International Symposium

THE PLACE OF WATER POWER IN THE RENEWABLE ENERGY

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Hydropower in Rural Development - Overview of solutions in India

By

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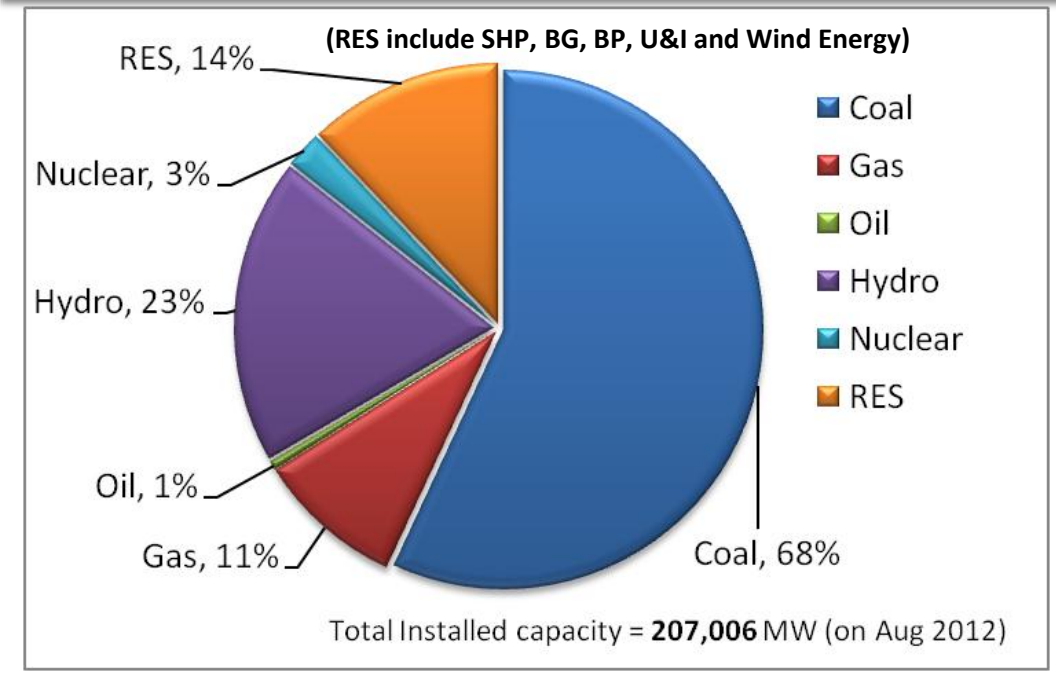
Introduction

- Renewable Sources of Energy attracted worldwide focus including the developing world.
- Large scale hydropower projects provide an excellent electricity base
- Small scale hydro power projects) – grid as well as to isolated is one of the proven option as a business as well as rural electrification
- Water in the most of the countries is government subject and hence for hydropower development permission from government is required.

STATUS OF ELECTRICITY IN INDIA



Peak Deficit : -9.8 %

Energy Deficit: -8.5 %

Un-electrified Villages:

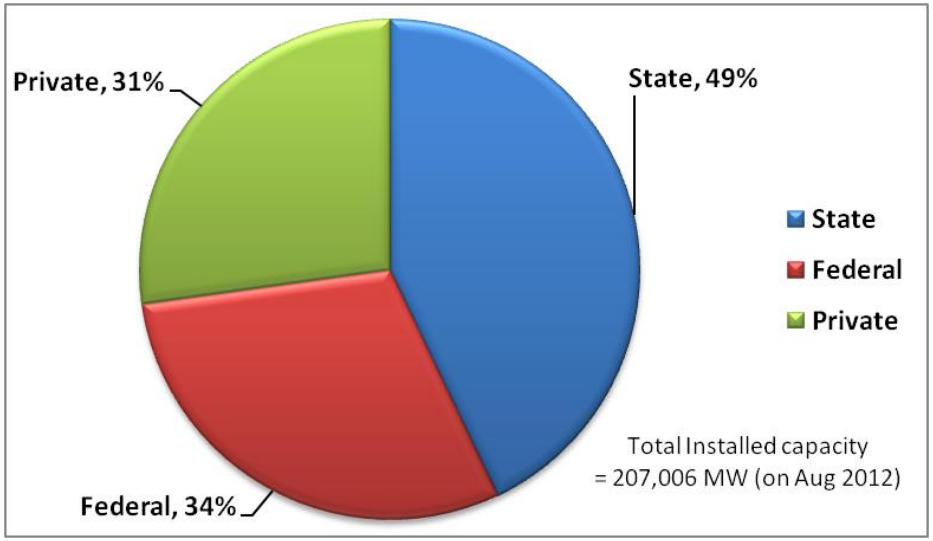
38,605 (6.5)%

Un-electrified households:

about 40%

Electricity Generation Capacity (MOP Aug, 2012)

Total:	207,006 MW
Thermal:	137,936 MW
Hydro:	***39,291 MW***
Nuclear	4,780 MW
RES	24,998 MW



CAPACITY ADDITION

A. Renewable during 12TH PLAN (2012-2017)

Total – 18500 MW out of a total 75,785 MW

- 11000 MW - wind
- 2100 MW – Biomass
- 1600 MW – SHP
- 3800 MW – Solar l

B. Renewable energy during 13th plan 2017-2022

30,500 MW out of a total 93,400 MW

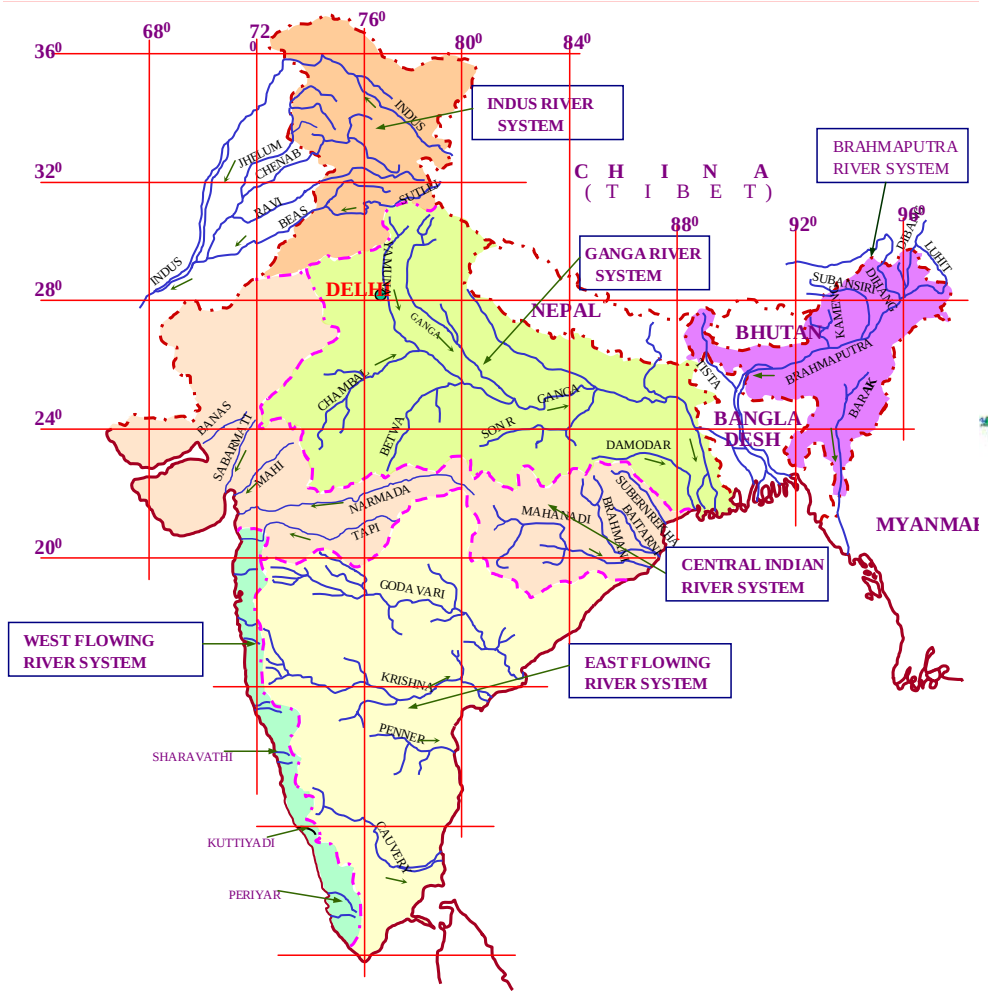
Total and Small Scale Hydropower Potential of South Asian Countries

