DISCUSSION MEETING ON ENERGY

ACKOWLEDGEMENT

Profs *M S Mathews* & *Prema Rajagopalan*

for the opportunity

The purpose of this exercise:

To generate flexible curriculum which can adopt to the fast changing developments in science and technology

To find ways of generating appropriate human resource with necessary and appropriate scientific and technical skills

DISCUSSION POINTS

1. What type of energy mix is appropriate for this country?

2. What type of trained manpower necessary for this energy mix?

3. What type of steps that many be necessary to keep pace with the changing situations?

4. What is the community or society's expectations in this sphere?

5.What are the steps are necessary for this goal to be achieved?

6. How well are we as a society tuned to accept the new energy mix that will be in place in due course?

Some provocative statements

What is so great about Energy?

This is similar to asking what is so great about climate change, global warming, environmental pollution, fossil fuel depletion, alternate energy sources?

It is clear that most of us will not ask the second set of questions since we feel they are so obvious so also the first question!

Can we make the first question also as obvious as the second set of questions?

For sustainability in the area of energy supply the following policy changes may be desired

1. Dependence on imported oil should be decreased through effective oil conservation programmes and inter-fuel substitution. Public mass transport systems should be improved in every possible way to discourage energy-intensive private modes of transport. Railway transportation should, both passenger and goods, be improved and encouraged through attractive fare structures. Administered price mechanism should be withdrawn.

2. Coal production is to be increased through mechanisation. Benefaction of coal is to be taken up and clean coal technologies including coal gasification are to be adopted. Privatisation of coal industry is also welcome.

3. Rural energy supply should receive priority for overall improvement of rural economy. Rural electrification programmes have failed to achieve the desired results. Energy supply through integration of renewable energy sources in an effective manner is to be worked out by the experts and implemented by local bodies to ensure better participation of people. Both conventional and nonconventional sources are to be used for the time being , whenever conventional sources are available and a judicious mix of the two should be promoted.

4. Renewable energy should be allotted a higher share of the total allocation of power starting with 10% with the Ninth Plan and increasing appropriately from the next Plans. A separate Solar Energy Commission is to be created in line with Atomic Energy Commission with identical terms of reference to adopt Solar energy to the maximum possible extent in every sector of consumption.

5. Massive education awareness programmes for people in every walk of life for efficient utilisation of energy through supply and demand management. Everybody is to be informed that energy is a really precious commodity

