Hydropower Report

Large & Small Hydropower

Ed 1 2005

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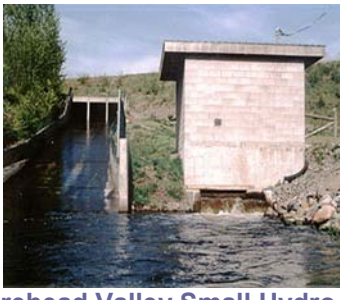

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Hydropower Report - Ed 1 2005
Large & Small Hydropower

Hydropower is the largest renewable source of electricity. It accounts for 6% of primary energy supply and 17% of electrical generation. Although there are hydro electric projects under construction in about 80 countries most of the remaining hydro potential is found in developing countries particularly in South and Central Asia, Latin America and Africa. This report is a comprehensive study and analysis of the global hydro power market.

Outline of the report

- Contribution of hydro power to the energy mix
- History of hydropower
- Development of Hydro power and the different patterns for PHP and SHP
- Technical background
- Base load & peaking with hydropower
- Environmental concerns
- Regional & country hydropower profiles of Europe, CIS, North America, Latin America & Carribean, Asia, Asia Pacific, Africa, Middle East

The report discusses environmental objections to hydropower and the different impacts on the futures for LHP and SHP. The effects on population, wild life, eco systems, water diversion, landscape, and the potentially critical new problem of methane, which is being researched and could condemn LHP as more environmentally damaging than fossil fuels.

Large Hydro and Small Hydro

- Covers both large hydropower (LHP) and small hydropower (SHP), mini and micro, and explains the differences between them. It is not simply a question of size but different technologies
- Outlines the size of the hydropower industry, separately for large and small
- Regional break and analysis of hydropower's distribution country by country
- Analyses future demand for hydropower, both LHP and SHP
- Profiles hydropower in each country
- Lists of hydro plants in each country, totalling over 2,400

Special features

- Development of SHP in Europe
- The Big Dam Period in the USA
- The SHP sector and its development in China, which accounts for 39% of the world's new SHP construction
- Provides summary of the different hydro technologies- construction of dams, turbines
- Analysis of plant utilisation country by country, and discussion of base load and peaking
- Compares the benefits and disadvantages of hydro versus other generation technologies

25 Charts and 71 Tables

- Statistics of total capacity and generation, hydro installed capacity and hydro generation
- Hydro energy resources by region
- Hydro capacity and generation by region
- Hydro plants listed by country
- Dam construction by region
- Analysis of SHP

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I. Executive Summary

Although not the largest renewable primary source, which is biomass, hydropower is the largest renewable source of electricity. It has been in use for many years and is effectively a conventional form of energy. Hydropower accounts for 6% of primary energy supply and 17% of electricity generation.

Although there are hydroelectric projects under construction in about 80 countries, most of the remaining hydro potential in the world may be found in developing countries, particularly in South and Central Asia, Latin America, and Africa. Other countries with remaining hydropower potential are Canada, Turkey, and Russia.

Size of the hydropower industry

Hydropower constitutes 21% of the world's electricity generating capacity. The theoretical potential of worldwide hydropower is 2,800 GW, about four times greater than the 723 GW which has been exploited. However, the actual amount of electricity which will ever be generated by hydropower will be much lower than the theoretical potential, because of the environmental concerns and economic constraints.

44% of the world's hydropower was generated in four countries in 2002, mostly large- and mid-scale plants. Asia accounted for 24% of the world's hydro generation, with 618 GWh, followed by North America with 23% (595 GWh) and Europe with 20% (537 GWh).

The largest generating countries were Canada with 315 GWh and China with 309 GWh, followed closely by Brazil with 282 GWh and the United States with 255 GWh. Although Canadian hydro generation is growing, China will overtake Canada very soon, if it has not already done so, to become the largest hydro generator in the world.

In Western Europe and the United States, the scope for additional hydropower is limited, as the most economic sites have already been developed and further expansion is hindered by environmental concerns.

