

# **ROLE OF HYDROPOWER IN MAINTAINING ENERGY SECURITY**



**A. K. GANGOPADHYAY**

**Director (Projects)**

**NATIONAL HYDROELECTRIC POWER CORPORATION  
LIMITED**

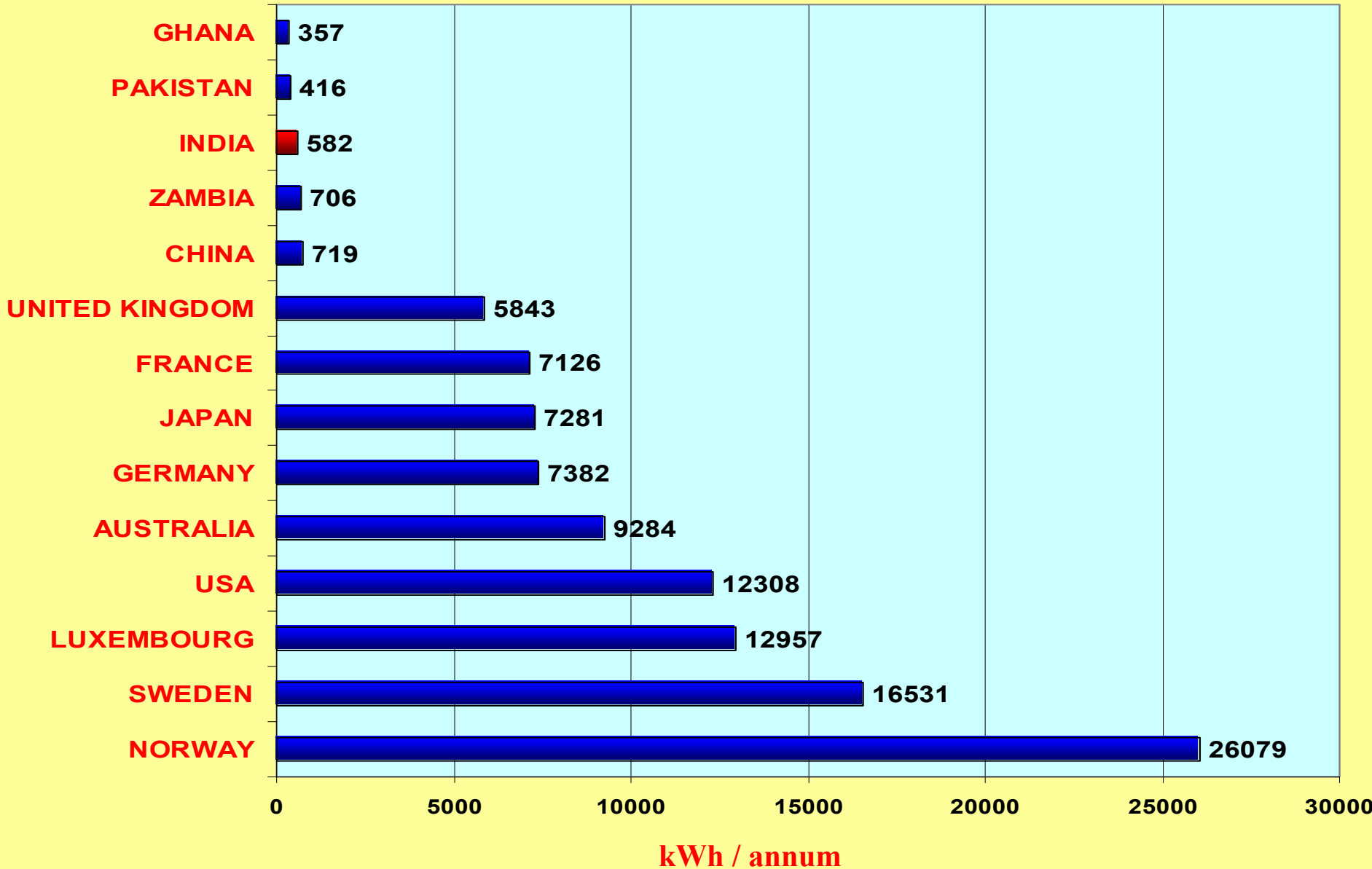
# **DEVELOPING COUNTRIES - STARVING FOR ENERGY**

