Twelve Reasons to Exclude Large Hydro from Renewables Initiatives

A MAJOR EXPANSION OF LARGE HYDRO WILL HARM SUSTAINABLE DEVELOPMENT

1. Large hydro does not have the poverty reduction benefits of decentralized renewables

2. Including large hydro in renewables initiatives would crowd out funds for new renewables

3. Promoters of large hydro regularly underestimate costs and exaggerate benefits

4. Large hydro will increase vulnerability to climate change

5. There is no technology transfer benefit from large hydro

A MAJOR EXPANSION OF LARGE HYDRO WILL HARM PEOPLE AND ECOSYSTEMS

6. Large hydro projects have major negative social and ecological impacts

7. Efforts to mitigate the impacts of large hydro typically fail

8. Most large hydro developers and funders oppose measures to prevent the construction of destructive projects

9. Large reservoirs can emit significant amounts of greenhouse gases

A MAJOR EXPANSION OF LARGE HYDRO WILL HARM ENERGY SECURITY

10. Large hydro is slow, lumpy, inflexible and getting more expensive

11. Many countries are already over-dependent on hydropower

12. Large hydro reservoirs are often rendered non-renewable by sedimentation

Eradicating poverty and reducing global warming are two of the biggest challenges facing the world in the 21st century. The urgent need to address these challenges has led to various international initiatives to promote the use of renewable energies. While the overall aim of these initiatives should be strongly supported, they could be counterproductive if – as the large hydro industry is advocating – they are turned into instruments to promote hydropower megaprojects.

There are three main aims of recent renewable energy initiatives:

- To support sustainable development in the developing world and, in particular, to help meet the UN's Millennium Development Goals[1]
- To reduce the environmental impact of energy production and consumption
- To enhance energy security

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IRN would like to thank Oxfam America and Friends of the Earth International for their financial contributions toward this publication.

As this paper explains, large hydropower projects fail to meet all three of these criteria. Large hydro also threatens to capture the bulk of special funds aimed at promoting renewables, so hindering the spread of clean and sustainable technologies. It is thus imperative that large hydro be excluded from any initiatives to promote renewables, in particular from the Johannesburg Renewable Energy Coalition, the "Renewables 2004" conference in Bonn, and the Kyoto Protocol's carbon trading schemes.

Background

The global push for renewables

The most prominent global initiatives to promote renewables are the Johannesburg Renewable Energy Coalition (JREC) and an intergovernmental conference to be held in Bonn, Germany in June 2004. JREC was launched by the European Union at the World Summit on Sustainable Development (WSSD) in Johannesburg in September 2002. As of June 2003, almost 80 countries had joined the Coalition.

Chancellor Gerhard Schröder announced at the WSSD that Germany would host a major conference in 2004 to review international progress on meeting renewables targets. The Bonn "Renewables 2004" conference is billed as "a first major milestone for reviewing the Coalition progress." Regional preparatory meetings are planned for Brazil, India, Kenya and Berlin.

Development and environment benefits of decentralized renewables

Over two billion people in the developing world, mostly in rural areas, have no access to modern energy services. Eighty percent of sub-Saharan Africans have no electricity. Access to basic, clean energy services – including non-electrical technologies such as biogas, improved cooking stoves and mini-hydro plants used for mechanical power – is essential for poverty eradication. These services can also provide major health and literacy benefits. At the same time, the world faces a climatic catastrophe if present fossil fuel consumption trends continue.

Fortunately there are a raft of new renewable technologies (see box) which can **provide clean, appropriate and efficient energy to the world's poorest, helping to eradicate poverty without costing the earth.** Realizing the potential of these "new renewables" is vital if we are to achieve the UN's Millennium Development Goals of halving extreme poverty and hunger by 2015 and reversing environmental degradation.

Photo: Shannon Graham

Rural Kenyan woman holding her new PV panel.