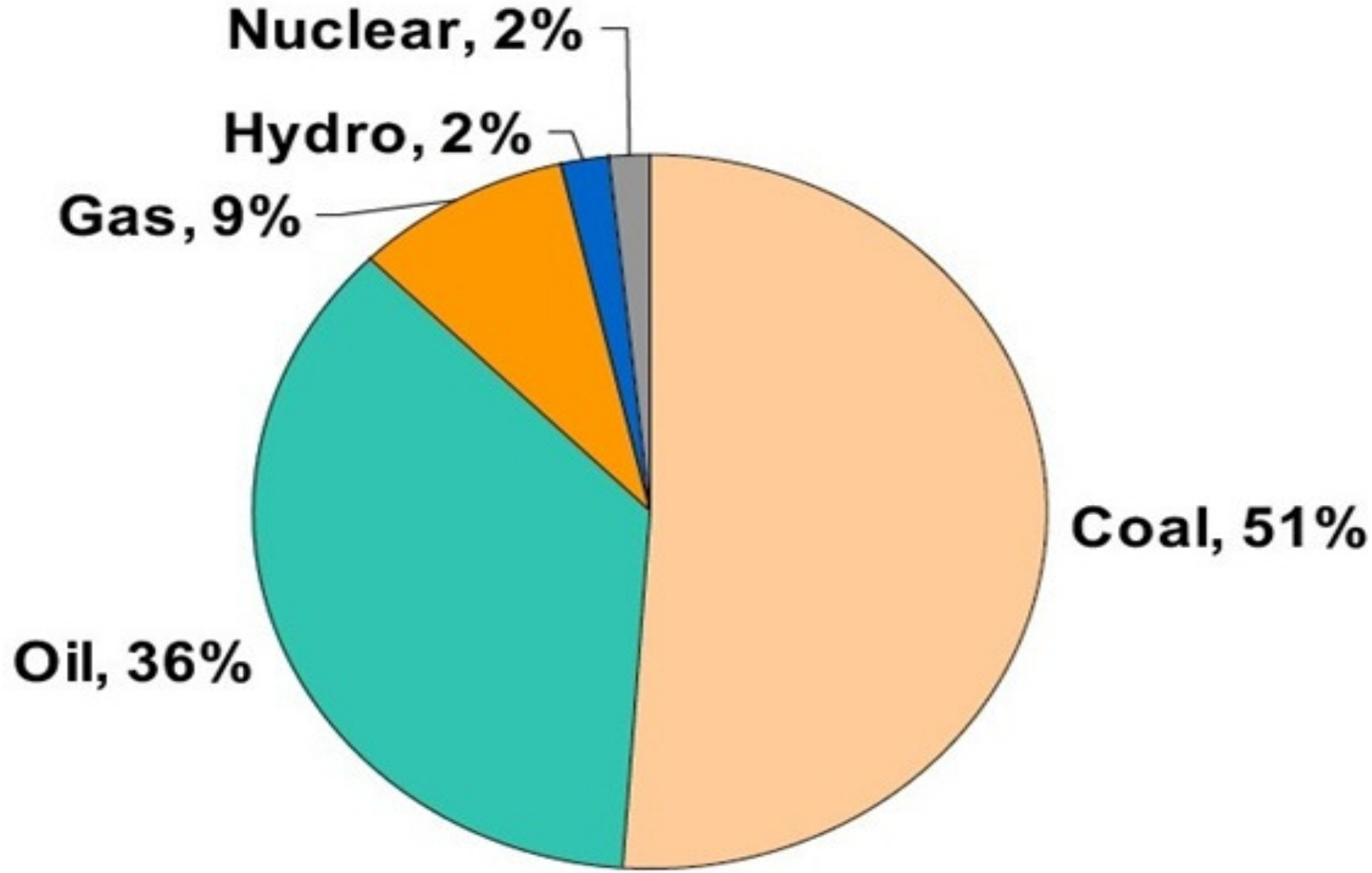
ENERGY SCENARIO IN INDIA

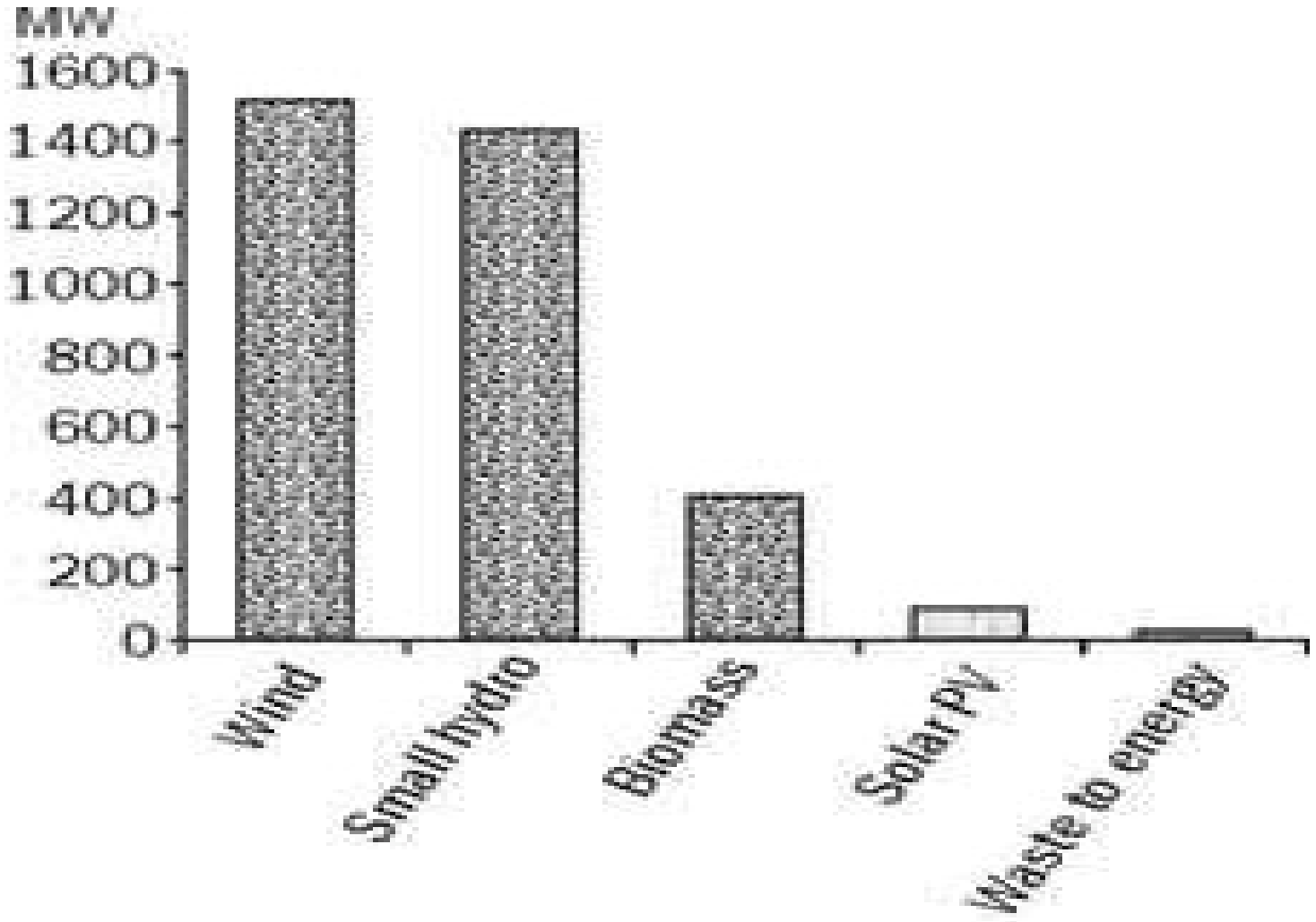
- India ranks fifth in the world in terms of energy consumption
- Commercial energy consumption in India 3.5% of the world consumption in 2002
- Average annual growth rate of energy consumption about 6% during 1981-2002

