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A REVIEW OF PRESENT STATUS AND POTENTIAL OF HYDRO POWER IN INDIA

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Abstract— Hydroelectric power is currently the world's biggest non-conventional energy source and plays a formidable part in the global generation of electric power. India has a large number of natural water resources that can be utilised to generate electric power. However, the pertinent growth of hydropower coupled with proper utilisation of available water resources in India should be undertaken in the future. Till, November 2016, the installed capacity of hydropower in India is 43133.43 MW. This installed capacity of hydropower is about 13.97% of the total installed capacity of the country. The current potential of hydropower in India is about 1,48,701 MW. This potential is 3.45 times the installed capacity. Our country has been blessed with the colossal amount of hydroelectric potential and ranks 5th in terms of usable hydropower in the global scenario. In this paper, the study has been carried out to retrospect the available resources of water, present situation and potential of hydropower in India.

Keywords— Hydro power, Renewable energy, Fossil Fuels, Small hydro power plants, Run of River plants

I. INTRODUCTION

Electrical power is considered to be a key factor in the generation of wealth, social development and improved quality of life in all developed and developing countries. It is essential to daily life in both the industrial and household sectors in the world. It is estimated that in coming year world energy consumption will increase faster than population. Out of total energy consumption in the world, over 75% is provided by non- renewable energy resources which mainly includes all fossil fuels[1].Indian power sector is predominantly based on fossil fuels where almost 70% of the total installed capacity is provided by thermal power plants. But over the last one and half decade Indian government has taken several steps to reduce the use of fossil fuels and also at the same time promotes the generation of electrical energy by renewable sources of energy [2, 3].Fossil fuels which mainly comprises of coal, oil and gas are presently the most widely used source of energy, even though they results in many environmental problem as a result of the release of harmful greenhouse gases such as carbon dioxide into the atmosphere. These green house gases result in global warming and climate change, which has become a very dangerous issue for the mankind. Also the combustion of fossil fuels produce harmful sulphur dioxide, which is the main reason for acid rain. In addition to environmental damages, the burning of fossil fuels can cause danger to human life also. On burning of fossil fuels, out of many great risk emissions, the major emission is nitrogen oxide, which is harmful to human lungs. Other emissions like, soot and dust highly contribute to serious respiratory diseases and heart problems. Due to this dangerous situation, it is the demand of time to produce energy with clean and sustainable resources such as hydro, wind, biomass and geothermal. These renewable sources of energy must be used to reduce the impact of fossil fuels on the environment. Between all the non conventional energy resources, it is the hydro power that causes no air pollution and only a little amount of green house gases [4, 5].In addition to this hydro power has a very high conversion efficiency of about 90% and a greater energy

payback ratio [6].Also the generation of hydroelectric power can be done on both large and small scales due to its reliability. However, it has some problems too, like high capital cost and resettlement of people .Table 1 shows the advantages and disadvantages of hydroelectric power. Small hydropower systems can be installed on canals, dams, and run-of-river sites. In countries without integrated national electricity grids, hydro power generated at small-scale provides impeccable access to electricity, which results in providing better life quality for rural population [7].Using small hydro power plants the problem of un electrified remote areas can be easily solved [8]. Due to these reasons, hydro power has so much importance for many countries .There are many small and big water resources in India that can be used to generate electricity. Therefore, a study on the available water resources, the present status of, the actual potential of, government policy and future development of hydro energy in India is very important. Hence, this paper gives a complete review of the water resources, current status, potential and future of hydro energy in India

II. CURRENT ENERGY SCENARIO IN INDIA

India is 3rd largest energy generator in the world, accounting for 4.8% of the global energy generation with total installed capacity of 308834.28MW as on 31 November 2016 [10]. As illustrated in fig.1 69.29% of the total generation is because of thermal power plant.14.86% is due to renewable energy sources.13.96% is due to hydro power and remaining power near about 2% is due to nuclear energy[10].With the technological advancements and also with the realization of the harmful effects of fossil fuels, Indian government is now promoting renewable sources of energy. Out of the total renewable energy, wind power forms the major share. At present the installed capacity for wind power is 28082.95MW.After that solar power has an installed capacity of 8513.23MW [10].