- THREE FOURTH OF WORLD POPULATION LIVES IN DEVELOPING COUNTRIES**
- LESS THAN ONE THIRD OF WORLD'S ENERGY IS CONSUMED BY DEVELOPING COUNTRIES**
- ENERGY USE IN DEVELOPING COUNTRIES HAS DOUBLED IN LAST TWO DECADES**
- ENERGY USE WILL FURTHER DOUBLE IN THE NEXT 15 YEARS**

# **DEVELOPING COUNTRIES - STARVING FOR ENERGY**

- DEVELOPED COUNTRIES HAVE ALREADY TAPPED BULK OF THEIR HYDROPOWER POTENTIAL**
- MORE THAN 90% OF HYDROPOWER POTENTIAL OF DEVELOPING COUNTRIES YET TO BE TAPPED**
- DEVELOPING COUNTRIES IN DIRE NEED OF ELECTRICITY TO BOOST THEIR DOMESTIC INDUSTRIES FOR EMPLOYMENT GENERATION AND BETTER STANDARDS OF LIVING**

# PER CAPITA CONSUMPTION OF ELECTRICITY IN SOME COUNTRIES (kWh / ANNUM)



# STATUS OF HYDROPOWER DEVELOPMENT

S. No.	Country	Technically Feasible <sup>1</sup> (MW)	Already developed <sup>2</sup> (MW)	Under development <sup>3</sup>	Already harnessed potential (%)
1	ANGOLA	16000	430	520	2.7
2	CAMEROON	23000	723	N/A	3.14
3	PHILIPPINES	12153	2300	555	18.9
4	BRAZIL	258494	64000	11000	24.8
5	URUGUAY	17644	1534	N/A	8.7
6	INDIA*	84044	15158	5014	18.04
7	INDONESIA	75625	4300	363	5.7
8	LAOS	20000	622	150	3.1
9	MYANMAR	108000	390	1862	0.36
10	NEPAL	83000	430	121	0.52
11	PAKISTAN	30000	5039	1469	16.8

\* As on 1.07.2004 at 60% load factor.

Source: 1 International Water Power and Dam construction Yearbook 1997: The World's Hydro resources.

2 & 3 Hydro Power and Dams World Atlas 2003.

# **INDIAN POWER SCENARIO (AS ON 01.12.2004)**

<b>• INSTALLED CAPACITY</b>	<b>1,14,565 MW</b>
<b>• HYDRO</b>	<b>29,905 MW</b>
<b>• THERMAL</b>	<b>79,452 MW</b>
<b>• WIND</b>	<b>2,488 MW</b>
<b>• NUCLEAR</b>	<b>2720 MW</b>
<b>• HYDRO SHARE</b>	<b>26.12%</b>
<b>• PEAK SHORTAGE (2003-04)</b>	<b>11.2%</b>
<b>• ENERGY SHORTAGE (2003-04)</b>	<b>7.1%</b>

# **ELECTRICAL POWER DEMAND IN INDIA**

- **BY 2007 ENERGY AND PEAK REQUIREMENT WOULD BE ABOUT 719.1 BUs AND 1,15,705 MW RESPECTIVELY**
- **BY 2012, LIKELY TO INCREASE TO 975.2 BUs AND 1,57,107 MW RESPECTIVELY**
- **DEMAND INCREASING AT A COMPOUNDED GROWTH RATE OF 9% ANNUALLY, AMONG ONE OF THE HIGHEST IN THE WORLD**
- **80,000 VILLAGES YET TO BE ELECTRIFIED**
- **BY 2012, CAPACITY REQUIREMENT ENVISAGED IS OF THE ORDER OF 2,00,000 MW**