PRIMARY COMMERCIAL ENERGY MIX – (%)

RESOURCE	WORLD	INDIA
OIL	37.4	30.1
NATURAL GAS	24.3	7.8
COAL	25.5	55.5
NUCLEAR	6.5	1.4
HYDEL	6.3	5.2

Primary Energy Sources (%)




MW
1600
1400
1200
1000
800
600
400
200
0
Wind
Small hydro
Biomass
Solar PV
Waste to energy

SUSTAINABLE ENERGY PATHWAY FOR INDIA: COMPONENTS

- Clean coal technologies
- Centralized production of electricity based on increasing share of hydro, nuclear and renewables.
- Decentralized power through renewable energy- sun, wind, biomass and small hydro.
- Alternative fuels for surface transportation- bio-fuels electric vehicles, hydrogen and fuel cell vehicles.
- Sustainable energy path way to progressively increase share of renewable energy.

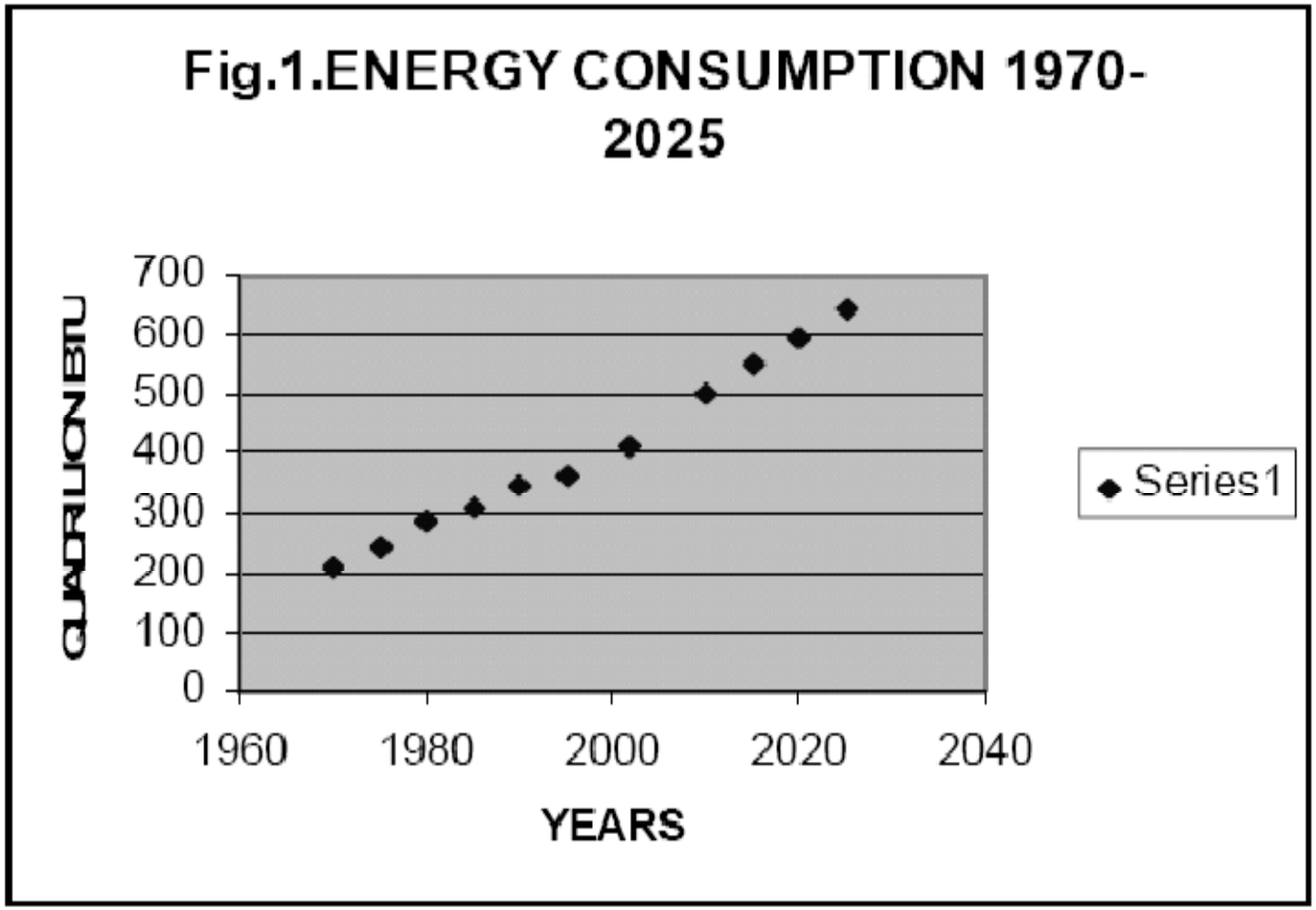


Fig.1. World energy consumption pattern

The Energy Security Problem

- Do you believe that over the next twenty years the oil producing countries will be more or less stable than over the previous twenty years?
- Do you believe that alternative providers of oil, such as Nigeria, Central Asia states, Russia, and Venezuela, are significantly more dependable?
- If world oil demand is to increase from 84 m/b/d to 110 m/b/d over the next twenty five years, where will the additional 26 m/b/d come from?

The Environmental Problems: Two Views

- Some worry about the environmental effects of energy sources: air pollution from burning fossil fuels, accidents and proliferation from nuclear power plants, land use from hydroelectric facilities and renewable sources
- Others worry that environment constraints – both regulatory and political – are limiting our energy options: moratoria on oil and gas exploration and production; siting issues; and air, water, wetland, waste, and antiquities regulations

Challenges

- Historically, it has taken about 50 years to significantly change energy systems
- This time around the task is more complicated. There are more people in the world, there are more economies competing for energy sources and the value of the existing investment in existing infrastructure is larger
- This transformation will occur in a world in which the availability of options will be constrained by the threat of climate change