Advantages	Disadvantages
a)**Economical aspects** • Functional and continuation costs are low • Operating life period is very high • Reliable service • Creates employment opportunities • Instigates regional development	• High initial investment • Requires long term planning • Requires long term agreements • For large investment foreign funding and contractors are required
b)**Social aspects** • Water left from the dams can be use for other purposes • Provides flood protection • Enhances recreation	• Involve resettlement of people • Local land use patterns will be modified • Usage of the tail race water requires proper management
c)**Environmental aspects** • Produces no pollutants • Produces no waste • Enhances air quality • Water used is neither polluted nor contaminated.	• The quality of water is to monitored continously • Special arrangements are required for monitoring the activities and population of the Species living in the dam • Extra barriers are required for migration of fishes

Table 1: Advantages and disadvantages of hydro power [data from [9]]

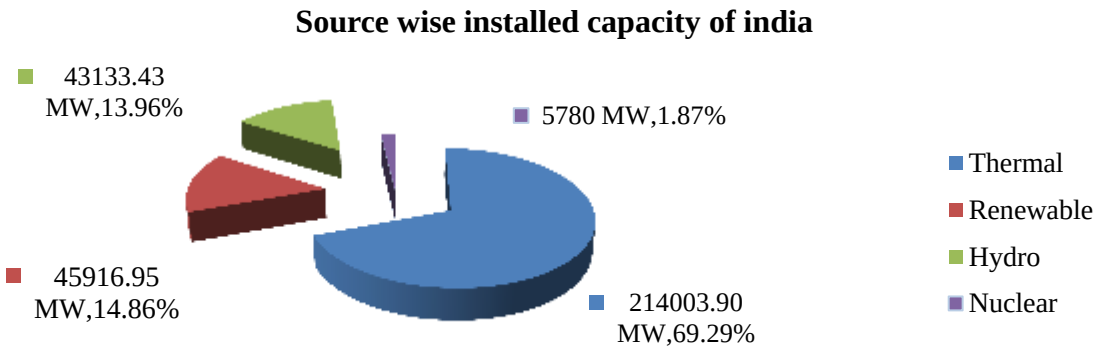

Fig 1. Aggregate installed power capacities in India

Government of India in 2010 launched the Jawaharlal Nehru national solar mission. At the time it was launched it had the mission of taking the solar installed capacity of India to 20,000MW by the year 2022. But in 2015, this mission was changed from 20GW to 100GW. Also there has been a lot of development in wind power sector. So it is clear from above discussions that energy sector in India is moving fastly towards renewable sources of energy mainly solar and wind power. But solar power has limitation like non availability during night, less efficiency, variation in solar energy during day time and power generated reduces during a cloudy day. Similarly wind power generation depends upon availability of wind, and wind cannot be predicted correctly. So before shifting towards these renewable sources, government must fully utilize the hydro power potential in India. As hydro power can be generated throughout the year and also it does depend on the time of the day.

III. HYDRO POWER POTENTIAL IN INDIA

India has an immense potential for hydro power. As discussed earlier that our country has a potential of 148GW for hydro power. But only 29.01% of that potential has been harnessed till date .India has large number of rivers flowing all over the country. These rivers include the river from the Indus basin, Ganga basin, rivers from central India, rivers from the Brahmaputra basin, western flowing rivers of southern India, eastern flowing rivers of southern India. All these rivers have great potential for hydro power which can be harnessed. Fig 2 shows the basin wise potential of Indian River system.