Lobbying for large hydro

At the WSSD, governments with major hydropower development plans pushed hard to have large hydro recognized as renewable. They succeeded in inserting the wording "renewable energy technologies, hydro included" into a sentence on energy diversification in the summit's Plan of Implementation.[2] The large hydro industry repeatedly stresses that the WSSD wording does not

New Renewables

Citizens United for Renewable Energy and Sustainability (CURES), an international NGO network formed in October 2003 in preparation for the "Renewables 2004" conference, defines new renewables as including: "modern biomass, **WCD-compliant small (up to 10MW) hydro (mechanical as well as electric),** geothermal, wind, all solar, tidal, wave and other marine energy. Modern biomass includes improved use of traditional biomass such as 'smokeless' efficient cookstoves as well as electricity generation, heat production and liquid fuels from carbon neutral and low input, sustainable sources of biomass."

Source: www.ee-netz.de/cures.html

differentiate between large and small hydro – although this distinction is usual in discussion of renewable energies. The International Hydropower Association, the World Bank, and other promoters of large hydro are now using the WSSD wording to lobby for large hydro to benefit from renewables initiatives.[3]

Small vs large hydro

Every hydro plant is unique in its design, location and impacts. While there is no directly proportional relationship between the installed capacity of a hydro plant and its impacts, in general one can expect higher impacts as the size of the project increases.

Small hydro can, if responsibly implemented, be environmentally and socially low-impact and provide many of the benefits of new renewables, in particular providing power and related development benefits to dispersed rural communities.

If badly implemented, however, without regard to community needs or its impacts on rivers and streams, small hydro can replicate many of the negative consequences of larger schemes. The cumulative impacts of multiple small hydro schemes on small watersheds are of particular concern. It is thus imperative that small hydro schemes be carefully evaluated on a case-by-case basis.

The site-specific nature of hydro means that it has been difficult to reach international agreement on a size limit for small hydro. According to the International Association for Small Hydro, however, a limit of up to 10MW capacity "is becoming generally accepted." The European Small Hydro Association and the International Energy Agency's Renewable Energy Working Party also define small hydro as less than 10MW. It is therefore logical to use this upper limit of 10MW in efforts to promote renewables. To ensure that small hydro projects have low impacts and meet community priorities it is imperative that all small hydro schemes are planned, built and operated in line with the recommendations of the World Bank/IUCN-sponsored World Commission on Dams.

A Note on Global Dam Statistics

No estimates have been done for the cumulative impacts of the world's large hydro projects, although estimates are available for the global impacts of the world's large dams. While large and small hydro are defined according to their generating capacity, large and small dams are defined according to their physical size. The key criterion for a large dam is that it is at least 15 meters high. The great majority of large hydro plants include a large dam – but the great majority of large dams were built for purposes other than electricity generation so are not hydro projects.

According to dam-industry statistics used by the World Commission on Dams, around 5,300 (11%) of the world's 48,000 large dams were built solely for hydropower. A further 13,300 (28%) were built for more than one function. Many of these multipurpose dams, especially the larger ones, have a hydropower function although the exact percentage has not been calculated. Hydropower is almost always a component of the biggest dams that have displaced the most people and have the greatest environmental impacts.

Twelve Reasons to Exclude Large Hydro from Renewables Initiatives

A major expansion of large hydro will harm sustainable development

1 Large hydro does not have the poverty reduction benefits of decentralized renewables

The UN Commission on Sustainable Development has identified access to sustainable energy services as an essential element of sustainable development. The Commission states that to implement the UN's Millennium Development Goal of halving by 2015 the proportion of people living on less than a dollar per day, "access to affordable energy services is a prerequisite."

Among the major benefits of renewables such as wind, solar, biogas and smaller hydro plants is they can be built as "distributed power" – small, geographically dispersed units of capacity that are built close to the end user. This minimizes transmission costs and power losses and grid reliability concerns and spreads out the local economic development benefits of project construction and access to power. Distributed power enables new capacity to be added incrementally in step with rising demand, has lower capital investment requirements and is quicker to build than big, centralized projects.