Importance of Hydrogen in India

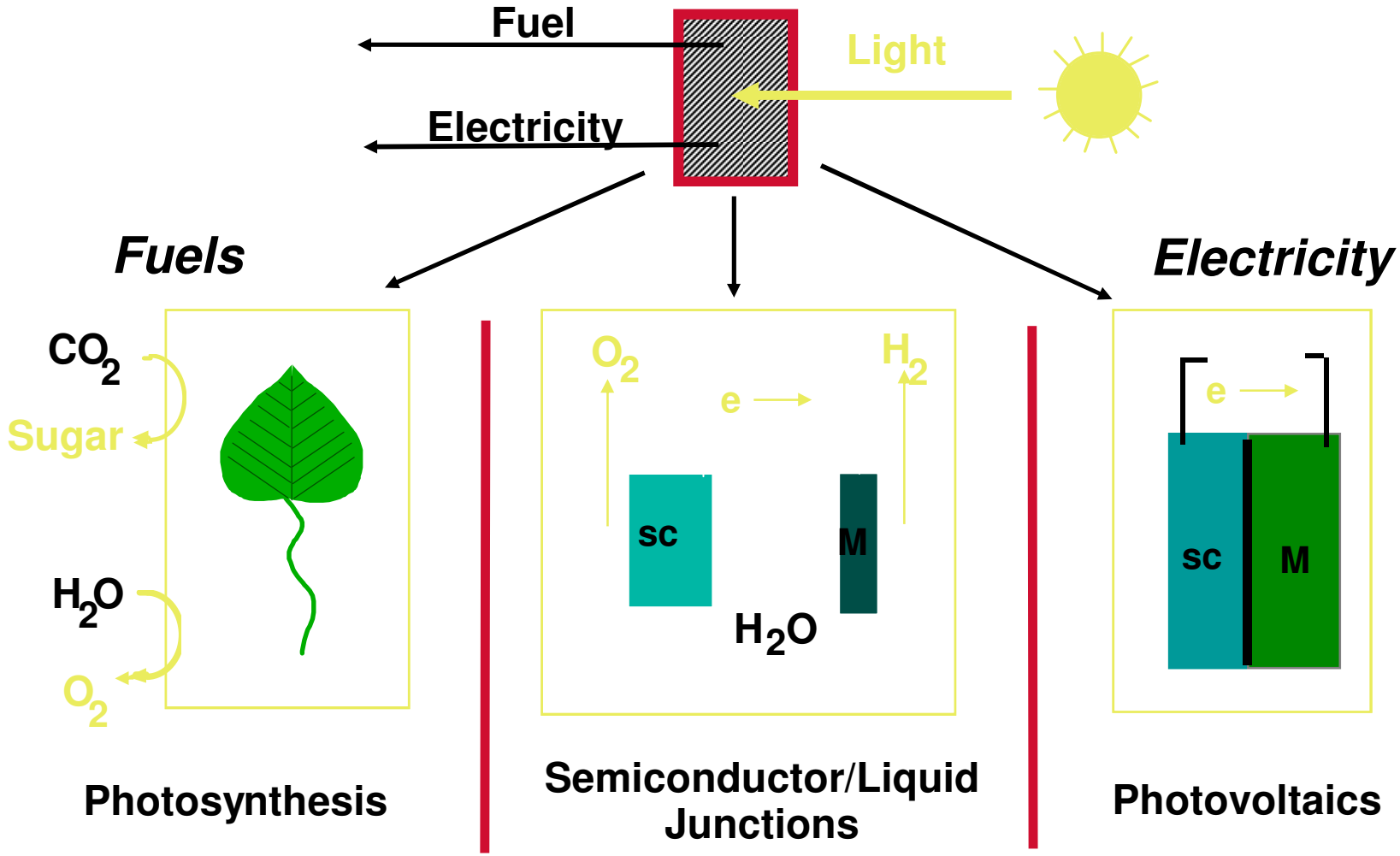
- Hydrogen has significant potential as a clean energy source for broad range of applications including power production and transportation.

- Large areas in the country do not have access to electricity which can be provided decentralized power based on hydrogen energy

- Hydrogen and fuel cell vehicles can progressively replace petroleum based vehicles specifically two and three wheelers.

- Hydrogen energy: carbon free fuel with major promise for ensuring sustainable energy security in India