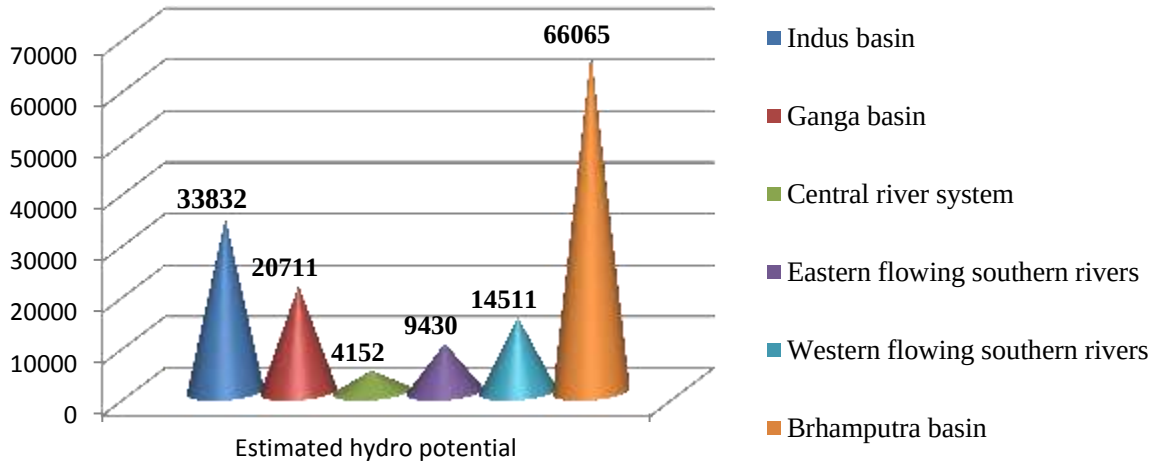

fig 2

Basin wise hydro potential of India

It is clear from fig 2 that near 45% of the Indian hydro potential lies within Brahmaputra basin. 22% lies within the Indus river system. The river Brahmaputra flows in the northeast region of the country. The hydro power installed capacity in northeast region as on 31 November 2016 is 1242MW, which is merely 2.87% of the total potential. Table 2 shows region wise installed hydro power capacity of India

REGION	INSTALLED CAPACITY(MW)
NORTHERN	18376.78
EASTERN	4378.12
WESTERN	7447.50
SOUTHERN	11689.03
NORTH EASTERN	1242

Table 2: Region wise installed hydro capacity

From above data it is clear that India can easily increase its hydro capacity in north eastern region .Also steps must be taken by the government to harness the remaining hydro power potential in rest of the regions. Hilly states of India, Himachal Pradesh, Uttrakhand and Jammu and Kashmir have a great hydro potential. So we can increase our hydro power generation by installing more power plants in these states. Fig 3 shows the comparison of Identified Capacity as per reassessment study and the actual installed capacity of five different regions of the country. It also shows the capacity which is under construction right now. From this figure analysis can be done on which area Indian government has to work more to increase the hydro potential of the country. Nearly 76% of the total identified capacity lies in the northern and north eastern region. This is mainly due to hilly terrain in these areas, availability of water throughout the year and natural occurrence of the head. But till august 2016 only 34.29% of the northern region potential and near about 2% of the north eastern region potential has been utilized. If the hydro power potential in these region is utilized completely then nation's dependence on thermal power plants can be reduced significantly.