These distributed benefits, as well as the ability of new renewables and small hydro to use locally available resources, mean they are often the best option for providing power to the low-income, dispersed populations of rural areas in developing countries. Four-fifths of the two billion people without access to electricity and other modern energy services live in these areas.

The nature of large hydro – capital-intensive, slow to build, centralized, dependent on large centers of demand and long, expensive and often inefficient transmission lines – means it is particularly inappropriate for meeting the needs of the unserved and rural areas.

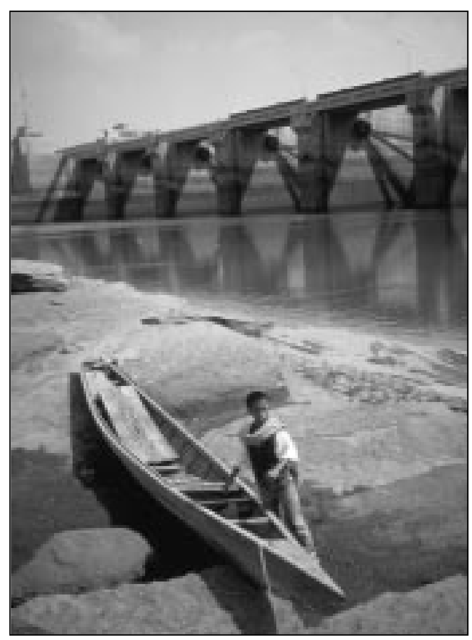
In many low-income countries, especially in Africa, power ministries, supported by foreign donors, have devoted large proportions of government budgets, aid funds and institutional resources and attention to building and managing large hydro projects. Meanwhile, distribution networks have been starved of investment. Around 4% of the land area of Ghana is flooded under the world's most extensive reservoir – yet 70% of Ghanaians have no access to electricity. The world's second largest reservoir by volume, Kariba, is shared by Zambia and Zimbabwe. Yet only a fifth of Zambians and a quarter of Zimbabweans have electricity. Paraguay owns half of the world's most powerful hydropower plant, Itaipú, yet almost half of Paraguayans have no electricity.

Because of their massive costs, huge hydro projects have entrenched corruption among elites in hydro-dependent countries and in many cases, especially in Latin America, are responsible for a major proportion of these countries' foreign debt. **In all but the largest developing countries, the planning and implementation of large hydro projects are dominated by foreign consultants and contractors. The low-income majorities in these countries see few if any benefits from large hydro projects.**

2 Including large hydro in renewables initiatives would crowd out funds for new renewables

Large hydro plants are among the most expensive infrastructure projects on the planet, with major projects costing in the billions and even tens of billions of dollars. Including subsidies for large hydro in renewables schemes could thus consume the lion's share of funds available to promote renewables.

The project pipeline for the Kyoto Protocol's Clean Development Mechanism illustrates how large hydros could capture the bulk of funds available to promote renewables. A single hydro project in Mozambique, the 1,300MW Mphanda Nkuwa dam, is proposing to sell seven million tonnes of carbon credits per year under the CDM.[4] Over 21 years (the maximum period over which supposed emission reductions can be claimed) Mphanda Nkuwa would generate 147 million credits.



Thailand's Pak Mun Dam has harmed the livelihoods of thousands of fishing families.

At current carbon prices of $3-5/tonne, Mphanda Nkuwa over 21 years would absorb $441-735 million of funds available to buy emission reduction credits. By comparison the World Bank's Prototype Carbon Fund, the largest single institutional purchaser of carbon credits, has a maximum of $180 million to fund carbon purchases.

The 24 new renewables projects in the process of applying for credits under the CDM would together generate 17 million credits over 21 years. Extrapolating from the average size of these renewables projects implies that the Mphanda Nkuwa dam alone would consume credits which could otherwise support 206 new renewables projects.

Photo: Patrick McCully

Resettlement site for Sardar Sarovar Dam, India.