# PROJECTED POWER DEMAND IN INDIA

REGION	ENERGY REQUIREMENT (Mkwh)		PEAK DEMAND (MW)	
	2006-07 End of 10th Plan	2011-12 End of 11th Plan	2006-07 End of 10th Plan	2011-12 End of 11th Plan
NORTHERN REGION	220820	308528	35540	49674
WESTERN REGION	224927	299075	35223	46825
SOUTHERN REGION	194102	262718	31017	42061
EASTERN REGION	69467	90396	11990	15664
NORTH-EASTERN REG.	9501	14061	1875	2789
A&N ISLANDS	236	374	49	77
LAKSHADEEP	44	70	11	17
<b>ALL INDIA</b>	<b>719097</b>	<b>975222</b>	<b>115705</b>	<b>157107</b>

SOURCE : 16<sup>TH</sup> EPS

# **FUTURE CONCERNS**

- **TODAY, A MAJOR PORTION OF ELECTRICITY AMOUNTING TO ABOUT 75% COMES FROM THERMAL SOURCES I.E., COAL, GAS AND OIL**
- **INCREASING GLOBAL CONCERNS ABOUT SUSTAINABILITY OF THESE FORMS OF ENERGY**
- **THEIR USE IN LONG TERM WOULD BEAR A QUESTION MARK VIS-À-VIS ENERGY SECURITY**
- **UNSATISFACTORY SYSTEM CONDITIONS WOULD CONTINUE TO PREVAIL DUE TO ADVERSE GENERATION MIX**

# **IMPACT OF ADVERSE GENERATION MIX**

- **PEAK SHORTAGES**
- **SYSTEM UNRELIABILITY/GRID INSTABILITY**
- **FREQUENCY EXCURSIONS**
- **FAST DEPLETING FOSSIL FUEL**
- **ENVIRONMENTAL ISSUES : CO<sub>2</sub> EMISSIONS**
- **FREQUENCY VARIATION DAMAGES THERMAL  
TURBINE PARTS AND ELECTRICAL APPLIANCES**
- **TRIPPING OF THERMAL MACHINES**
- **MACHINE ISOLATION LEADS TO CASCADING AND  
EVENTUAL FAILURE**