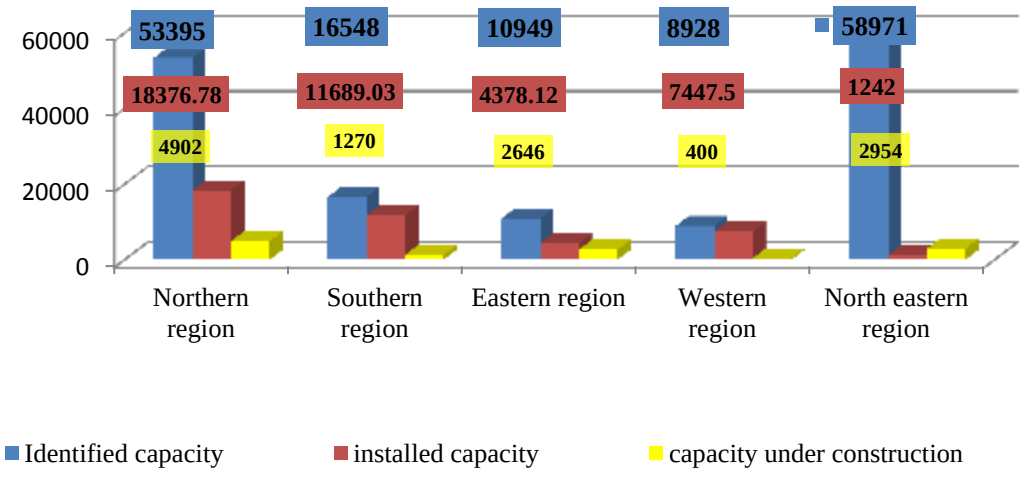

Fig3 Region wise comparison of identified ,installed and capacity under construction

IV. CURRENT STATUS OF HYDRO ELETRIC PLANTS IN INDIA

India ranks third after China and USA in the world in terms of numbers of dams. Nearly 4800 large dams have been completed in the country. Hydro generating unit sizes has been increased from 22 MW (from the independence) to 250 MW till today .At the time of independence the installed capacity of hydro electric power was only 508MW and the number of units operating then was only 51.Indian government invests in large amount for the development of hydro electric power. Construction of hydro

electric plant and its commissioning take near about 8-10 years. Thus building a hydro plant requires pre planning. Soon after the independence in the year 1948 the construction of Bhakra and hirakud dam started. The construction of Bhakra dam completed in 1963, and the construction of hirakud dam completed in 1957.In 1955 the construction of Nagarjuna dam started on the river krishna .The construction for this completed in 1967 .Another large gravity dam, indrasagar dam on Narmada river whose construction started in 1984, got commissioned in 2005.With the passage of time many large dams are built across the nation. Hydro electric power stations are built across these dams and thus they help in production of large hydro electric power. Table 3 shows major water dams with the river on which they are built and the installed hydro electric capacity on them. Hydro power in India has mainly three sectors, depending upon entity that is generating the power. These entities are the central government, respective state governments and the private companies.

Sr no.	NAME OF THE DAM	RIVER ON WHICH IT IS BUILT	INSTALLED HYDRO ELECTRIC CAPACITY(MW)
1	TEHRI DAM	BHAGIRATHI (UTTARAKHAND)	2400
2	KONYA DAM	KONYA (MAHARASHTRA)	1960
3	SRISAILAM DAM	KRISHNA (A.P)	1670
4	NATHPA JHAKRI	SATLUJ(H.P)	1500
5	SARDAR SAROVAR	NARMADA (GUJARAT)	1450
6	BHAKRA NANGAL	SATLUJ (H.P&PUNJAB)	1325
7	INDIRA SAGAR	NARMADA (M.P)	1000
8	NAGARJUNA	KRISHNA (TELANGANA)	816
9	IDUKKI DAM	KERALA(PERIYAR)	780
10	HIRAKUD DAM	MAHANADI (ODISHA)	307.5

Table 2: Major dams in India with their installed hydro electric potential

Each state has its electricity board which generates hydro power for its respective state. These state entities are HPSEBL, JKSPDCL, PSPCL etc. Central government generates hydro power and sell it to state government .Various utilities which generate hydro power for central government are NHPC,NTPC,BBMB,SJVNL etc .Other than these central and state government utilities ,there are some private companies which also generates hydro power in India .Some of the major hydro power producing companies in India are HBPCL, MPCL, EPPL, ADHPL and TPCL .Out of the total installed capacity the state utilities have the highest share with 57.53%.Figure 4 shows the sector wise installed capacity of hydro power in India. The electricity act 2003 has revolutionized the electric sector in India. It encourages private players in the field of generation, transmission and distribution. Major Private Companies producing hydro power in India are HBPCL (himachal baspa Power Company limited) with installed capacity of 1300MW, JPPVL (jaypee power ventures limited) with installed capacity of 400MW. TPCL (Tata Power Company limited) with installed capacity of 447MW.AHPC (ALAKNANDA HYDRO POWER COMPANY LIMITED) with installed capacity of 330MW.