In North America, hydropower is the most widely used form of renewable energy. The installed hydropower capacity amounts to 175 GW (67 GW in Canada, 99 GW in the US, and 10 GW in Mexico). Hydropower accounts for 57% of the electricity generated in Canada, 7% in the US (the US uses hydro power for peaking not base load) and 12% in Mexico. Canada's economical hydropower potential is second only to that of Brazil in the Western Hemisphere. Canada still has several projects under either construction or planning, amounting to 6.6 GW.

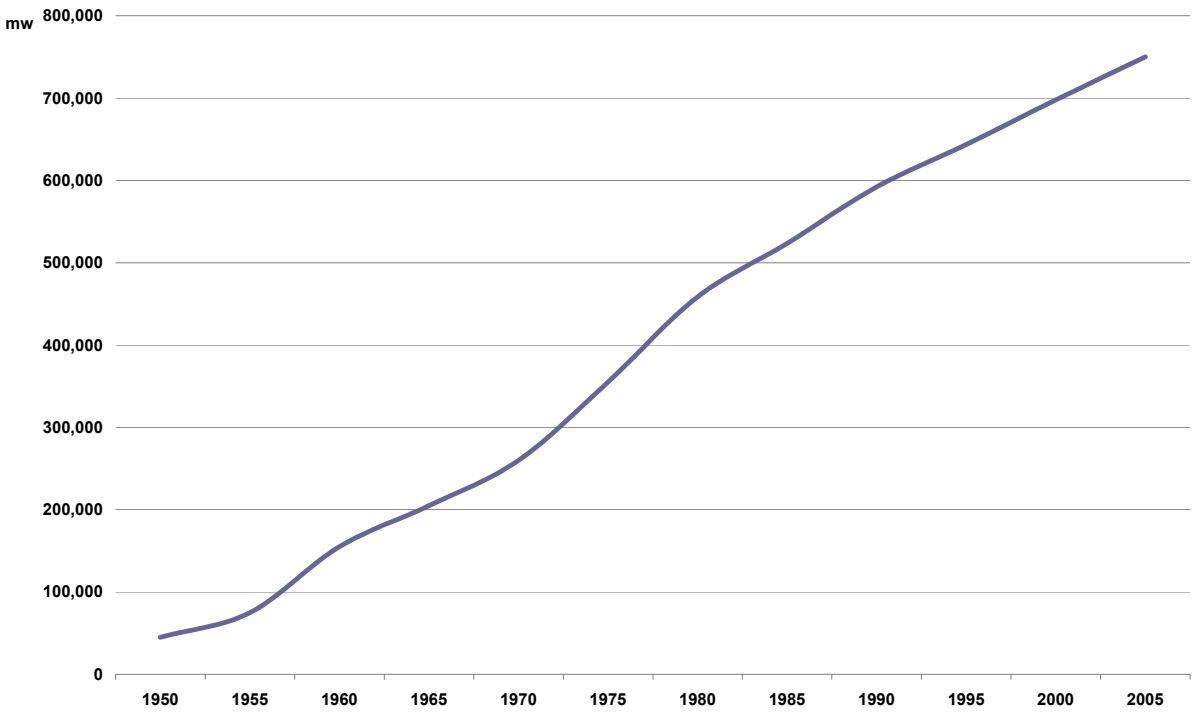
Latin America has a very large hydropower potential. Many countries rely heavily on hydropower for their electricity supply. For instance, hydropower makes up 80% of Brazil's electricity generation.

Brazil has abundant hydropower resources. Its installed hydropower capacity is 64 GW. The capacity under construction or planning is more than 25 GW. One of the hydropower plants under construction is the giant 11.18 GW Belo Monte power plant. Hydropower capacity under construction or planning in other South American countries, particularly Argentina, Bolivia, Chile, Colombia, Guyana, Peru, and Venezuela, amounts to 9.7 GW. Also, 4.4 GW of hydropower capacity is under construction or planning in Central American countries.