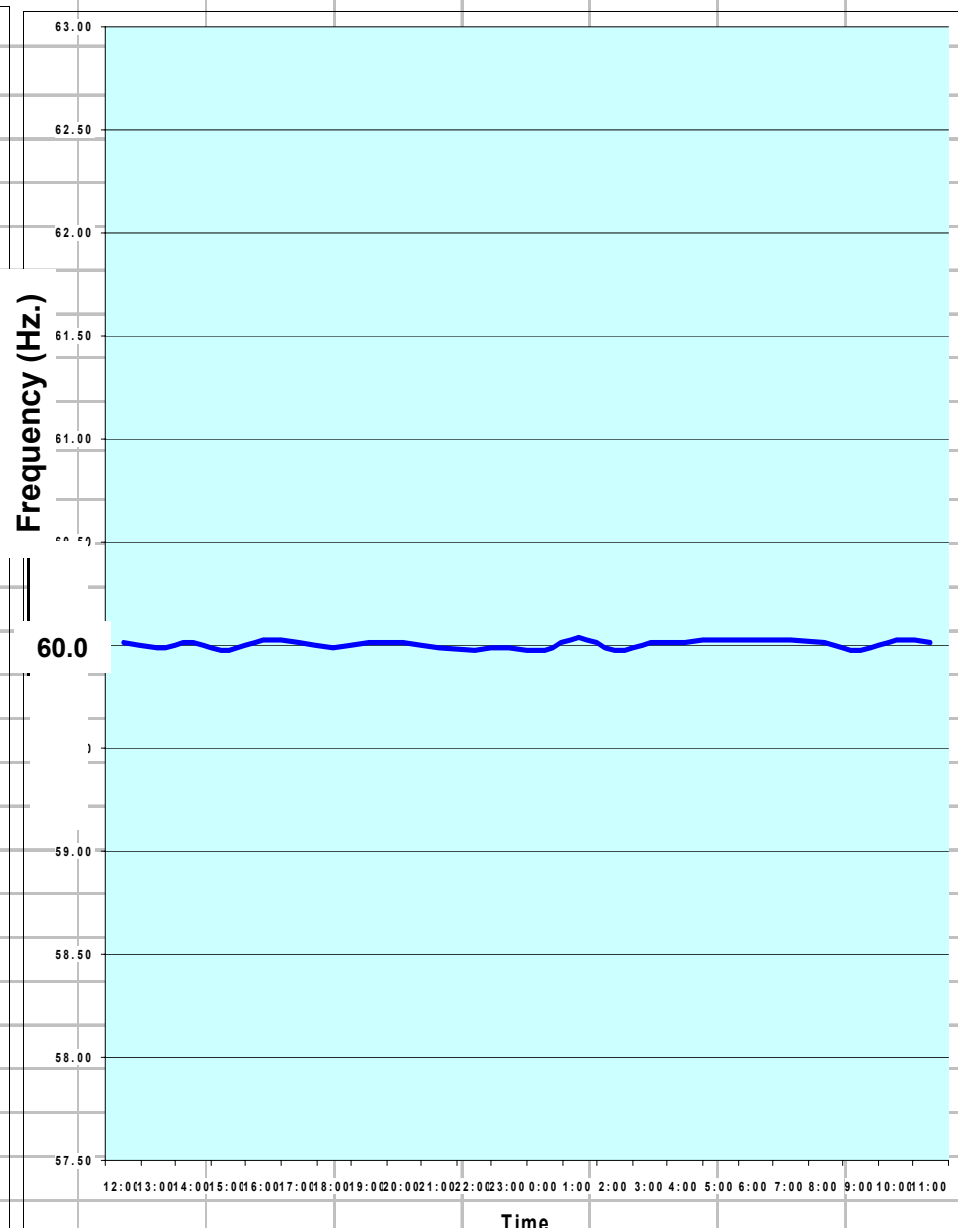
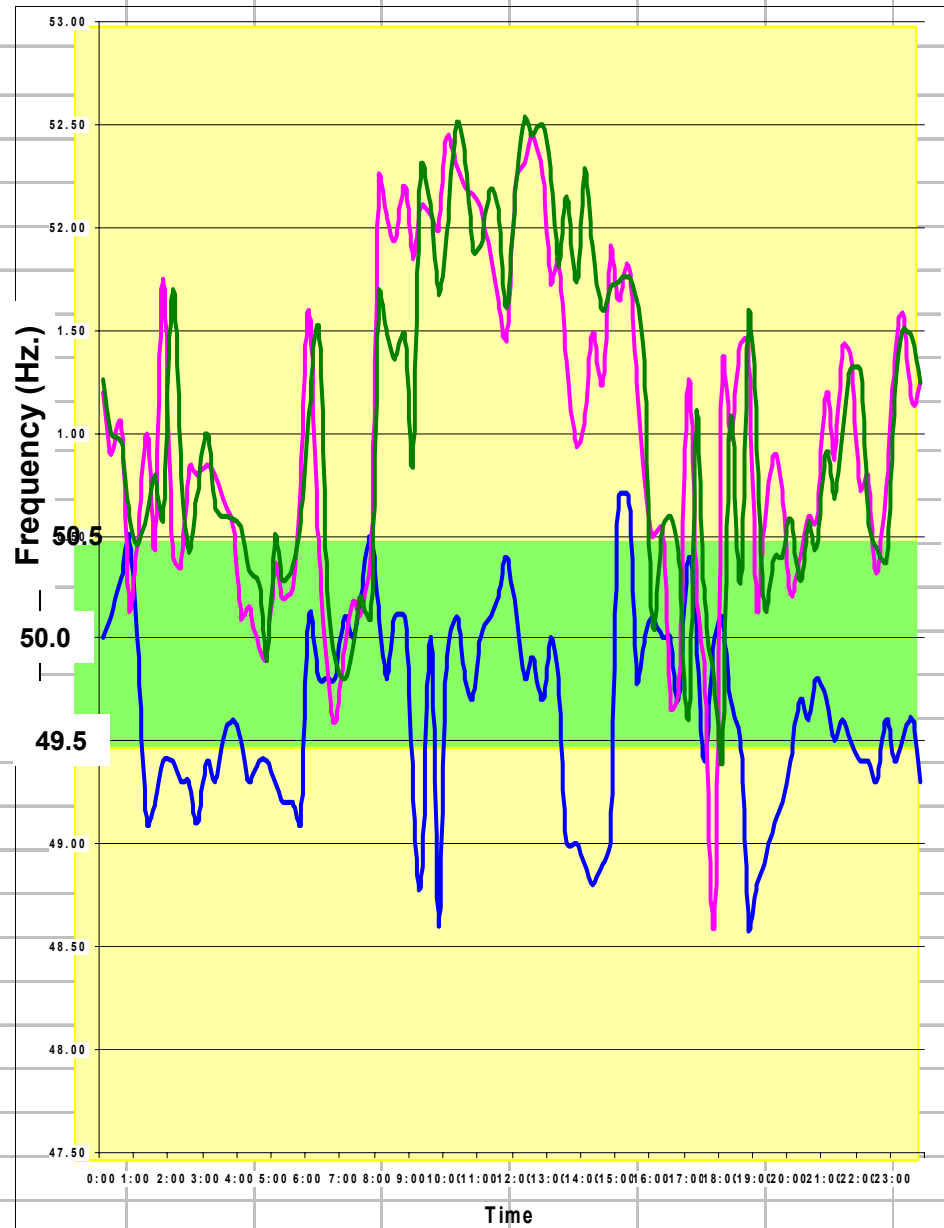
# TYPICAL FREQUENCY CURVES ON 01.10.2002 (IST)

