Water and Hydro Power

C.V.J. Varma

Abstract: Water is life and energy, basic human needs. The water supply and hydropower demand scenario for India for the year 2025 shows that 90% of the area of the country falls under the Physical Water Scarcity Group. While 500kWh/year per capita energy consumption is considered to be the minimum needed to ensure a quality of life, many developing countries consume less than 76 kWh/year. Hydropower is renewable clean energy and needs to be fully exploited. In Asia and Africa, there is a great opportunity for regional cooperation in development of water resources and hydropower with which to benefit cooperating countries.

Key words: Water resources, water scarcity, regional cooperation, per capita electricity consumption, electricity production capacity, India

Global Water Availability

Earth water content is about 1.39 billion cubic kilometers (331 million cubic miles) and the vast bulk of it, about 96.5%, is in earth's ocean; c. 1.7% is stored in polar ice caps, glaciers, and permanent snow; and another 1.7% is stored in ground water, lakes, rivers, streams and soil. A thousandth of 1% exists as water vapor in the earth's atmosphere. One estimate of global water distribution is as under Table 1:

Areas	Volume ($100km^3$)	% Water	% Fresh Water
Oceans etc.	1338000	96.8	—
Ice Caps Glaciers and Permanent Snow	22064	1.74	68.7
Ground Water	23,400	1.7	—
Fresh Water	10,530	0.76	30.1
Saline Water	12,870	0.94	—
Soil Moisture	16.5	0.001	0.05
Ground Ice and Permafrost	300	0.22	0.86
Lakes	176.2	0.013	—
Fresh	91.0	0.007	0.26
Saline	85.4	0.006	—
Atmosphere	12.90		0.04
Swamp Water	11.47	0.0008	0.03
Rivers	2.12	0.0002	0.006
Biological Water	1.12	0.0001	0.003
Total	1,385,984	100.0	100.0

Table 1. Global Water Availability. (Gleick 1996)

Estimates of ground water values vary widely amongst sources. The values indicated in Table 1 are near the high end of the range. As per the values of this table, ground water constitutes approximately 30% of fresh water, whereas ice (including ice caps, glaciers, permanent snow, ground and permafrost) constitutes approximately 70% of fresh water. With other estimates, groundwater is sometimes listed as 22% and ice as 78% of fresh water.

Energy

- World energy demand, especially for electricity, will increase greatly during 21st century.
- Hydro power is the most important and widely-used renewable source of energy, representing 19% of total electricity production. Canada is the largest producer of hydroelectricity, followed by the United States and Brazil.
- Dams built to provide hydropower and irrigation water and to regulate river flow to prevent floods and droughts, have had a disproportionate impact on the environment.
- There are now about 45,000 large dams in operation worldwide, providing 19% of world's electricity generation, as well as water for irrigation on land producing 16% of world's food.
- Hydro power plays a major role in reducing green house gas emissions.

Energy Security

More than 1.6 billion people of the world still do not have access to modern energy systems, with the prospect of 400 million more people to be added to this figure during next 20 years, according to a World Energy Council (WEC) report. These populations will be mostly in the rural areas of developing countries where unexploited hydro development potential is very high. To meet the forecasted increased energy requirements, almost 100 million people will have to be given access to modern energy sources every year for the next 20 years, as compared with 40 million people per year between 1970 and 1990 and 30 million/year since then.

A comparison of the per capita electricity consumption shows that while Norway has 26,280 kWh/yr, and the USA has 13,800 kWh/yr, some of the African countries have less than 100 kWh/year; but these countries have technical and economic hydro potential that, if exploited, can significantly enhance per capita consumption. See Table 2.

It is clear that even the development of all available hydro potential would still be insufficient to meet the needs of many countries. Nonetheless, great efforts should be made to maximize the use of hydropower together with other renewable sources, to minimize the use of alternative energy sources which will be detrimental to the environment. However, exploitation of even these potential may not be adequate to meet the requirement of many countries. As per the WEC report, 500 kWh/year per capita use should be taken as the minimum to ensure a reasonable quality of life.