With a vast territory and a host of rivers, China has the largest hydropower resources in the world. China's installed hydropower capacity stood at 83 GW by the end of 2002. A large number of hydropower plants areunder construction or planning, amounting to 77.7 GW. The giant 18.2 GW Three Gorges Dam with a dam height of 181 m on the Yangtze River (the country's longest river) is the world's largest hydropower project under construction. Although hydropower plants based on dams and reservoirs may require relocation of large numbers of people, China has one of the best resettlement programs in the world.

Russia lies in fifth place with 180 GWh and Norway in sixth with 125 GWh. Norway is regarded by many as having the best managed hydro system in the world, which accounts for 99.3% of the total power generated in that country.

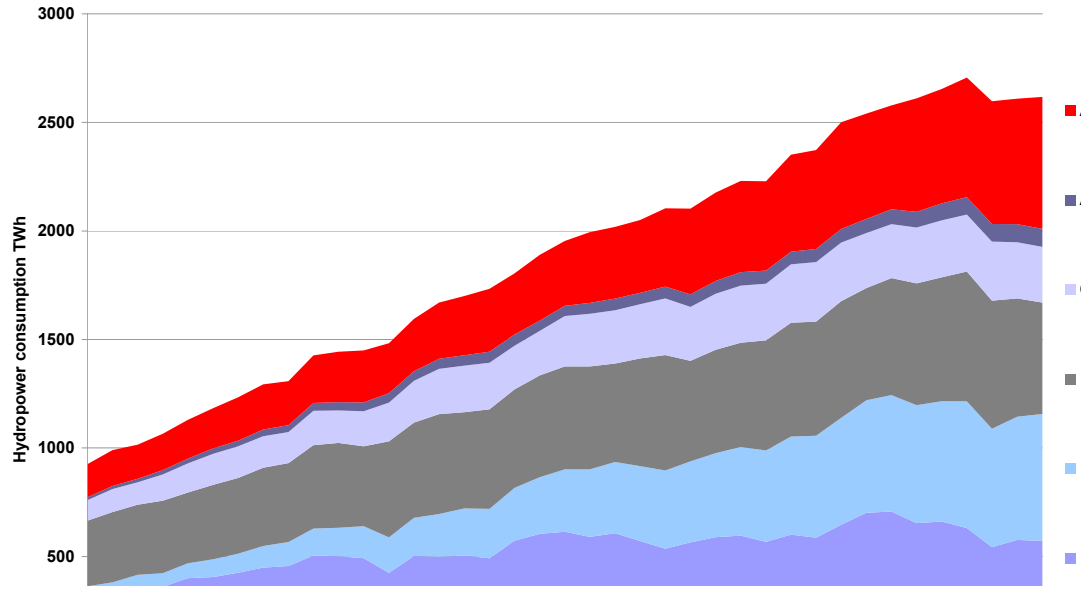
Figure II.4: The growth of hydropower generating capacity, 1950-2005, MW



Source: EIA

In 2002, Asia accounted for 24% of the world's hydro generation, with 618 GWh, followed by North America with 23% or 595 GWh and Europe with 20% or 537 GWh. 44% of the world's hydropower was generated in four countries in 2002. The largest generators were Canada with 315 GWh and China with 309 GWh, followed closely by Brazil with 282 GWh and the United States with 255 GWh. Asia is constructing more and more hydropower capacity as its economies mushroom and although Canadian hydro generation is growing, China will overtake Canada very soon if it has not already done so, to become the largest hydro generator in the world. Russia lies in fifth place with 180 GWh and Norway in sixth with 125 GWh. Norway is regarded by many as having the best managed hydro system in the world, which accounts for 99.3% of the total power generated in that country.