Energy Conversion Strategies



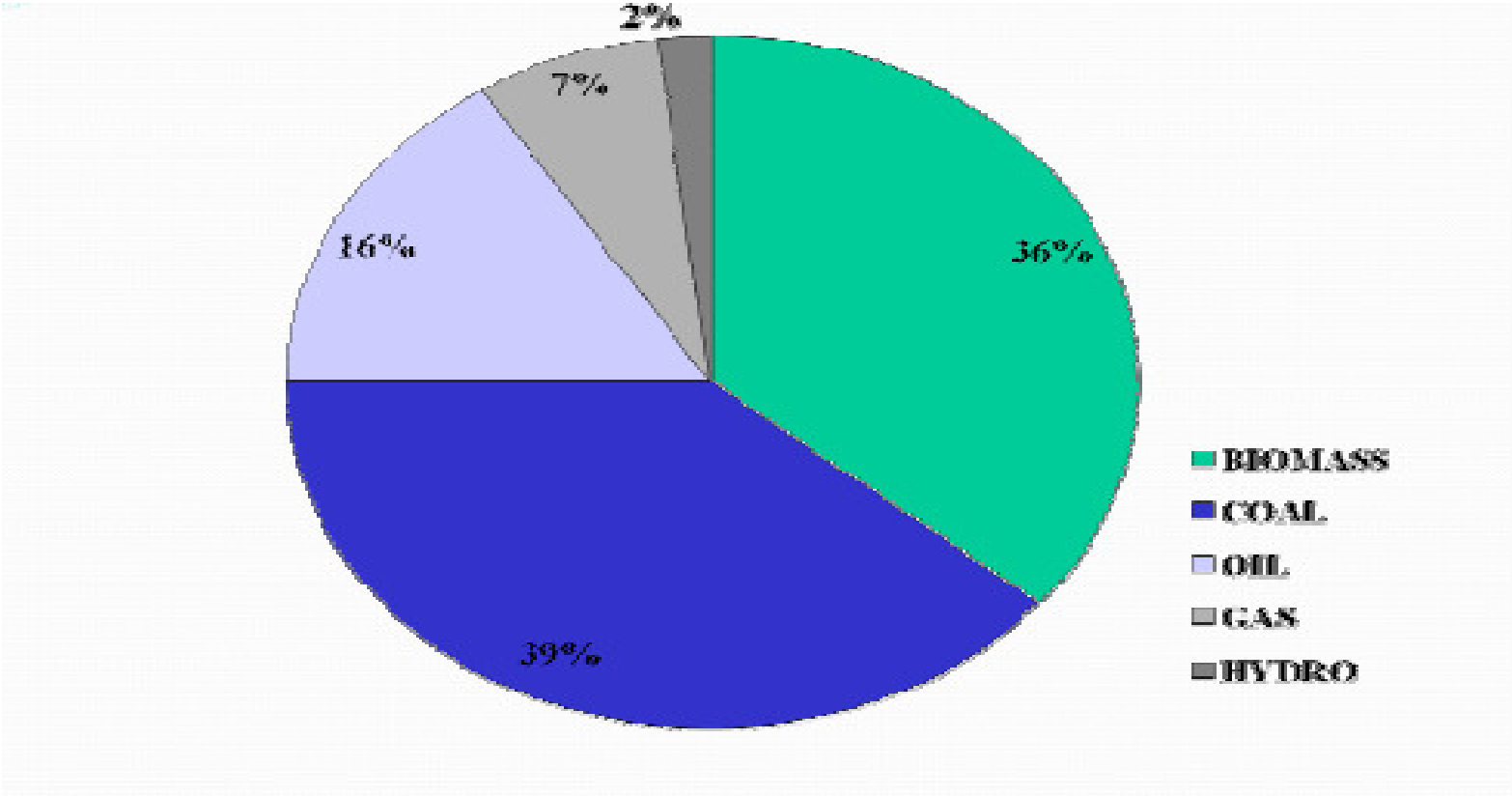
Energy Consumption in Different Countries

Country/Region	Energy consumption/capita (kWh)
China	1379
India	435
Indonesia	440
Japan	7818
World	2429

84 million households did not have electricity in 2000

(Draft Report of the Expert Committee on Integrated Energy Policy, Planning Commission, December 2005)

Primary Energy Use in India (MTOE)



- Oil provides energy for 95% of transportation and the demand of transport fuel continues to rise.

- The requirement of Motor Spirit is expected to grow from little over 7 MMT in 2001 – 02 to over 10 MMT in 2006-07 and 12.848 MMT in 2011-12 and that of diesel (HSD) from 39.815 MMT in 2001-02 to 52.324 MMT in 2006-07 and just over 66 MMT in 2011-12.

- The domestic supply of crude will satisfy only about 22% of the demand and the rest will have to be met from imported crude.

- Our dependence on import of oil will continue to increase in the foreseeable future.

Projected Fuel Mix for India

Is It Feasible ?