Hydropower is the world's leading source of renewable energy. It is emission free and offers enormous system reliability benefits. The policy and guiding principle of hydropower development must aim at ensuring recognition of the value of the hydropower resources in its energy supply portfolio. This will support a responsible balance between economic and environment concerns.

Take the case of China and India, two developing countries in Asia. Together they account for more than 1/3rd of the world's population. Both have the problems of floods and drought in different parts of the country, simultaneously. Additionally, the demand for energy in each country is rapidly increasing.

Country	Population (millions)	Present annual per capita electricity consumption (1999 data)	Economically and technically feasible hydro potential	Increase in per capita figure if all potential is developed
Mozambique	18.1	76 kWh	37 647 Gwh/yr	(2080 kWh)
Tanzania	30	63 kWh	1 789 Gwh/yr	(59.6 kWh)
Benin	5	49 kWh	n/a	n/a
Madagascar	13.9	46 kWh	49000 Gwh/yr	(3525 kWh)
Mali	10.7	40 kWh	~ 5 000 Gwh/yr	(~ 467 kWh)
Burkina Faso	0.4	27 kWh	216 Gwh/yr	(20.7 kWh)
Niger	10	25 kWh	1 300 Gwh/yr	(130 kWh)
Ethiopia	60	22 kWh	260000 Gwh/yr	(43333 kWh)
Rwanda	8	22 kWh	~ 330 Gwh/yr	(~ 41.25 kWh)
Chad	6.4	14 kWh	~ 150 Gwh/yr	(~23.4 kWh)

Table 2. Comparison of Per Capita Electricity Consumption in Selected Countries of Africa.

So what is the solution? In the present scenario, when the available coal reserves are reducing, the only way to meet energy demand is to develop hydro resources. There is no alternative; there is no other solution but to provide hydropower to the people.

The World Declaration on Dams and Hydropower for African Sustainable Development, adopted for Africa in 2008 by leading international organizations like IHA, WEC, ICOLD, ICID, etc., shows the way for sustainable development of Water Resources and Hydro Power.

Indian Scenario

India is one focal point for this discussion because of its size and population. India's population has already reached one billion and is increasing by one million per month, an increase equivalent to the population of Switzerland. At this rate, the population will increase by 650 million and 18% of the world's population by 2050.

Land and Water Resources

- Geographical Area: 328.8 million ha.
- Cultivable Land: 186 million ha. (56.5% of the geographical area). There is no possibility of extending the amount of cultivable land because of increasing urbanization and other developments.

Existing Water Resources

- Actual Precipitation: 400 Million hectre metre (M.ha. m.).
- Available Surface Water Resource: 180 M.ha.m (45%)
- Utilizable Water Resources: 70 M.ha.m (38%)
- Utilizable Ground Water: 42 M.ha.m.
- Total Utilizable Water: 112 M.ha.m

India requires storage dams/facilities to convert more monsoon flood waters to useable water.

The International Water Management Institute estimates, based on water supply and demand scenario, that about 90% area of India falls with the Physical Water Scarcity Group, meaning that even with highest feasible efficiency and productivity of water use these areas do not have sufficient water resources to meet their agricultural, domestic, industrial and environmental needs in the year 2025. But, although India claims to have nine percent of the world's large dams by number, the major storage water potential flows as waste to the sea.

As regards the energy production in India, the greater need can be understood when it is seen that the per capita consumption is about 717 kWh compared to China's 2179, Brazil's 2166 and Australia's c. 11249 kWh. With increasing economic development

Basin	Area in million hectares	Water Resources in km³	
Ganga-Brahmaputra Meghna	110.13 (33.5%)	1202 (62%)	33% area has 62% share of water
West Flowing Rivers South of Tapi	11.31 (3.5%)	201 (10%)	
Other Basin	207.29 (63%)	550 (28%)	
Total	328.73	1953	

Table 3. Major Basin-wise Water Resources of India.

and standard of living, per capita consumption in India should rise to at least 1000 kWh. The present situation exists in spite of the fact that during last 50 years after Independence the electricity production capacity has increased from 1500 MW to about 100,000 MW in 2000.