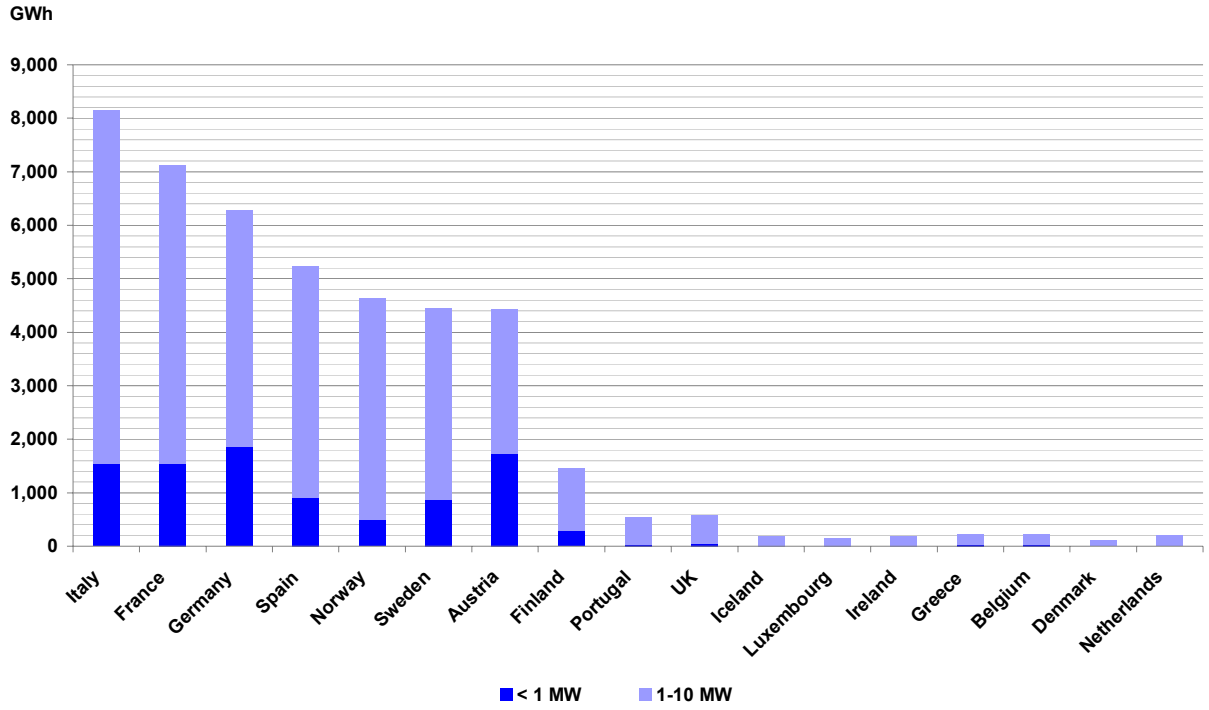
Figure II.5: Regional development of hydropower, TWh



Source: BP World Energy Statistics 2004

Overall, on a regional basis, hydroelectricity contributes the highest proportion to total electricity supply in Central and South America where it accounts for 68% of electricity produced. There is a large gap to

Figure VII.2: Generation in GWh of SHP plants (capacity < 10 MW) in Europe by size, 2003



Source: EREC, BS Global Plant Database

Hydropower potential

In most European countries the economically feasible hydro potential has largely been harnessed. From the still untapped potential the SHP plants have a better chance for realisation than large hydro with reservoirs, which face severe opposition due to their environmental impact. However, even the small and mini-hydro run-of-river plants meet various obstacles. Although feed-in regulations are now in place in almost all European countries, the licensing and contract procedures are cumbersome and time consuming. Opposition from environmental groups, often based more on emotion than rational arguments, has to be countered. Requirements for minimum water in the original river or stream limit the exploitable flow. Demands for the installation of fish ladders or changes in civil structures in line with the natural environment can drive up civil engineering costs to levels where the investment is no longer economical.

The ESHA study estimates, that from a purely technical viewpoint, an additional 2,000 MW of SHP could be made available by up-grading the existing plants and restarting abandoned ones. Environmental concerns, however, would reduce this volume to around 1,100 MW. The potential for new SHP is theoretically estimated to be more than 14,000 MW, however this assumes no constraints. Taking into account environmental and economic constraints, the study assumes a potential of 6,700 MW still to be exploited. Both potentials combined (new and refurbished) add up to 7,900 MW, which is 71% of present installed SHP capacity. Consequently, despite the high exploitation ratio in Europe there is still ample room for further development of SHP.