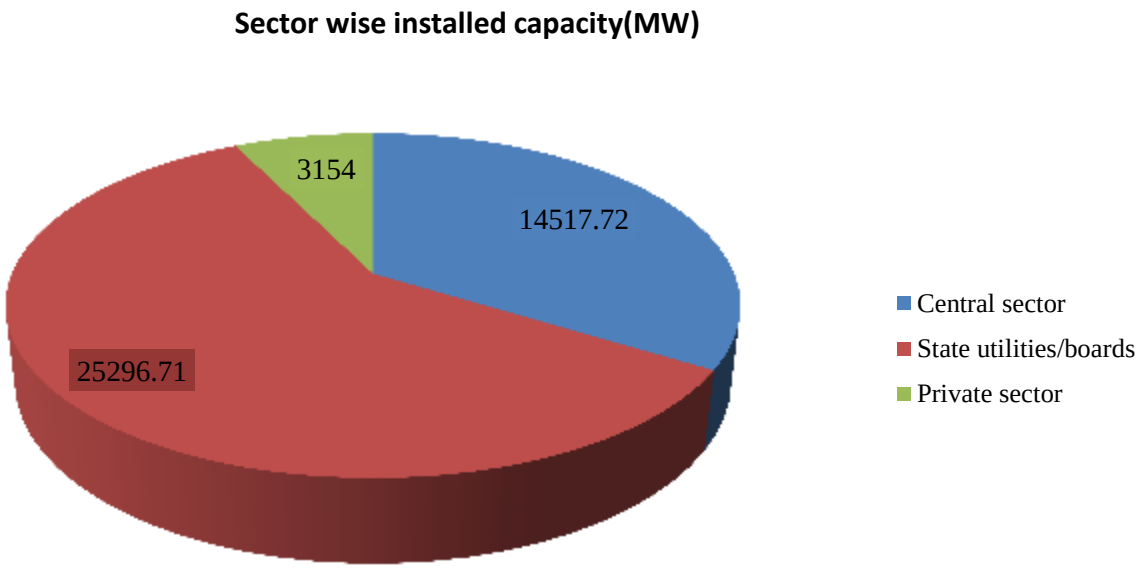

Fig 4: Sector wise installed capacity of hydro power of India

V. GROWTH OF SMALL HYDRO POWER IN INDIA

India's energy demand is going to increase rapidly in the coming decades. To fulfill the demand of industrial and residential loads, India must utilize the available energy source. Besides the large hydro potential, India can also utilize small hydro power plant for fulfill the energy demand of rural loads. In India, hydro power plants with generating capacity of up to 25 MW are considered as SHP plants and MNRE(Ministry of new and renewable energy) of Government of India has been authorized with the responsibility of developing this particular sector[11]. Small hydro power can creates competition, do not require long term planning, less expensive than large hydro power plant an d for rural electrification over a complete lifetime they are cheapest technology available. For fastening the inclusive development of the country and also the industrial development of the country, small hydro power is best energy solution available now [12]. By decreasing the use of fossil fuels by substituting them, small hydro power reduces the harmful emissions made by them, like carbon dioxide emission and green house gases [13, 14]. Small hydro power also plays part in reducing poverty and economic development in rural and remote parts of the country [15-18]. The potential of small hydro power in our country is estimated to be more than 20,000 MW from nearly 6500 sites and is increasing with each amendment [11]. Much of the SHP potential is concentrated in the states of the Himalayan region and north–east namely Himachal Pradesh, Uttarakhand, Jammu & Kashmir, and Arunachal Pradesh. In the plain region Karnataka, Andhra Pradesh, Maharashtra, Chhattisgarh, Madhya Pradesh and Kerala have sizeable potential. It is noted every time that the development of large hydro power plant is resisted by local community, environmentalist and NGOs due to issues such as deforestation and resettlement of the community [19]. However, of the total SHP potential nearly 75% is "run-of-river" type; this means they don't stop the natural flow of river and use the actual flow of river water to run the turbines and any dam or barrage that is built is very small, sometimes just a weir, and water stored in such dams is of very small quantity. Therefore, the problems of deforestation and resettlement associated with large hydro plants are eliminated in Small Hydro Plan [12]. MNRE has encouraged the development of small hydro projects in the public as well as private sector and has also focused on to lower the equipment cost used for these small plants, increase their reliability and set these projects in areas which give the maximum advantage in terms of capacity utilization. Water is a state government subject in India, and therefore the responsibility of SHP development remains with the state governments under the overall direction of