3 Promoters of large hydro regularly underestimate costs and exaggerate benefits

The consistent underestimation of costs and exaggeration of benefits of large hydro projects makes economically unviable projects appear viable, and gives an unfair advantage to large hydro when its viability is being compared to that of other generation options.

World Bank research published in 1996 found that inflation-adjusted cost overruns on 66 hydropower projects funded by the Bank since the 1960s averaged 27%. This compares with average cost overruns on World Bank thermal power projects of 6% and on a sample of over 2,000 development projects of all types of 11%.[5]

Multipurpose projects, many of which include hydro components, appear to have even greater overruns than single purpose hydro projects: the World Commission on Dams found an average overrun of 63% on 45 multipurpose large dams studied. There is no indication that the industry's ability to estimate costs is getting any better – the most recent of the dams studied in detail by the WCD, Thailand's Pak Mun large hydro project commissioned in 1994, had a 68% overrun.

The numbers of people requiring resettlement or compensation for lost lands, homes, jobs and sources of livelihood have also been regularly underestimated. An internal World Bank review, published in 1994, looked at a group of projects that according to planning documents would cause the displacement of 1.34 million people (63% of them by dams). The review estimated that the actual number evicted was almost two million.[6]

The World Bank's 1994 resettlement review and the WCD's findings show a consistent pattern of excluding important groups of people from estimates of project social costs. The numbers of these uncompensated affected groups can be greater than those officially counted as "affected." **The WCD states that many of the complex negative social impacts of dams "are – even today – often not acknowledged or considered in the planning process and may remain unrecognized during project operations."**

While costs of all types are commonly far higher than predicted, benefits have been shown to be lower. Of the 63 large dams with a hydropower component reviewed by the WCD, 35 generated less power than predicted. Of the dams that met their generation targets, a quarter were only able to do so at the cost of increasing their originally planned installed capacity. (The WCD's figures are likely to give a conservative estimate of dam underperformance as the majority of data used in its analyses came from dam operators and were not independently verified).

The WCD analyzed project evaluation reports carried out by the multilateral development banks. Of 20 large hydro dams evaluated, 11 failed to meet their economic targets. Nine of the 20 had an economic internal rate of return (EIRR) under 10%. Infrastructure projects in developing countries are usually only judged acceptable if they have an EIRR exceeding 10-12%. The WCD found that multipurpose projects tend to fall even further behind their economic targets than single purpose projects.

Development bank evaluations are undertaken at project completion or just a few years afterwards. They thus incorporate the effects of cost overruns and initial operating results, but not the long-term underperformance that the WCD has identified. They are also likely to reflect the inherent biases of self-evaluations. Furthermore, the evaluations ignore many of the negative social and environmental impacts of the projects.

Large hydro promoters argue that their projects would look more attractive to investors and society in general if the non-hydro functions of reservoirs were included in project assessments. Yet as the WCD has shown, multipurpose projects show even worse economic performance than projects built only for hydropower. One reason is conflicts between the different purposes of the project (for example between needing to store water for irrigation, but release it for power generation). Another reason is the extremely poor technical and economic performance of large dam-based irrigation and water supply schemes.[7]

Operators of multipurpose projects rarely capture any revenue from flood control benefits they might provide to communities downstream. However they are also invariably immune from paying the costs of the increased flood damages that dams regularly cause due to reasons including misoperation and the inability to hold back extremely large floods.

The rapid development of new renewables means they are now frequently a better option for power generation than large hydro. Similarly, changing technologies and attitudes mean that alternatives to large dams are now frequently the best options for irrigation, water storage and supply, and flood management.

4 Large hydro will increase vulnerability to climate change

The urgent need to lessen the vulnerability of societies to a changing climate is now receiving increasing attention from governments and international agencies. It is likely that the most serious consequence of global warming for human society will not be hotter weather, but the changes in rain and snowfall patterns that a warmer world will bring. We are already experiencing an unprecedented number and intensity of extreme floods and droughts and there is little doubt that much worse is on the way.