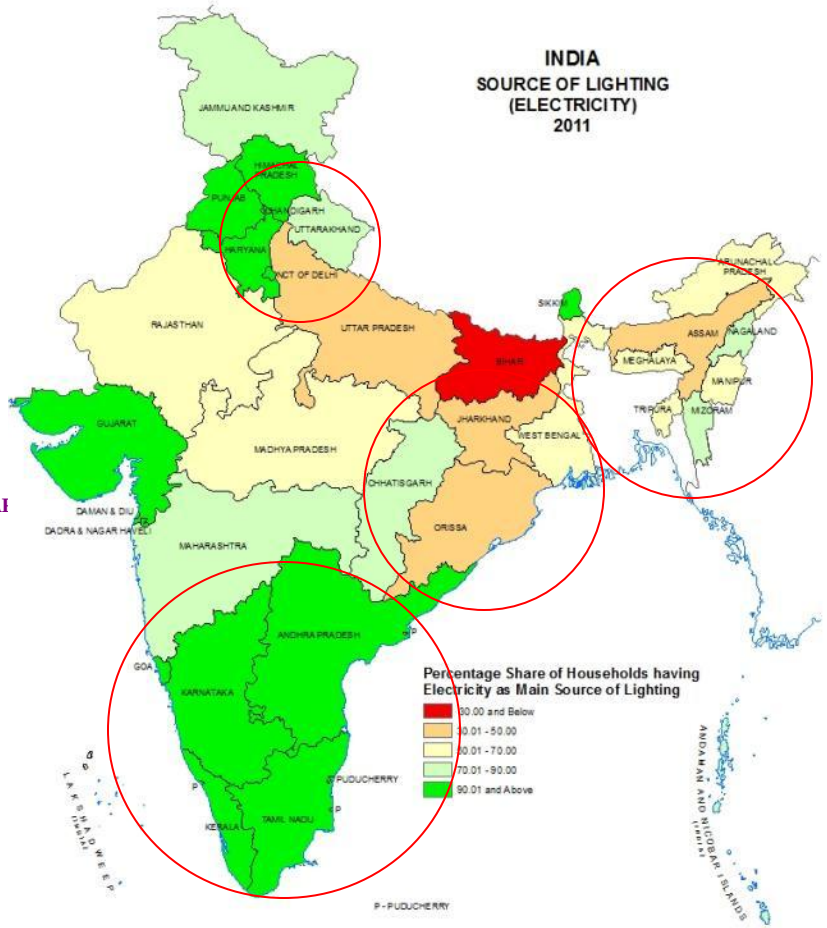
S. No.	Country	Total Potential (MW)	Installed hydro capacity (MW)	Annual Production (MU)	Total SHP Potential (MW)	Installed SHP Potential (MW)
1.	Afghanistan	25,000	400	1,000	1,200	22
2.	Bangladesh	1,500	230	1,200	1	0
3.	Bhutan	23,760	1,489	7,304	not available	8.8
4.	**India**	**148,701**	**38,706**	**114,300**	**15,000**	**3,198**
5.	Iran	35,427	8,488	17,900	5,600	129
6.	Nepal	83,600	664	3,060	1,430	60
7.	Pakistan	59,208	6,516	30,900	2,265	280
8.	Sri Lanka	8,250	1,357	5,634	400	182
South Asia Total		385,446	57,850	181,298	25,896	3,784

India has a 400 million energy poor population…..

- Nearly 400 million people (75 million out of 168 million rural households ie 45% , 6.5 million out of 79 Million urban households ie 7 %) without grid connectivity nationally. Ie 33 % still don't have electricity
- Another 33% of the population may be facing under-electrification
  - *Accessing less than 50 kWh of electricity per month/household*
  - *Many electrified villages also face shortage of electricity*
- Residents of off-grid villages use biomass for cooking and kerosene for light at night

Households using Electricity as Source of Lighting

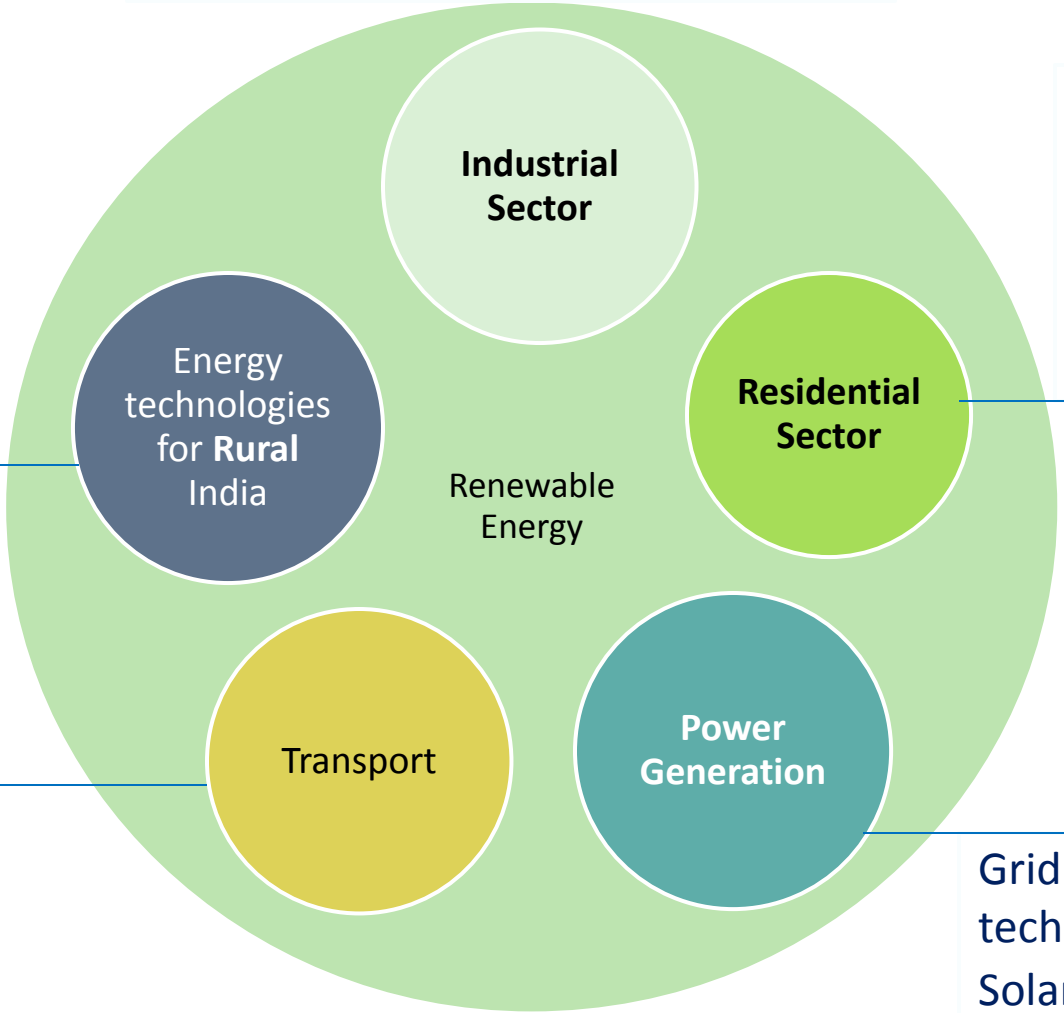




Renewable Energy contributes to growth across diverse sectors of Indian Economy

Solar water heaters, Green buildings

Off grid technologies like small hydro, Solar water pumps and lighting, water heaters, Biogas plants