GOI. MNRE is supporting SHP development through various policies, regulatory support and financial backing and has also issued guidelines to the state governments for developing policies on their own, considering the factors responsible for their respective states, for renewable energy development, with special attention for SHP. Water of the river can be used directly by small hydro power plant, such plants are called run off river plant and these plants can be built on canals that are existing already and naturally formed barrages. Fig.5 shows that out of total small hydro power potential; more than 75% o is ROR (Run of river) type. ROR hydropower plant harnesses energy for electricity production mainly from the available flow of the river with only small amounts of water stored, if any and they do not make any harmful environment impact like the large hydro power plants. However, ROR plants cannot maintain the same capacity throughout the year, it may decrease in dry season and increase in rainy season. [20]. Further to utilize the SHP potential , efforts are being made to find out the hidden potential in facilities like, drinking water pipelines and other pipelines for industrial usage, effluent outfall at water treatment plants and sewage treatment plants, water outlet from small hydro dams can be further utilized for power generation and hydro kinetics in flowing channels/ streams[20] .

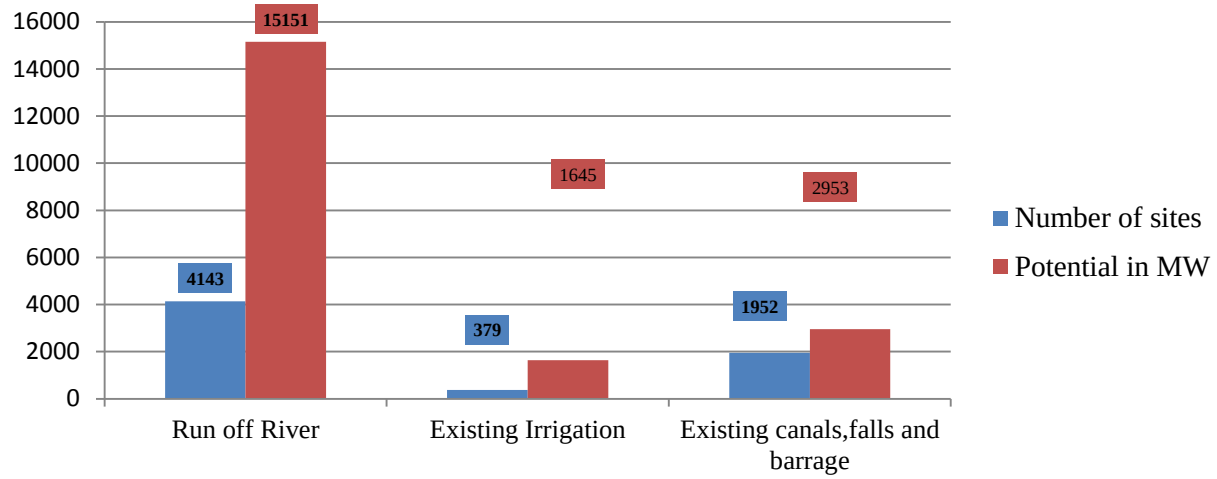

Fig 5 Sites with their corresponding potential

VI. CONCLUSION

Hydro power presently is the biggest source of renewable energy in the world and plays a predominant role in the world wide production of electricity .India has many hydro electric power stations which generates power in large amount .Over the last few years' Indian government has shifted towards other renewable energy sources like solar, wind biomass etc. This shift is because of the fact that hydro power plant requires many years for their full construction, this includes civil engineering works, installation of machinery and after that commissioning of plant .With energy demand of the country increases very rapidly, and other renewable sources must be utilized to meet the energy demand within few months or few years. But the development of hydro power plants must not stop, as they are the most reliable renewable energy source. To overcome the limitations which arise due to building of a dam, like requiring larger area, resettlement of the population nearby, small hydro power plant is the best alternative. Small hydro power plants are best for rural electrification and can generate revenue for rural population.