The estimated capacity additional requirement to achieve different per capita consumption level from 1000 kWh per year to 1500 kWh per year during 2000-2020 AD is estimated on Table 4.

We estimate that by 2050 the electricity production capacity may be:-

- Hydro: 200,000 to 250,000 MW
- Thermal: 600,000 to 800,000 MW
- Nuclear: 50,000 to 70,000 MW
- Nonconventional (wind, etc.): 50,000 to 60,000 MW

With this capacity, the per capita level may reach about 3000 kWh by 2050 AD.

The challenges are many, but every effort should be made to provide uninterrupted, quality electricity supply. The aim of the Government of India is to provide electricity for all by 2012, and hydropower plays a major role.

In developing countries in Asia and Africa there is, of late, awareness of the benefits of regional cooperation between countries. Many countries in Asia have hydropower potential but do not have sufficient load of utilization, and sell the hydro potential for use in neighboring countries. This has given scope for improvement of the economy of the country and the quality of life of the people.

In developed countries, the classic example is interaction between Canada and USA. Canada has the hydro potential which can be sold to USA by bilateral agreement.

Per Capita Consumption Level (kWh/yr/)	Estimated Installed Capacity (2020) MW	Estimated Additions Required (MW)
760 (existing) for 2010	160,000	–
1000	336,060	236,000
1250	402,060	302,000
1500	500,060	400,000

Table 4. Additional Capacity Requirement

Similarly, Nepal can develop its vast hydropower potential for utilization in India. A sense of give and take will go a long way in improving the quality of life of both the countries and, incidentally, help improve the environment by using green hydro energy.

In future, we may look back and find that all the developed countries are those that have developed their hydro potential.

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C.V.J. Varma *is graduate in engineering. He has more than 30 years of experience in the field of hydropower development in India. He was involved in the construction of the Tungabhadra dam and hydroelectric plant. Subsequently, he was involved in the design of hydro projects, such as Lower Sileru, Srisailam, and others. He joined Prof. Ven Te Chow, Prof. Gabor Karadi and Prof. Masony in formation of International Water Resources Association and held the office of Secretary General. In 1997, he became First Governor of the World Water Council's Board of Governors. From 2000 to 2003, Mr. Varma served as President of the International Commission on Large Dams (the first Indian, and Asian, to have held this post). From 2004 to 2006, he was President of the Association of the Electricity Supply Industry of East Asia and the Western Pacific (AESIEAP), and is the only Indian to have been elected to this post. He hosted the CEPSI 2006 in Mumbai, attended by more than 1000 delegates from 23 countries, and additionally 350 delegates from India. This included more than 300 CEOs. He is currently President of Council of Power Utilities, New Delhi. Corresponding address: cvjvarma@indiapower.org*

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NEWS UPDATE

Chinese Proposal in Nalsyaugadh (400MW) Hydro Project

Developer of the world's largest 3- Gorges Hydro Project – China Three Gorges Project Corporation (CTGPC) has proposed to build 350M US$ Nalsyaugadh (400MW) storage Hydro Project in Nepal. A Technical Team of CTGPC plans to visit the project site (30 km away from District HQ of Jajarkot) for a reconnaissance. A MOU has been signed for preliminary understanding between Vice President Mr. Wang Shaofeng of CTGPC and Mr. Jibendra Jha MD of Nepal Electricity Authority (NEA).

CTGPC with 39,000 MW of hydro projects completed is a resourceful company and has annual saving of US$. 1.7 Billion. CTGPC has shown interest for a majority share (normally 51%) and NEA getting 49 %. Further, it also proposed that Govt. of China may provide a soft loan for NEA's share or the company itself can put up NEA's share as a soft loan. The Govt. of Nepal had requested the Govt. of China for a soft loan for this project.