Large hydro plants are built on the assumption that past hydrological regimes can be used to accurately predict future power production and the size of floods that could threaten dam safety. This has always been a dubious assumption – the main reason hydro plants regularly underperform is that developers have failed to properly allow for droughts in their power projections – but it is now clearly invalid. The future will bring extremes of drought and flood outside the historical record, continually worsening as the climate warms, and extremely difficult to predict.

Large hydro developers do not currently take climate change into account in their plans. If they were to do so, dams would have to have much greater capacities to safely pass high floods, and projections of power generation would have to allow for the probability of new extremes of drought. These factors would increase the costs and reduce expected benefits from hydro, thus reducing their expected economic viability.

Droughts bring much economic and social hardship, especially to poor countries that are heavily dependent on agriculture. Hydro dependency means that droughts also cause power shortages at a time when agriculture-based economies are already likely to be suffering food shortages and lower export earnings. **Building more large hydro will only make it more difficult to adapt to a changing climate.**

5 There is no technology transfer benefit from large hydro

A key argument for global renewable funds and carbon trading mechanisms is that these can promote the transfer of new and improved technologies from North to South. This argument does not apply to large hydro as the technology is already well established in Southern countries and there have been no significant technological advances in recent decades and none are expected.

Promoters of renewables also argue that government support is needed to help scale up production and bring down the unit costs of new technologies. This also does not apply to large hydro, which was already a mature technology in the first half of the 20th century.

A major expansion of large hydro will harm people and ecosystems

6 Large hydro projects have major negative social and ecological impacts

According to the World Commission on Dams, the benefits derived from dams "have been considerable." Yet "in too many cases an unacceptable and often unnecessary price has been paid to secure these benefits, especially in social and environmental terms, by people displaced, by communities downstream, by taxpayers and by the natural environment." The WCD calculated that this "unacceptable" price includes:

- Forty to eighty million people forcibly evicted from their homes to make way for the world's 48,000 large dams.
- Many of the displaced received no form of compensation and "where compensation was provided it was often inadequate," so that "those who were resettled rarely had their livelihoods restored."
- The number who have lost land, livelihoods and access to natural resources, and who have suffered ill-health because of downstream and other indirect impacts of dams is unknown, but certainly in the millions.
- "Indigenous and tribal peoples and vulnerable ethnic minorities have suffered disproportionate levels of displacement and negative impacts on livelihood, culture and spiritual existence," the WCD notes. Women have "frequently borne a disproportionate share of the social costs and were often discriminated against in the share of benefits."

Photo: Narmada Bachao Andolan

Houses submerged by Sardar Sarovar reservoir, India.

- Sixty percent of the length of the world's large river systems is highly or moderately fragmented by dams, inter-basin transfers and water withdrawals for irrigation. This massive alteration of the world's riverine habitats is a major reason for the rapid loss of freshwater biodiversity. Up to 35% of freshwater fishes are estimated to be extinct, endangered or vulnerable. A significant but unknown share of shellfish, amphibians, plants and birds that depend on freshwater habitats are also at risk.
- Reservoirs flood forests and other terrestrial and riverine ecosystems including irreplaceable habitats for endangered species. Dams "alter the natural distribution and timing of streamflow" thus compromising "the dynamic aspects of rivers that are fundamental to maintaining the character of aquatic ecosystems;" block sediment flows, leading to the erosion of downstream river channels and coastlines; block species' migrations; and reduce the productivity of downstream riparian areas, floodplains and deltas.

7 Efforts to mitigate the impacts of large hydro typically fail

According to the WCD, even where the impacts of dams are acknowledged by developers and mitigation plans put in place, these plans "typically fail to address adequately the problems caused by the decision to build a large dam." The WCD notes that even where compensation is provided it often proves inadequate and that even when people are recognized as eligible for resettlement they rarely have their livelihoods restored. The WCD also found that:

"There is a clear relationship between the magnitude of displacement and the ability to rehabilitate and restore livelihoods adequately – the larger the number of displaced people, the less likely it is that livelihoods can be restored."

