the impacts of climate change.

Conclusion

The hydropower chapter of the new IPCC report reflects a systematic bias towards the interests of the hydropower industry. It ignores, glosses over or misrepresents the findings of key research on the environmental and social impacts of large dams and their vulnerability to climate change, including the knowledge base of the World Commission on Dams, the most thorough and independent evaluation of the impacts of dams that has ever been undertaken.

Combating climate change must be part of a holistic effort to protect the world's ecosystems. We cannot afford to sacrifice the planet's arteries to save her lungs. Many large hydropower projects have serious and irreversible ecological impacts. They are not resilient to the vagaries of climate change, and if located in the topics, can produce large amounts of greenhouse gas emissions. Hydropower has not seen major technological breakthroughs in decades, and its role cannot be significantly scaled up beyond the current level.

As the IPCC report demonstrates, renewable energy sources can make a big contribution to global energy supply. Large amounts of public funds will be required to achieve a breakthrough of renewable energy at the necessary scale. These funds should be invested in truly renewable energy sources, and not squandered on large hydropower projects.[25]

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[23] Ibid., p. 14.
[24] Ibid., p. 12.
[25] See www.internationalrivers.org/files/12Reasons.pdf for an elaboration of this argument.