Green Buildings, Solar water heaters, Solar Cooking units, Rooftop solar

Biofuels and battery operated vehicles

Grid Renewable technologies: Wind, Solar, Biomass, **Hydro**

PURPOSE of SHP

Social Sector SHPs-

- aims to supply electricity specially in stand alone mode,
- characterized with poor load factor and of small capacity
- often involved in distribution also
- Often are fully supported by government
- O&M is recovered through user charges collection

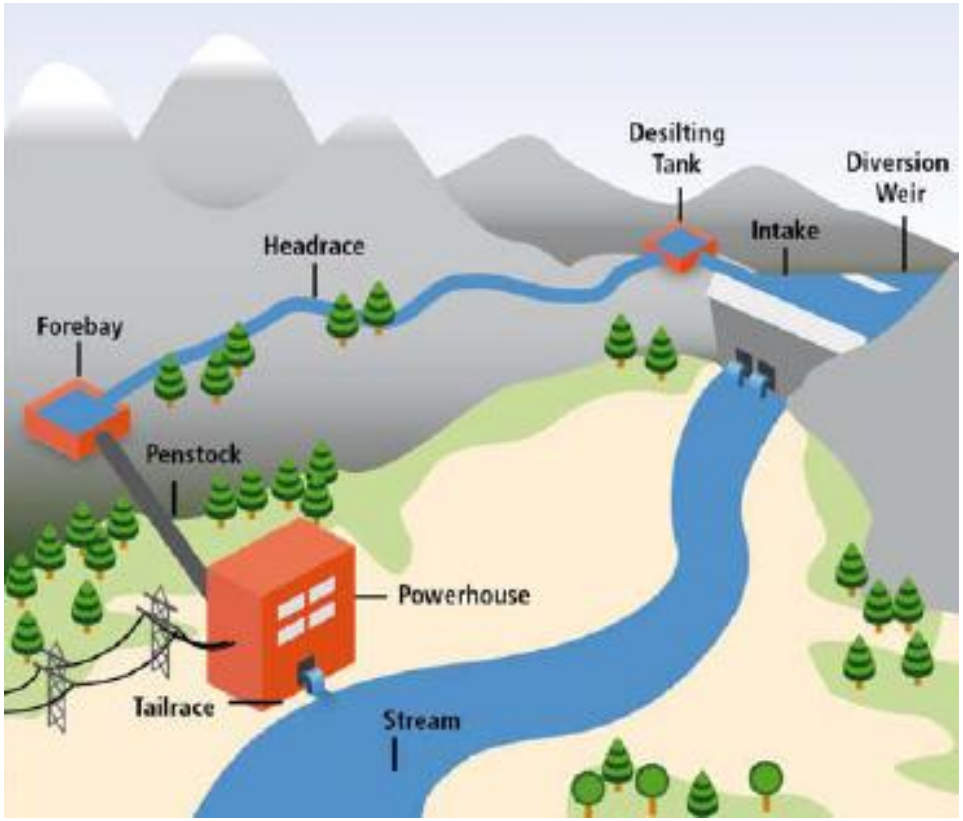
Commercial SHPs-

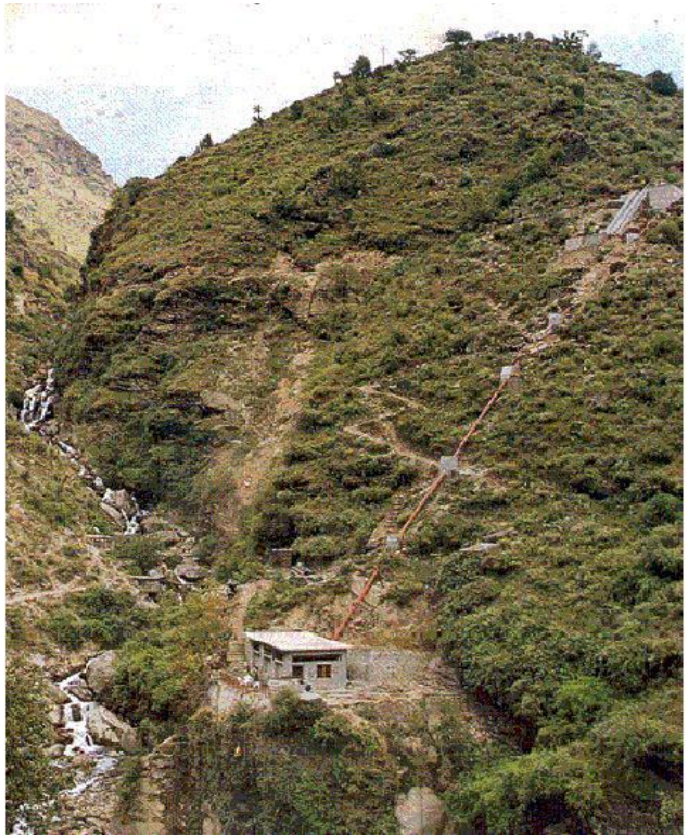
- aims to sell electricity to power distributing or trading companies or for captive use,
- are grid connected and are relatively larger capacity
- have high load factor
- Financially sound

Both are required and different level of approach, subsidy, tariff etc are needed