The WCD found a similar record on the mitigation of the ecosystem impacts of large dams; **many impacts go unacknowledged or underestimated, and measures to prevent or reduce impacts that are predicted frequently fail.**

8 Most large hydro developers and funders oppose measures to prevent the construction of destructive projects

The WCD has developed criteria for water and energy planning processes, which could prevent destructive hydropower projects from being built, encourage the implementation of better alternatives, and reduce the impacts of existing projects. Since implementing the WCD recommendations would mean building fewer dams, many hydro proponents have strongly attacked the credibility of the WCD and lobbied to prevent the application of its recommendations.

The World Bank's response to the WCD has been especially controversial. While some Bank officials have broadly endorsed the report, others have actively encouraged governments and other lenders to oppose it. The Bank's latest water strategy, released in February 2003, announces that the World Bank will reverse the decline in its funding for large hydro projects, yet it rejects calls to incorporate the WCD's recommendations into its binding policies.

Until the WCD issued its November 2000 report, the main set of international norms on social and environmental aspects of dam construction were contained in the World Bank's "safeguard policies." Efforts to pressure the World Bank into applying these policies have caused a drop in the number of large hydros funded by the Bank in recent years. Yet the safeguard policies, as noted by the WCD, are insufficient in their content and application to prevent major problems with the World Bank's projects. However not only is the Bank refusing to use the WCD's recommendations to strengthen the safeguard policies, it is actually seeking to weaken the content and application of the policies.

The Bank's desire to dilute its own policies is being encouraged by the large hydro industry. The US Hydropower Council for International Development recently called for the safeguard policies to be weakened so that hydropower builders no longer need to undertake "lengthy and expensive environmental studies and mitigation."[8]

Unless the WCD's recommendations are followed by the World Bank and other dam funders and builders there is no reason to expect future large hydros to be any less damaging and underperforming than those of the past.

Photo: Bill Pottinger

9 Large reservoirs can emit significant amounts of greenhouse gases

Scientists have studied more than 30 reservoirs, and found emissions at all of them. In tropical countries, several of the hydropower plants studied appear to have a much greater impact on global warming than natural gas plants generating equivalent amounts of electricity. The global warming impact of hydropower outside the tropics appears to be significantly lower than that of fossil fuel-generated electricity, but not negligible as has commonly been assumed.

Reservoirs emit greenhouse gases due to the rotting of organic matter – the vegetation and soils flooded when the reservoir is created, the plants that grow in the reservoir, and the detritus that flows into the reservoir from upstream. Gases are emitted from the reservoir itself and when water is discharged through turbines and spillways.

Gross hydropower emissions are those directly due to the reservoir surface and dam. But the actual impact of a dam on the global climate depends on *net* emissions. These are calculated by factoring in pre-existing sources and sinks of greenhouse gases in the watershed.

The science of quantifying reservoir emissions is still young and the subject of much debate. Controversies include the best methods for measuring emissions from the reservoir, how to measure the impact of the dam on carbon sources and sinks throughout the watershed, and how to compare hydropower emissions with those from fossil fuels.[9]

A major expansion of large hydro will harm energy security

10 Large hydro is slow, lumpy, inflexible and getting more expensive

Large hydro projects take much longer to build than other types of power plants. The reasons include their huge scale, the fact that every dam site is unique and thus involves specific design challenges, and the opposition they invariably provoke. Large hydro also usually takes much longer to build than feasibility studies estimate. **Forty-nine hydro projects reviewed in a World Bank study published in 1990 took an average of five years and eight months to build – 14 months longer than the average pre-construction estimate. Wind turbines and solar panels, by comparison, can start delivering benefits – and repaying loans – within months of entering construction.**

Including the planning phase of hydro projects would widen this timing gulf with other power technologies even further. The decision to build the Bujagali dam was taken by the Ugandan government in 1994, yet after nearly a decade of planning and tens of millions of dollars spent it has still not entered construction. The Nam Theun 2 dam in Laos has been promoted by the World Bank since 1989, and again despite volumes of studies and a huge expenditure of human and financial resources the project has been unable to move forward. Both projects are promoted by the World Bank as models of good hydropower planning.