Table VII.3: Estimated hydro potential and exploitation in Europe MW

	SHP < 10 MW			LHP > 10 MW			Total hydro		
	Existing	Additional	Total	Existing	Additional	Total	Existing	Additional	Total
Austria	837	1,105	1,942	10,835	124	10,959	11,672	1,229	12,901
Belgium	60	66	126	43		43	103	66	169
Denmark	11		11				11		11
Finland	304	148	453	2,577	640	3,217	2,881	788	3,669
France	2,016	1,261	3,277	22,916		22,916	24,932	1,261	26,193
Germany	1,402	550	1,952	1,980		1,980	3,382	550	3,932
Greece	40	101	150	3,052	471	3,523	3,101	572	3,673
Iceland	68		68	1,107	186	1,293	1,175	186	1,360
Ireland	34	39	73	199		199	233	39	272

Pajarito	5	
Palmas	18	Eléctrificadora de Santander
Paraiso	270	EMGESA
Piedras Blancas		EPM
Playas	216	
Porce II	392	EPM
Río Grande	75	EPM
Río Mayo	21	Centrales Electricas de Mariño
Río Piedras	19	Generar
Río Prado	50	Eléctrificadora del Tolima
Salto	127	EMGESA
Salvajina	285	EPSA
San Carlos	1,240	ISAGEN
San Francisco Caldas	135	Hidroeléctrica de Caldas
Sonson II	10	
Troneras	42	EPM
Urrá (Alto Sinú)	344	Corp. Electrica Costa Atlantica
Dolores	9	
Pajarito	5.4	
Playas	249	

Source: ABS Global Database of Operational Power Plants

Chile

Chile has 4,400 MW of installed hydro capacity out of a total electricity supply of 11,800 MW. Hydropower has historically been Chile's single largest power source, at times comprising over half of the country's installed electric generation capacity and production. Droughts, however, have periodically curtailed hydropower production, causing supply shortfalls and blackouts (see graph). In response, the Chilean government began to diversify its energy mix in the 1990s to become less reliant on hydropower, mainly by building natural gas-fired power plants.

The recent natural gas export restrictions by Argentina have not only cast doubt on the reliability of Chile's gas imports, but have also prompted the Chilean Government to rethink its entire energy strategy. One proposal suggested by the Government would provide incentives to encourage power producers to diversify their energy sources and reduce dependence on natural gas supplies from Argentina. One of the incentives would be to award gas-fired plants that have fuel-switching capabilities (e.g., coal or fuel oil) with higher prices for their power while allocating plants which only use natural gas with a lower price. The Government hopes that this programme will encourage power producers to invest in backup capacity and to use fuels other than natural gas.

Chile has another 6,000 MW of hydropower generation potential, if small (0.8 MW to 10 MW) hydropower units could be installed in existing watercourses. However, current legislation does not offer enough economic incentives (via market price) for small producers to extract electric power from these smaller sources as compared to those mega-units that characterize Chilean hydropower suppliers. If current regulations were modified accordingly, this power generation potential could be realised in a third of the time or less than it would require to install conventional large generation units.

Table X.8: Hydropower plants in Chile

Plant	Capacity MW	Owner
Abanica 5-6	46	Endesa-Chile
Abanico 1-4	92	Endesa-Chile
Aconagua (Juncal) 1	27	Aconcagua SA
Aconagua (Juncal) 1	2	Aconcagua SA
Aconcagua (Blanco) 1	47	Aconcagua SA
Agua de Castilla 1	4	Min Comercial Sali Hochschild
Alfalfal 1-2	160	AES Gener SA
Alto Cachapoal 1	195	Andrade Gutierrez Construction
Alto Cachapoal 2	195	Andrade Gutierrez Construction
Alto Tinguirrica	100	Chilquinta Energia
Antuco 1-2	300	Endesa-Chile

XVI. Appendix 2 – Statistics of Hydro Capacity and Generation by Country

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