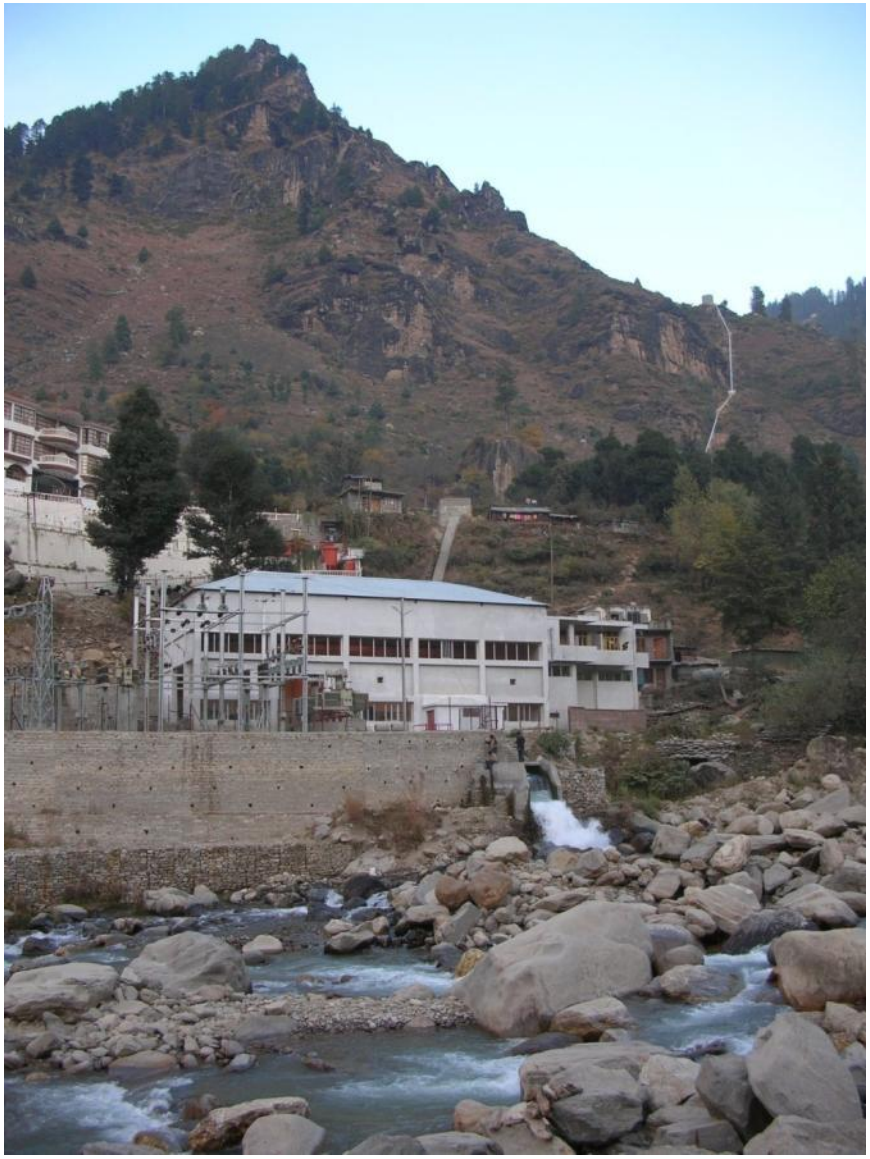
Types of Hydropower

Run of River:





Run of river hydropower development

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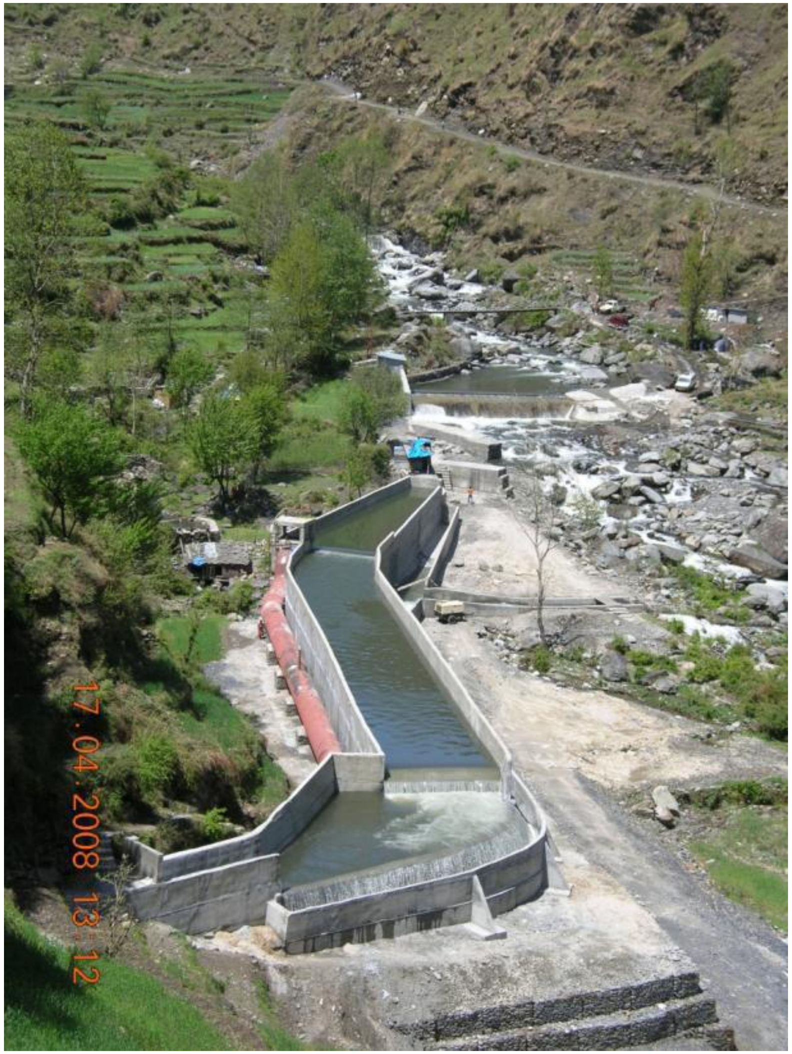
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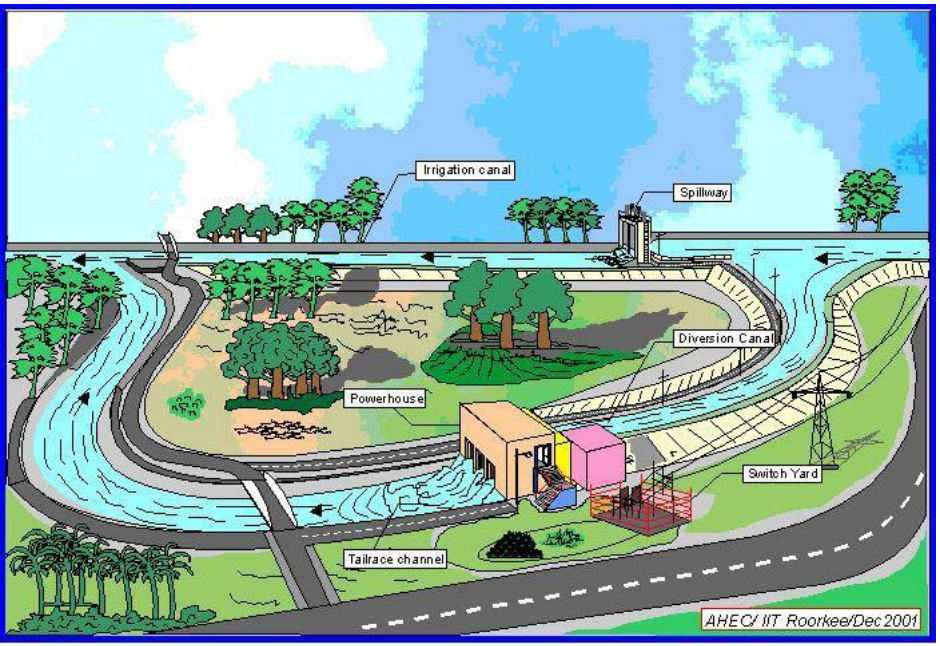
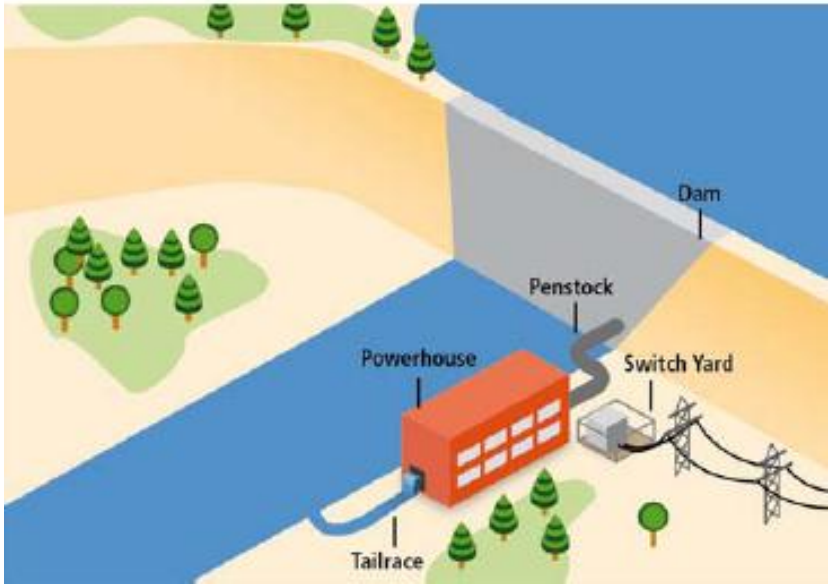
Using existing facilities:



Typical Arrangement of canal fall small hydropower development



Reservoir Based Hydropower Development

GOI POLICY ON HYDRO DEVELOPMENT

- In Aug 1998, the Government of India announced a Policy on 'Hydro Power Development' and revised in Nov.2008.
- Hydro is used to supplement the base load provided by thermal power plants.
- Central Electricity Authority has issued various hydro related reports and guidelines:
  - **the best practices in Hydroelectric Generation;**
  - **Preliminary ranking study of hydroelectric scheme;**
  - **Guidelines for accord of concurrence of HE Scheme;**
  - **Guidelines for formulation of DPRs for HE scheme;**
  - **Draft model contract document for hydro projects;**
  - **Project monitoring status reports;**
  - **Project clearance status reports**
  - **Status of 50,000 MW Hydroelectric Initiative reports .**

Small Hydro Potential Assessment is Required

Several opportunities where hydro power potential is yet to be assessed are

- Pipelines for drinking and industrial use.
- Effluent outfall at water treatment plants and sewage treatment plants
- Small scale pumped storage plants
- Hydro kinetics in flowing channels/streams

MNRE, GOI is contemplating a small scale hydropower assessment programme during the 12^{th} plan period.

About IPCC – SRREN Special Report on Renewable energy and Climate Change Mitigation has ***Hydropower*** Chapter

Team

- India
- Brasil
- China
- Ghana
- Norway
- France
- USA
- El Salvador
- Cuba

Objective of report was to be politicy relevant but not policy prescriptive

Hydropower Potential

Regional hydropower technical potential in terms of annual generation and installed capacity (GW); and current generation, installed capacity, average capacity factors in percent and resulting undeveloped potential as of 2009. Source: IJHD (2010).

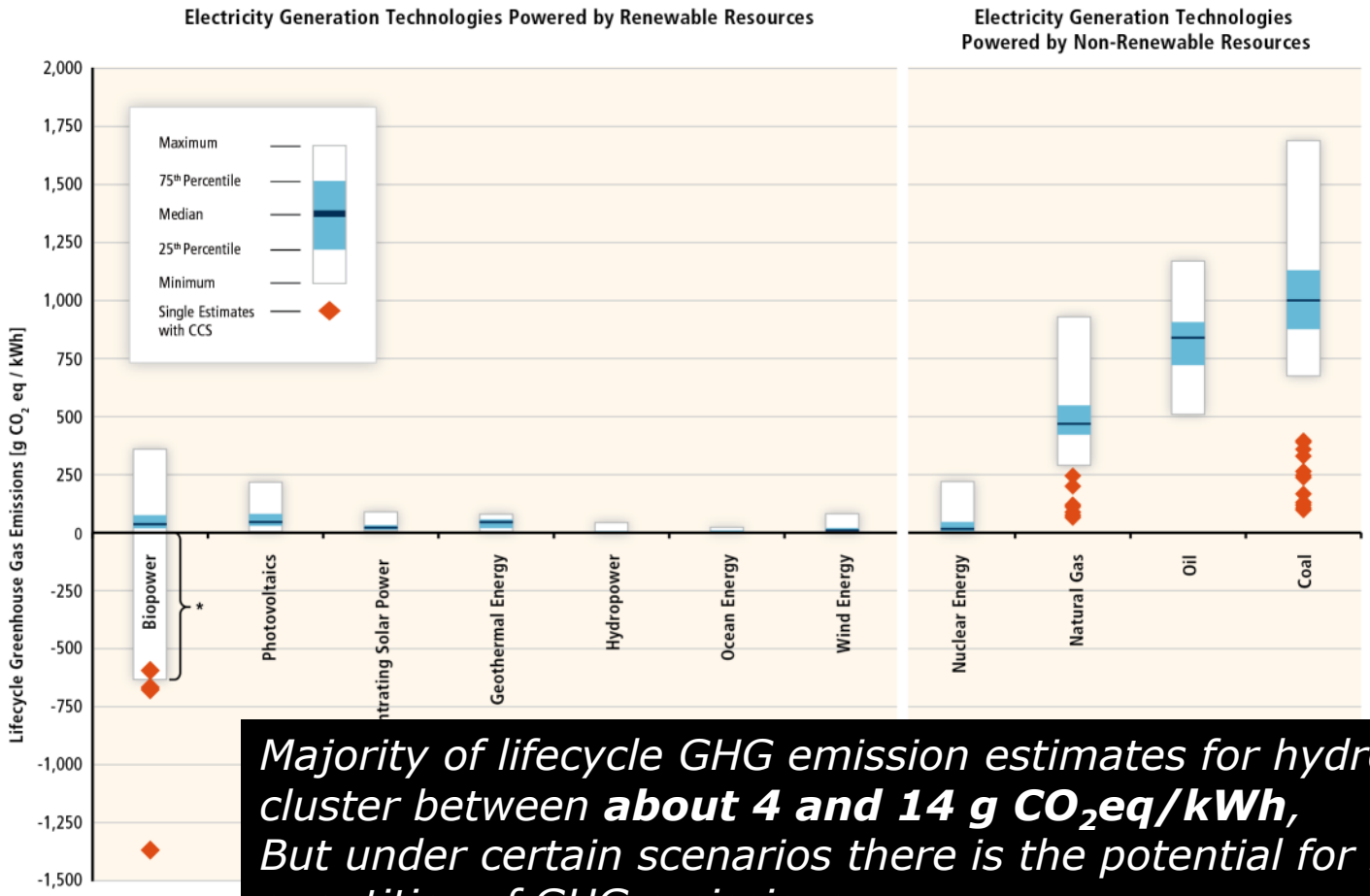
World region	Technical potential, annual generation TWh/yr	Technical potential, (GW)	2009 Total generation TWh/yr	2009 Install capaci (GW)	Un-developed potential (%)	Averag regiona capacity factor (%)
North America	1,659	388	628	153	61	47
Latin America	2,856	608	732	156	74	54
Europe	1,021	338	542	179	47	35
Africa	1,174	283	98	23	92	47
Asia	7,681	2,037	1,514	402	80	43
Australasia/ Oceania	185	67	37	13	80	32
World	**14,576**	**3,721**	**3,551**	**926**	**75**	**44**

Hydropower Sustainability

11 sensitive issues

- **Hydrological regimes**
- **Reservoir creation**
- **Water quality**
- **Sedimentation**
- **Biological diversity**
- **Barriers for fish migration and navigation**
- **Involuntary population displacement**
- **Affected people**
- **Public health**
- **Cultural heritage**
- **Sharing development benefits**