Large hydros also contrast sharply with new renewables in terms of what power planners refer to as "lumpiness." Large hydro plants by definition add large increments of capacity to grids when completed, a particular problem for grids with relatively small loads as is common in many developing countries. If demand exists for a sudden addition of new capacity this likely means that serious power shortages will have existed before the hydro was completed – if the shortages did not exist it will likely mean that the dam's full generation is not needed when it comes on line, tying up investment in a non-productive plant.

World Bank studies show that demand growth is typically overestimated by power planners, especially over the long time periods it takes to build a large hydro project. Large hydros have thus frequently resulted in overcapacity on grids. **It is preferable in economic and power planning terms to add capacity in small increments, which are easier to match with rising demand.**

Another contrast with the benefits of the new renewables is the inflexibility of where large hydro plants can be sited. Many of the most technically feasible large hydro sites are in remote areas far from the main sources of power demand, meaning huge expenditures are required for long transmission lines (which also result in considerable power losses).

Large hydropower is also suffering from the problem of "site depletion" – the "best" dam sites have generally already been developed over the past century of large hydro construction. Unlike the new renewables, whose unit costs are fast declining, large hydro appears to be rapidly increasing in cost. The World Bank's 1990 study of hydropower economics found that constant dollar costs of hydroelectric facilities were increasing at 3.5-4% per year.[10] The study concluded that site depletion was the main reason for this inflationary trend.

11 Many countries are already over-dependent on hydropower

Worldwide, large hydro contributes 10% or more of total generation in 113 countries. It contributes at least 20% of generation in 91 countries and more than half of total electricity supply in 63 countries. Almost all of these 63 countries are in the global South and ex-Soviet Union. Even with our existing climate, many of the hydro-dependent countries are already experiencing energy shortages when drought strikes. Yet also it is in the already hydro-dependent countries where the bulk of new large hydro capacity is planned.

Countries that have suffered drought-induced blackouts and energy rationing in recent years include Albania, Brazil, Chile, Colombia, Ecuador, Ghana, Guatemala, India, Kenya, Peru, Sri Lanka, Tajikistan, Thailand, Vietnam, Zambia and Zimbabwe. Norway, New Zealand and parts of the US are also experiencing power supply problems due to low hydro reservoir levels.

The WSSD's call for countries to increase their energy diversification and security will best be met through demand-side management and rapidly increasing the use of new renewables from their currently small proportion of total supplies.

Targets for increasing the proportion of electricity generated from renewables are typically set at levels of 10-20% of total generation from renewables over the next decade or so. Yet for many countries **the already high proportion of their generation from large hydro makes it nonsensical to include large hydro in their renewables targets.**

12 Large hydro reservoirs are often rendered non-renewable by sedimentation

The World Energy Council defines renewables as "forms of energy which are not exhausted by use." The reservoirs used by large hydro plants frequently are "exhausted by use" due to the loss of storage capacity to sediments. The World Bank has calculated that every year some 0.5-1% of global reservoir capacity is lost to sedimentation (meaning that 240-480 new large dams would have to be completed every year just to maintain global reservoir capacity). An increasing volume of sediments in its reservoir will eventually seriously impede or end the ability of a hydroplant to operate.

The great majority of annual sediment loads are typically carried during flood periods. The higher intensity and frequency of floods due to global warming are therefore likely to increase sedimentation rates and exacerbate their already difficult-to-predict nature. Changes in watershed vegetation due to the changing climate will further complicate efforts to predict future sedimentation rates.

Techniques are available to reduce the rate of reservoir sedimentation and to remove sediments that have already settled in reservoirs. These techniques, however, have serious limitations for reasons including that they only work for specific reservoir types, they are prohibitively expensive, and they reduce the dam's ability to generate power.