## INDIAN GRID

## AMERICAN GRID

NORTHERN REGION, EASTERN REGION, NORTH-EASTERN REGION

APAGCC



# HYDRO POWER IN INDIA

As on 01.12.2004

A)	TOTAL HYDRO POWER POTENTIAL		
	ASSESSED	:	1,48,701 MW
B)	PUMPED STORAGE POTENTIAL		
	ASSESSED	:	93,920 MW
C)	SMALL HYDRO POTENTIAL		
	ASSESSED	:	6,782 MW
	TOTAL	:	2,49,403 MW
	INSTALLED CAPACITY DEVELOPED	:	29,905 MW

SOURCE: CEA

# **ADVANTAGES OF HYDROPOWER**

## **TECHNICAL AND SYSTEM BENEFITS**

- **PROVEN & WELL-ADVANCED TECHNOLOGY**
- **LONGER LIFE**
- **ABILITY TO START AND STOP QUICKLY AND ALMOST INSTANTANEOUSLY**
- **HELP IN STABILISING POWER SYSTEM**
- **FACILITATES TO INCREASE PLF OF THERMAL PLANTS**
- **IDEALLY SUITED FOR MEETING PEAKING REQUIREMENTS**
- **ZERO COST RENEWABLE ENERGY, AND NOT SUBJECT TO MARKET FLUCTUATIONS**
- **NET ENVIRONMENTAL BENEFITS ARE FAR SUPERIOR TO FOSSIL FUEL GENERATION**

# ADVANTAGES OF HYDROPOWER

## ENVIRONMENT

- **CLEAN POWER**
- **ENVIRONMENT FRIENDLY**
- **REDUCED SOIL EROSION DUE TO CATCHMENT AREA TREATMENT**
- **REDUCED LAND SLIDES**
- **AVOIDED EMISSIONS**
- **WASTES LIKE FLY-ASH etc. MAY BE USED FOR CONSTRUCTION AND FILLING**