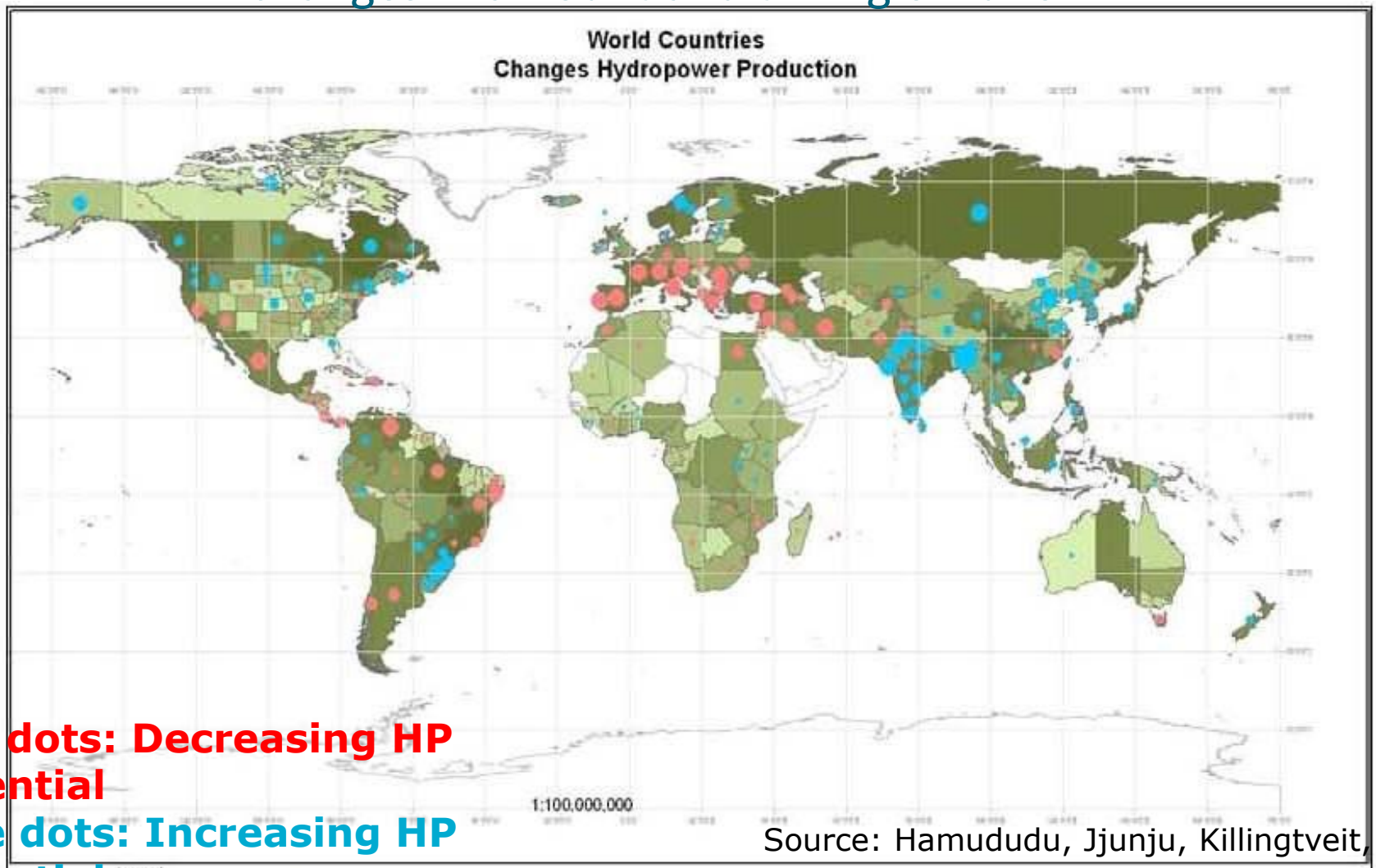
Mitigating climate change



Majority of lifecycle GHG emission estimates for hydropower cluster between ***about 4 and 14 g CO_2eq/kWh,***
But under certain scenarios there is the potential for much larger quantities of GHG emissions

Count of Estimates	222(+4)	124	42	8	28	10	126	125	83(+7)	24	169(+12)
Count of References	52(+0)	26	13	6	11	5	49	32	36(+4)	10	50(+10)

Hydropower potential could change due to changes in amount and timing of runoff



Source: Hamududu, Jjunju, Killingtveit, 2010

Red dots: Decreasing HP potential

Blue dots: Increasing HP potential

Size of dots indicate rate of change

Globally a slight increase in HP potential is predicted This conclusion was based on research from NTNU

Power generation capacity in GW and TWh/yr (2005) and estimated changes (TWh/yr) due to climate change by 2050

Region	Power Generation Capacity (2005)		Change by 2050 TWh/yr
	GW	TWh/yr	
Africa	22	90	0.0
Asia	246	996	2.7
Europe	177	517	-0.8
North America	161	655	0.3
South America	119	661	0.3
Oceania	13	40	0.0
TOTAL	737	2931	2.5

Source: Hamududu and Killingtveit (2010)

Barriers to SHP Development

Technical Barriers

- Absence of feasibility reports Reports with Sufficient Details to take Investment Decisions
- Absence of basic data for the project like Hydrological data
- To increase plant load factor integration with other development and livelihood activities like irrigation, rural industries, education, health etc
- To connect to main electricity grid
- To have qualified and well trained personnel at all levels
- Absence of Manuals /Guidebooks/Hand books for various items of work

Barriers to SHP Development....contd

Institutional Barriers

- To provide basic data for the project
- To provide conducive environment
- To provide attractive tariff by the users or utility

Manufacturers and Suppliers Barriers

Barriers to SHP Development…. contd

Policy Barriers

- Undecided about the development priority of the area
- Hidden subsidies to other energy sources not taken into consideration
- Absence of integration of different sector development

Social barriers

- Hesitation in participation in development process
- Lack of visualization for enhancing livelihood activities

Difficulty in Getting Clearances from Government

Possible solutions to Barriers to SHP Development

- **Capacity development is the key to success for scaling up of SHP programme** ***for*** *planning, oversight, and monitoring; training to all project developers, facilitators, financial institutions and community members; adopting the standard equipments and designs*
- **Upfront public financing**
- **Encouraging higher participation of private sector**
- **Continued support R& D in several areas**
- **Clarity in Policies and regulations**
- **Setting up and enhancing institutions capacity**

Tariff for SHP by different Regulators

Plant capacity (MW)	Tariff (US cents/kWh)			
	Uttrakhand state	Federal	Maharastra st	Punjab State
Up to 5	7.5	7.8 (Hilly) 9.24 (Others)	8.56	8.52
5 to 10	7.3	6.7(Hilly) 8.0(Others)	7.3	7.3
10 to 15	7.0			
15 to 20	6.8			
20 to 25	**6.5**			

Assumed 1 UD $ = 50 Indian Rupees

SMALL SCALE HYDRO POWER- new Issues

- Mostly run of river type and don't provide adequate power during lean season
- Mostly new private developers
- Several new turbine manufactures and don't provide reliable quality equipment
- Automation is not provided as normal choice
- New consultant for engineering not having experience to handle hydraulics and sediment
- Not much regulations available for releasing environmental flows at diversions causing great concern at several places

Hydel Generating Sets of Laptap MMHP (2 x 20 kW)