REFERENCES

[1] Ummadisingu A, Soni MS. Concentrating solar power-technology, potential and policy in India. Renewable and Sustainable Energy Reviews 2011;15: 5169–75.
[2] Singh R, Sood YR. Transmission tariff for restructured Indian power sector with special consideration to promotion of renewable energy sources. IEEE TENCON Conference 2009:1–7

[3] Mishra S, Singal SK, Khatod DK. Optimal installation of small hydropower plant—a review. Renewable and Sustainable Energy Reviews 2011;15:3862–9.J. Clerk Maxwell, A Treatise on Electricity and Magnetism, 3rd ed., vol. 2. Oxford: Clarendon, 1892, pp.68-73.
[4] Yuksel I. As a renewable energy hydropower for sustainable development in Turkey. Renew Sustain Energy Rev 2010;14:3213–9.
[5] Rojanamon P, Chaisomphob T, Bureekul T. Application of geographical information system to site selection of small run-of-river hydropower project by considering engineering/ economic/environmenta
[6] Intergovernmental Panel on Climate Change. special report on renewable energy sources and climate change mitigation: summary for policymakers and technical summary; 2012. ⟨https://www.ipcc.ch/pdf/special-reports/srren/ SRREN_FD_SPM_final.pdf⟩ [accessed 11.07.2014]
[7]] Schumann K, Saili L, Taylor R, Abdel-Malek R. Hydropower and Sustainable Development: A Journey, World energy congress, ⟨http://www.worldenergy.org/ documents/congresspapers/392.pdf⟩; February 2010 [accessed 27.02.2013]
[8]] Nautiyala H, Singalb SK, Varuna, Sharmaa A. Small hydropower for sustainable energy development in India. Renew Sustain Energy Rev 2011;15:2021–7
[9] International Hydropower Association. The role of hydropower in sustainable development, IHA white paper. ⟨http://www2.ce.metu.edu.tr/
[10] CEA.June2016Report,⟨http://www.cea.nic.in/reports/monthly/installedcapacity/2016/installed_capacity-11.pdf
[11] MNRE.SHP Program,⟨http://www.mnre.gov.in/schemes/grid-connected/ small-hydro⟩; [accessed 29.06.14]
[12]] Nautiyal H, Sk Singal, Varun, Sharma A. Small hydropower for sustainable energy development in India. Renew Sustain Energy Rev 2011;15(4):2021–7.
[13] Nautiyal H, Sk Singal, Varun, Sharma A. Small hydropower for sustainable energy development in India. Renew Sustain Energy Rev 2011;15(4):2021–7.
[14] Purohit P. Small hydro power projects under clean development mechanism in India: a preliminary assessment. Energy Policy 2008;36(6):2000–15
[15] Bhide A, Monroy C,R. Energy poverty: a special focus on energy poverty in India and renewable energy technologies. Renew Sustain Energy Rev 2011;15 (2):1057–66.
[16] Bhattacharya S, Jana C. Renewable energy in India: historical developments and prospects. Energy 2009;34(8):981–91.
[17] Nouni MR, Mullick SC, Kandpal TC. Providing electricity access to remote areas in India: Niche areas for decentralized electricity supply. Renew Energy 2009;34(2):430–4.
[18] Khan R. Towards realizing social sustainability in the small hydropower sector in India: opportunities for social innovations. Int J Innov Sustain Dev 2015;9 (1):48–62.
[19] Höffken JI. A closer look at small hydropower projects in India: Social acceptability of two storage-based projects in Karnataka. Renew Sustain Energy Rev 2014;34:155–66.
[20] World Small Hydropower Development Report; 2013
[21] ElectricityAct2003. ⟨http://powermin.nic.in/acts_notification/electricity_ act2003/preliminary.htm.

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