# **ADVANTAGES OF HYDROPOWER**

## **SOCIAL IMPACTS**

- **COST EFFECTIVE OPTION IN THE LONG RUN**
- **OPPORTUNITY GENERATED FOR GAINFUL EMPLOYMENT IN THE REGION**
- **PROVIDES A WINDOW TO THE INHABITANTS OF REMOTE AND INACCESSIBLE AREA TO SEE OUTSIDE WORLD**
- **ROAD LINKS PROVIDE A FAST ROUTE TO MARKET LOCAL PRODUCE AND FACILITATES IN TACKLING EMERGENCY SITUATIONS DUE TO EPIDEMICS, ACCIDENTS AND NATURAL DISASTERS**
- **HEALTH CENTERS ESTABLISHED BY PROJECT CONTRIBUTE SIGNIFICANTLY IN MINIMIZING CHILD MORTALITIES, ERADICATION OF SMALL POX, POLIO, MALARIA ETC. AND SAVES MANY PRECIOUS HUMAN LIVES**
- **DAMS PROVIDE IRRIGATION WATER AND DRINKING WATER**

# GREEN HOUSE GASES

- **The Earth's atmosphere is like a green house.**
- **Green House Gases (GHG)**
  - **NATURALLY OCCURRING GHG ARE CARBON DIOXIDE (CO<sub>2</sub>), OZONE (O<sub>3</sub>), METHANE (CH<sub>4</sub>), NITROUS OXIDE (N<sub>2</sub>O), AND WATER VAPOUR**
  - **CERTAIN HUMAN ACTIVITIES ADD TO THE CONCENTRATION LEVELS OF MOST OF NATURALLY OCCURRING GREEN HOUSE GASES.**
  - **OTHER GASES CAUSING GREEN HOUSE EFFECT ARE CHLOROFLUOROCARBONS (CFCS), HYDROCHLOROFLUOROCARBON (HCFC-22) AND PERFLUOROMETHANE (CF<sub>4</sub>).**
  - **CO<sub>2</sub> IS RESPONSIBLE FOR OVER HALF THE ENHANCEMENT OF GREENHOUSE EFFECT.**

# ATMOSPHERIC LIFETIME OF GHG's

**GAS**

**YEARS**

**CO<sub>2</sub>**

**50-200**

**CH<sub>4</sub>**

**9-15**

**N<sub>2</sub>O**

**120**

**CFC-11**

**50**

**HCFC-22**

**12**

**CF<sub>4</sub>**

**50,000**

**(SOURCE: IPCC 1996 a)**

# **SOURCES OF GHG**

- **GREEN HOUSE GASES ARE EMITTED BY VIRTUALLY EVERY ECONOMIC SECTOR**
  - **RESIDENTIAL AND COMMERCIAL ENERGY USE**
  - **INDUSTRIAL PROCESSES**
  - **ELECTRICITY GENERATION**
  - **AGRICULTURE**
  - **FORESTRY**

# COMPARATIVE CHART ON GHG EMISSIONS

<b>SOURCES OF ELECTRICITY</b>	<b>RANGE OF GHG EMISSION (In kilo ton equivalent CO<sub>2</sub> per billion unit energy production)</b>
<b>Hydropower (run-off –the-river)</b>	<b>1-18</b>
<b>Hydropower with reservoir</b>	<b>2-48</b>
<b>Nuclear</b>	<b>2-59</b>
<b>Biomass: Forestry waste combustion</b>	<b>15-101</b>
<b>Biomass: Energy Plantation</b>	<b>17-118</b>
<b>Large fuel cells (Natural gas to hydrogen conversion)</b>	<b>290-520</b>
<b>Natural Gas combined cycle turbines</b>	<b>399-511</b>
<b>Heavy Oil, without scrubbing</b>	<b>686-726</b>
<b>Bituminous coal, modern plant</b>	<b>790-1182</b>
<b>Lignite- old plant</b>	<b>1147-1272</b>