MHP IN Nagaland

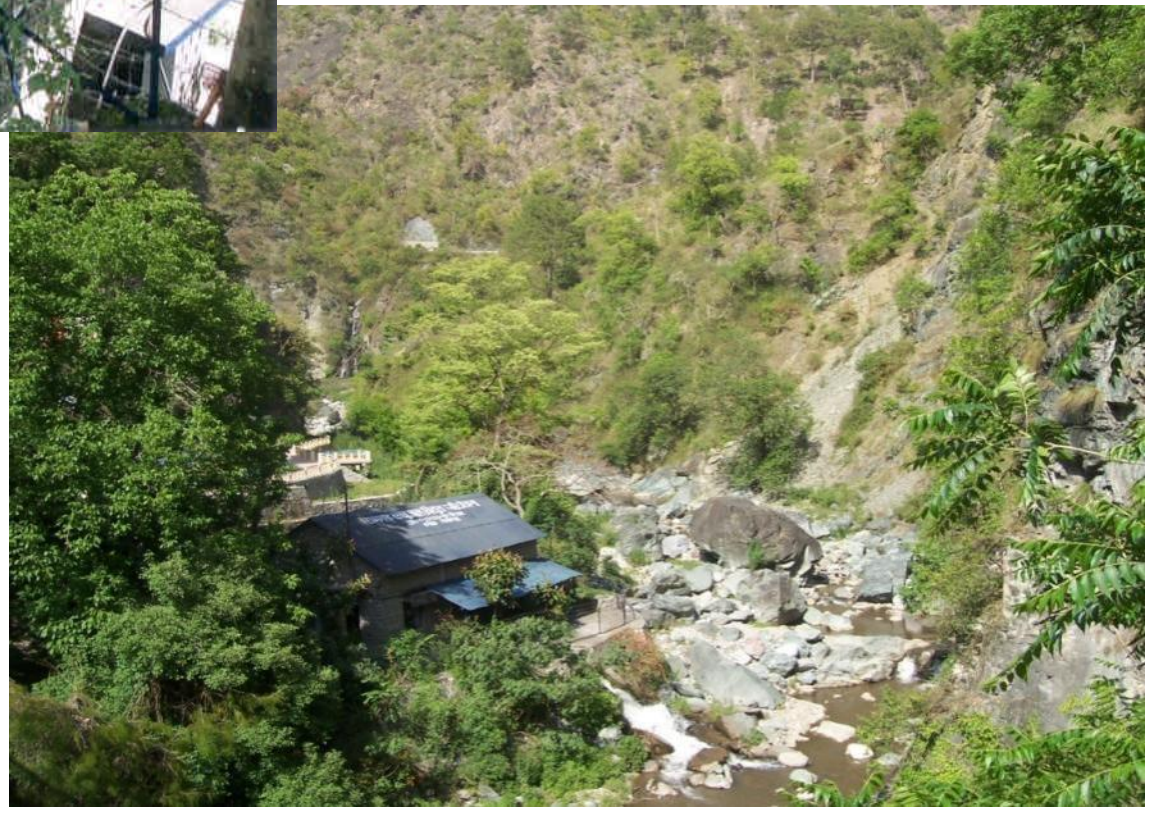
manufacturing unit

Pico-hydro (Karnataka)

Case study of “Ramgad MHP” in District Nainital

- Installed Capacity = 100 KW
- Year of Installation = 1995
- No. of Unit = 2x50 KW
- Net Head = 50 m
- Design Discharge = 382 LPS
- No. of operators = 1x3(shifts)
- Electrician = 1 No.
- Electrification = 372 Households
- Local Grid Network = 15 Kms.
- Operation & Maintained= By Ramgad Urja Samiti having 12 Members from user villages including 30% women members.
- Ramgarh Urja Samiti : Shri Inder Singh Chairman


रामगाड़ ऊर्जा समिति रामगाड़- नैनीताल.



Case study of “Ramgad MHP Nainital

- Electricity was erratic before Grid connectivity
- In 2005 grid connectivity completed at total cost of all civil works and E&M works at about USD 70,000 under special grant from UREDA
- Villages now advantage of almost 24 hours of supply even during the days of low flows
- A sum of USD 400 is collected from the villagers per month. Project has almost USD 6,000 as saving after deducting annual operation cost of USD 5,000
- Replacement of 1000 traditional bulbs with LED Bulb.
- Installation of 100 LED Street Light in the beneficiary villages.
- The project site is being developed as tourist place by local administration with eco-friendly environment and waterfall.

Achievements in MHPs

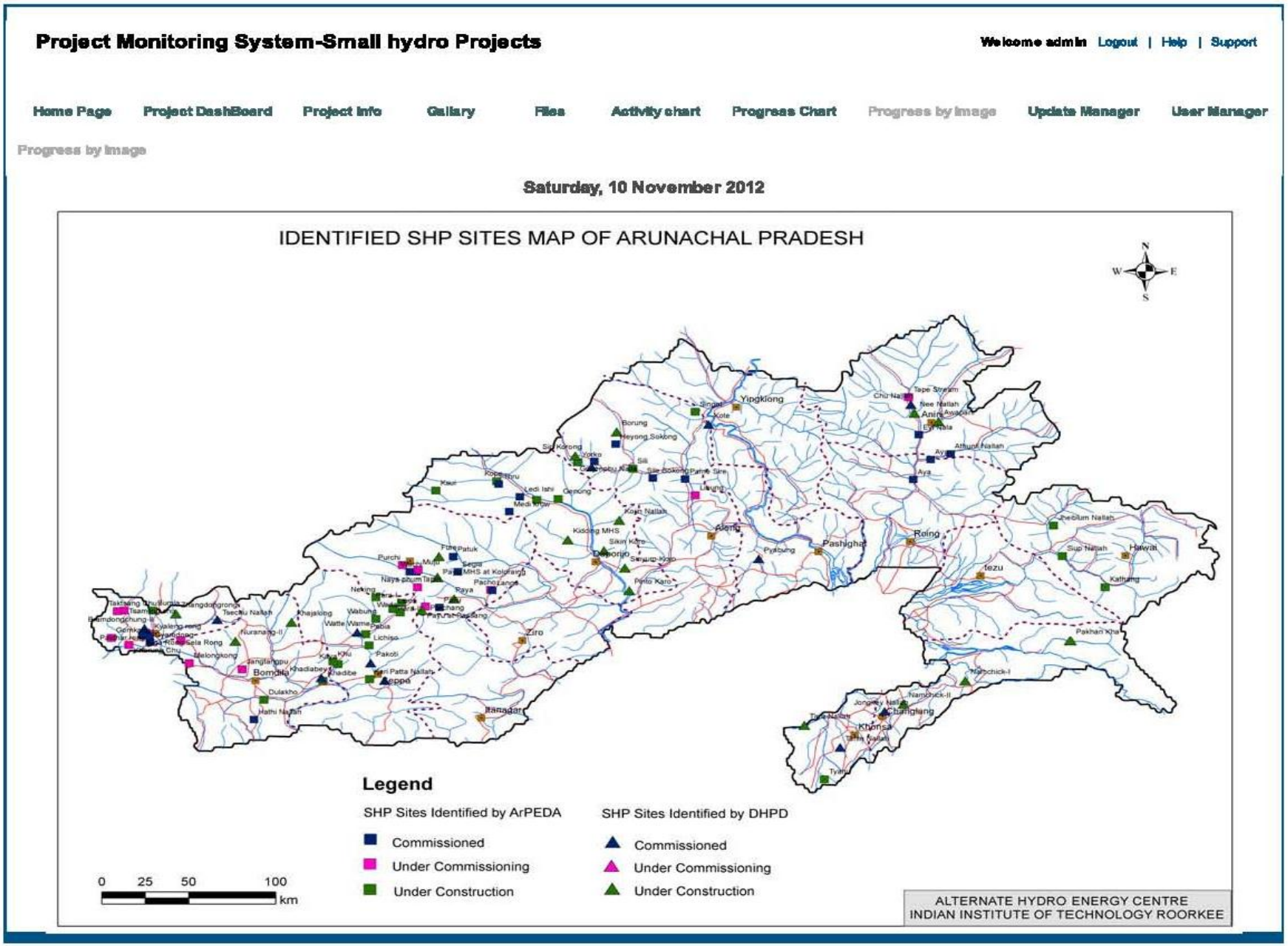
- **37 MHPs Constructed**
  - Installed Capacity : 3.635 MW
  - Capacity Range : 20 KW - 500 KW
  - Electrified Villages/Hamlets: 286 Nos.
  - Grid feeding Schemes : 03 Nos.
- **20 MHPs Under Construction**
  - Capacity : 2.19 MW
  - Capacity Range : 20 KW - 500 KW
  - Proposed Electrification. : 59 Village/Hamlets
  - Proposed Grid Feeding : 3 MHPs.