Large hydro should also not be considered sustainable due to its irreversible impacts, in particular the extinction of species, and destruction of ecosystems and human cultures. (Some of the impacts of large hydro, for example the blocking of fish migrations and trapping of sediment, can be considered reversible if the dams are to be decommissioned).

Notes

[1] See www.developmentgoals.org.

[2] Para 19 (e): "Diversify energy supply by developing advanced, cleaner, more efficient, affordable and cost-effective energy technologies, including fossil fuel technologies and renewable energy technologies, hydro included . . ."

[3] See *e.g.*, World Bank (2003) *Water Resources Sector Strategy,* pp. 4, 17, 22.

[4] See *CDM Investment Newsletter,* No. 1-2, 2003, p. 9.

[5] Bacon, R.W., *et al.* (1996) "Estimating Construction Costs and Schedules," *World Bank Technical Paper No. 325,* p. 29. Average overruns would have exceeded 27% if four "outlier" dam projects with exceptionally large overruns had been included. See also WCD (2000) *Dams and Development: A New Framework for Decision-Making,* p. 41.

[6] World Bank (1994) *Resettlement and Development: The Bankwide Review of Projects Involving Involuntary Resettlement 1986-1993,* p. 2.

[7] See *e.g.*, WCD (2000), pp. 42-49, 56-58.

[8] Stone, D. (2002) "Untapped Resources," *Electric Perspectives.*

[9] Canadian researchers estimate *gross* emissions from hydropower (without considering turbine and spillway releases) to average 10-200 grams of CO_2-equivalent per kilowatt-hour generated in Canada; and 200-3,000 gCO_2-eq/kWh in the tropics. By comparison a modern coal plant releases around 1,000 gCO_2-eq/kWh. See Duchemin, E. *et al.* (2002) "Hydroelectric Reservoirs as an Anthropogenic Source of Greenhouse Gases," *World Resource Review,* Vol. 14, No. 3, p. 334. Also see WCD (2000) *Dam Reservoirs and Greenhouse Gases: Report on the Workshop held on February 24 & 25. Hydro-Quebec, Montreal. Final Minutes.*

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United Nations Environment Programme Dams and Development Project:
www.unep-dams.org

Citizens United for Renewable Energy and Sustainability:
www.ee-netz.de/cures.html

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Twelve Reasons to Exclude Large Hydro from Renewables Initiatives

A MAJOR EXPANSION OF LARGE HYDRO WILL HARM SUSTAINABLE DEVELOPMENT

1. Large hydro does not have the poverty reduction benefits of decentralized renewables
2. Including large hydro in renewables initiatives would crowd out funds for new renewables
3. Promoters of large hydro regularly underestimate costs and exaggerate benefits
4. Large hydro will increase vulnerability to climate change
5. There is no technology transfer benefit from large hydro

A MAJOR EXPANSION OF LARGE HYDRO WILL HARM PEOPLE AND ECOSYSTEMS

6. Large hydro projects have major negative social and ecological impacts
7. Efforts to mitigate the impacts of large hydro typically fail
8. Most large hydro developers and funders oppose measures to prevent the construction of destructive projects
9. Large reservoirs can emit significant amounts of greenhouse gases

A MAJOR EXPANSION OF LARGE HYDRO WILL HARM ENERGY SECURITY

10. Large hydro is slow, lumpy, inflexible and getting more expensive
11. Many countries are already over-dependent on hydropower
12. Large hydro reservoirs are often rendered non-renewable by sedimentation

IRN
International Rivers Network

Co-published by IRN and the following organizations:

Campagna per la riforma della Banca Mondiale

Oxfam America

ERN European Rivers Network

ITDG Practical Answers to Poverty

Friends of the Earth International

ENERGY WORKING GROUP OF THE BRAZILIAN FORUM OF NGOS AND SOCIAL MOVEMENT FOR THE ENVIRONMENT AND DEVELOPMENT

NAWISA Network for Advocacy on Water Issues in Southern Africa

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