# **HYDRO POWER – AVOIDED EMISSIONS**

- **ONE ESTIMATE OF 1997 SAYS THAT HYDROPOWER SAVED GHG EMISSIONS EQUIVALENT TO ALL THE CARS ON THE PLANET (IN TERMS OF AVOIDED FOSSIL FUEL GENERATION).**
- **ONE STUDY OF ICOLD REPORTS 100 MW HYDROELECTRIC PROJECT OPERATING 50% OF TIME SAVES 600,000 BARRELS OF FUEL OIL ANNUALLY.**
- **BASED ON A ROUGH ESTIMATE, IF ENTIRE HYDROPOWER POTENTIAL OF INDIA IS DEVELOPED, ON THE FACE VALUE ANNUALLY AVOIDED CO<sub>2</sub> EMISSION COULD BE ≈ 500 MILLION TONNES IN ADDITION TO FUEL OIL SAVED ≈ 800 MILLION BARRELS.**

# **COMPARING VARIOUS OPTIONS FOR HYDROPOWER DEVELOPMENT**

## **THERMAL AND GAS BASED**

- **LESSER TIME TO DESIGN, OBTAIN STATUTORY APPROVALS AND RECOVER INVESTMENT**
- **HIGHER OPERATING COSTS, TYPICALLY SHORTER OPERATING LIFE OF 25 YEARS FOR COAL BASED AND 15 YEARS FOR GAS BASED**
- **SOURCE OF AIR POLLUTION AND GREENHOUSE GASES**
- **LOW QUALITY COAL WITH HIGH ASH CONTENT (IN INDIA)**
- **PRICE UNCERTAINTY IN THE INTERNATIONAL MARKET**
- **DRAIN ON FOREIGN EXCHANGE RESERVES**

# **COMPARING VARIOUS OPTIONS FOR HYDROPOWER DEVELOPMENT**

## **OTHER RENEWABLE SOURCES (SOLAR, WIND etc.)**

- **INTERMITTENT GENERATION REQUIRING BACKUP SUPPLY**
- **VALUABLE OPTIONS IN SPECIFIC CONTEXT BUT LARGE CAPACITY ADDITION UNLIKELY IN THE COMING DECADES**
- **LEVEL OF SERVICE PROVIDED INFERIOR TO CONVENTIONAL SOURCES**

# **HYDROPOWER – ENSURING ENERGY SECURITY OF THE NATION**

- **FUEL IS WATER- AVAILABLE FREE OF COST**
- **SUPPLY ROUTE CANNOT BE STOPPED- GOVERNED BY HYDROLOGICAL CYCLES**
- **NO IMPORT NEEDED**
- **FREE FROM INFLATION**
- **AVAILABLE IN ABUNDANCE**
- **RENEWABLE SOURCE**
- **REPRESENTS ENERGY INDEPENDENCE OF THE COUNTRY**
- **PLAYS SIGNIFICANT ROLE IN AVOIDING HARMFUL EMISSIONS INCLUDING GHG**

# IN A NUTSHELL

- THE 'HUNGER' FOR POWER INCREASING DAY BY DAY
- POWER IS THE BACKBONE FOR DEVELOPMENT
- INDIA HAS LARGE UNTAPPED HYDROPOWER POTENTIAL
- ACCELERATED DEVELOPMENT OF HYDROPOWER IS A TECHNICAL COMPULSION
- FUEL 'WATER' BEING INDIGENOUSLY AVAILABLE, FREE OF COST, NO IMPORT REQUIRED AND INFLATION FREE, HYDROPOWER IS CHEAPER IN THE LONG RUN
- HYDROPOWER AVOIDS HARMFUL EMISSIONS
- GHG EMISSIONS FROM HYDROPOWER IS MERELY A PROPAGANDA WITHOUT ANY CREDIBLE SCIENTIFIC PROOF

***Encouraging hydropower means ensuring energy security of nation***

THANK YOU