Decentralized Village Hydro Scheme

CASE STUDY OF ARUNACHAL PRADESH

- ✓ Under a Project on "Electrification/ illumination of all villages along the State border of Arunachal Pradesh" 2008-1367 micro hydropower projects being implemented in Arunachal Pradesh from 2009 onwards under special package.
- ✓ The project sizes varies from 10 to 200 kW
- ✓ All of them are stand alone system at present
- ✓ There is a possibility of grid extension in next 10 – 20 years
- ✓ Accordingly all units have been provided the possibility of connecting to grid by providing provisions of
- ✓ Excitation system of the generator with automatic power factor controller
- ✓ Synchronization panel
- ✓ An attempt has been made to standardize the shp sites to achieve economy of scale, to reduce design and management efforts

Arunachal Pradesh map showing Part ‘C’ schemes of PM’s package



Standardization of E&M Works (capacity)

Sl. No.	E & M	Discharge		APEDA	DHPD	Total Site
	Group range	Min.	Max.			
1.	1 × 10	0.029	0.121	23	0	23
2.	1 × 15	0.051	0.157	8	0	8
3.	1 × 25	0.028	0.303	22	3	25
4.	1 × 50	0.147	0.428	7	7	14
5.	2 × 50	0.265	1.235	4	9	13
6.	2 × 100	0.438	0.482	3	2	5
7.	2 × 150	2.454	2.454	0	1	1
8.	2 × 250	0.697	1.845	0	3	3
9.	2 × 500	0.735	3.136	0	2	2
10.	2 × 1000	3.774	3.774	0	1	1
	Total			**67**	**28**	**95**

Standardization for Civil Works

Sl. No.	CIVIL	APEDA	DHPD	Total Site
	Group range	Total	Total	
A.	Standard category discharge			
1.	0.050	19	0	19
2.	0.075	10	0	10
3.	0.100	0	0	0
4.	0.125	12	2	14
5.	0.175	2	0	2
6.	0.250	14	6	20
7.	0.325	0	0	0
8.	0.400	0	0	0
9.	0.500	9	10	19
10.	0.625	0	0	0
11.	0.750	1	4	5
	Total	**67**	**28**	**95**

Wachi (1 X 10 kW)
District – Kurung Kumey
Agency – APEDA

A view of Feeder Channel (April 2012)

Inside view of Power

A view of Power house with

Naya Phum (1 X 10 kW)
District – Kurung Kumey

A view of Feeder Channel (April 2012)

Inside view of Power House

A view of T&D Line

Jonkey Nallah (1 X 25 kW)
Distrit – Changlang
Agency – DHPD

A view of Turbine (May 2012)

A view of Transformer and T&D Line

A view of Power House

SMALL SCALE HYDRO POWER- Areas for collaboration

- Silt erosion measurements, assessment and silt resistive material for turbines
- Efficiency evaluation and development of variable-speed operation (Optimal use of low and variable heads sites) using the hydraulic turbine testing laboratory
- Environmental Management of rivers for hydropower development- e-flows
- Sediment management and handling hydropower development during snow and ice conditions
- Development of standardized control and monitoring hardware and software package

SMALL SCALE HYDROPOWER- Areas for collaboration

- Diagnostic analysis and solutions on the performance and behavior of the hydro turbine under control conditions.
- Cost effective development of very low head technology (0.5 to 2 m)
- Adaptation of high pole permanent magnet excitation generators to small hydro
- Optimizing Water Resources for Multiple Uses
- Integrating Renewable and Distributed Energy Technologies

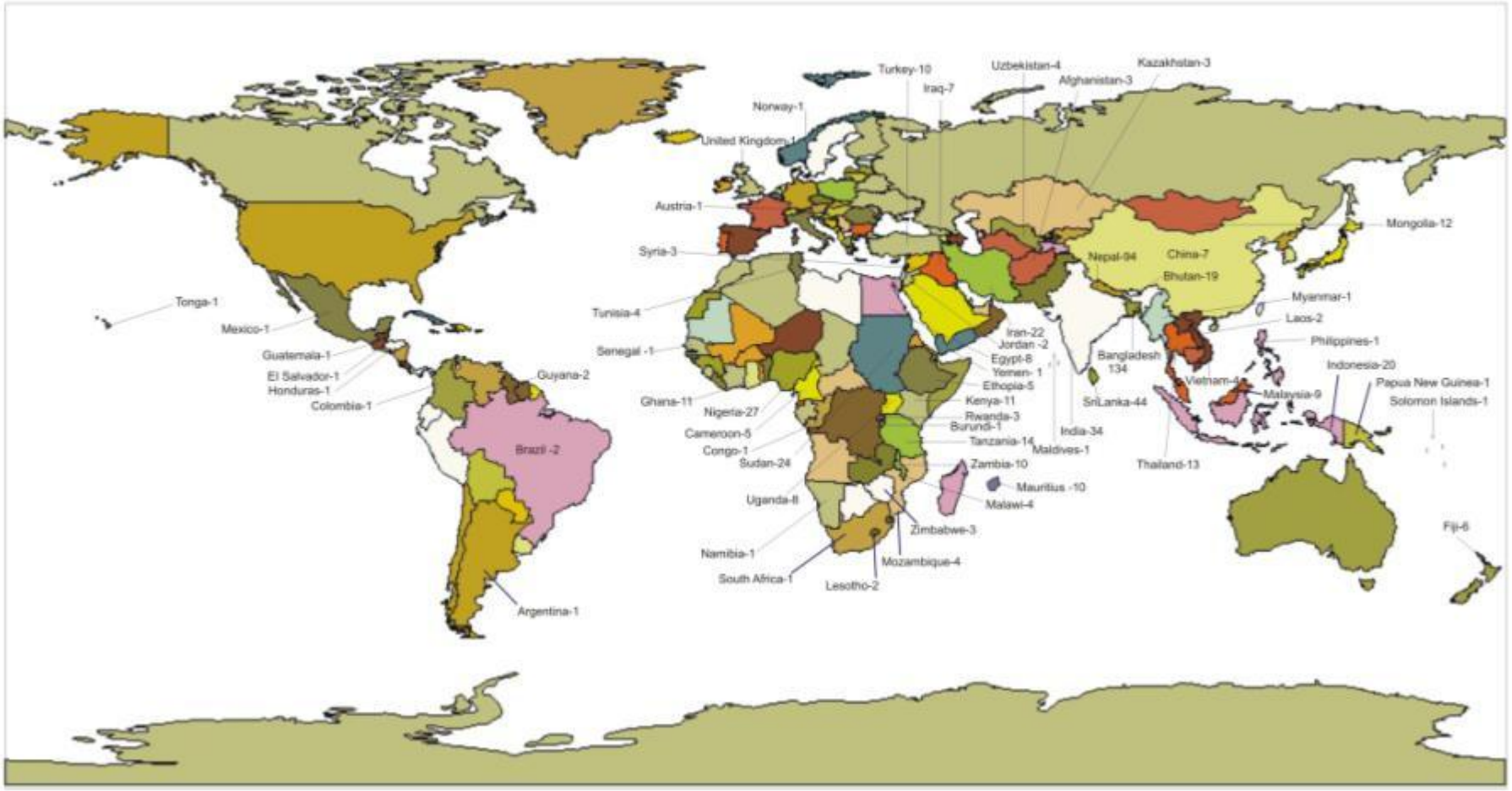
AHEC, IIT Roorkee

- Set up initially by MNRE government of India in 1982
- Exclusive academic center of IIT Roorkee working with focus on SHP development and recognized as National Resource Centre for Small Hydropower.
- Large national database and resource assessment for shp development and rural electrification.
- Preparing the National Standards/ Code of Practices for SHP development.
- Systematic state master plans for shp and remote village electrification
- Training and education in shp at all levels and related field as per requirement. Two Masters of Techonlogy and PhD programmes are offered
- Independent performance and efficeincy testing and evaluation of shp stations
- International training and technical support.

Real-Time Digital Simulator (RTDS) for Small Hydropower Plant at Alternate Hydro Energy Centre IIT Roorkee

Number of Participants attended the International Training Courses on SHP Development Organised by AHEC,IIT Roorkee

1999 Onwards



AHEC/Feb. 2012

Thank You