Percentage

	2001 02	2011 12	2020 2025
Coal	36.1	36	30
Oil	23.4(70)	23(60)	25*(40)
Gas	7.2	7.5	16**
Renewable	1.8	3.5	8
Nuclear	0.9	2.5	5
Traditional	30.6	27.5	**16**
Energy Requirement (MMTOE)	450	720	940
			?

IMPORTED Oil : (%)

** Predominantly Indian

Energy – Ecological Balance

- Agriculture produces and consumes energy
- Energy consumption in rural areas is about 1/10th of the country's average per capita consumption
- Biomass use for energy

	Consumption / annum
Fuelwood	300-330 million tonnes
Dung cake	189-221 million tonnes
Agricultural waste	90-104 million tonnes

- Population – Increased biomass fuel consumption – leading to agricultural and ecological imbalances

Renewable Energy at a Glance in India

Grid-Interactive Renewable Power

Source/System	Estimated Potential, MW	Cumulative installed capacity (as on March, 31, 2006), MW
Wind Power	45, 000	5, 340.00
Biomass Power	16, 000	440.50
Bagasse Cogeneration	3, 500	502.03
Small Hydro (up to 25 MW)	15, 000	1826.43
Waste to Energy	2, 700	45.98
Solar Photovoltaic	20 MW per km^2	2.80
Total		8, 157.74

Sl. No.	Source/System	Estimated Potential	Cumulative installed capacity (as on March, 31, 2006)
1	Family size biogas plant	120 lakh	38.34 lakh
2	Community/ Institutional/ Night soil biogas plant	-	3952 No.
3	Improved chulah	12 crore	3.52 crore
4	Solar photovoltaic systems		
	a) Solar street lighting systems	-	54795 No.
	b) Homc lighting systems	-	342607 No.
	c) Solar lanterns	-	560292 No.
	d) SPV power plants	-	1566 00 kWp
5	Solar water heating systems	140 million m^2 collector area	1.5 million m^2 collector area

6	Solar cooking systems		
	a) Box type solar cookers	-	6, 00, 000 No.
	b) Concentrating type community cookers	-	12 No.
	c) Schefler/ dish type solar cookers	-	2, 000 No.
7	Soalr PV Pumps	-	6, 818 No.
8	Wind Pumps	-	1, 087 No.
9	Hybrid systems	-	410 kW
10	Biomass gasifiers	-	76 MW
11	Biomass/Cogen (Non-bagasse)	-	7.50 MW

Remote Village Electrification

Item	Remote village/hamlets electrified through RE (as on March, 31, 2006)
Remote Village	2237 remote village
Electrification	594 remote hamlets

Source: Renewable Energy (Akshay Urja). Ministry of Non-Conventional Energy Sources, GoI, March-April 2006. Vol: 2, Issue: 2, Pp:48.

Some Recent Initiatives in India to Obtain Future Energy Security

Draft Report of the Expert Committee on Integrated Energy Policy, Planning Commission, December 2005)

Energy related R&D

- **Technology Missions**
  - Coal Technologies for efficiency improvement
  - Solar Technologies
  - Biofuels (Biodiesel and Ethanol)
  - Biomass Plantation
  - Wood Gasification
  - Community based biogas plants

A. BIO-FUEL (Ethanol & Biodiesel)

1. Ethanol

- Government of India has started nationwide launch of 5 % ethanol blended petrol w.e.f. 1 January, 2003. The ratio should gradually be increased to 10 and 20%.

Ethanol Demand And Supply For Blending In Gasoline

Year	Gasoline demand MMT	Ethanol demand Th KL	Molasses production MMT	Ethanol Production			Utilization of Ethanol		
				Molasses Th KL	Cane Th KL	Total Th KL	Potable Th KL	Industry Th KL	Balance Th KL
2001-02	7.07	416.14	8.77	1775	0	1775	648	600	527
2006-07	10.07	592.72	11.36	2300	1485	3785	765	711	2309
2011-12	12.85	756.35	11.36	2300	1485	3785	887	844	2054
2016-17	16.4	965.30	11.36	2300	1485	3785	1028	1003	1754

Notes:

1. Area under sugarcane cultivation is expected to increase from 4.36 mha in 2001-02 to 4.96 in 2006-07 which would add additional cane production of around 50 MMT.
2. About 30% of cane goes for making gur and khandsari. If there is no additional increase in khandsari demand, sugar and molasses production would increase.
3. The present distiller capacity is for 2900 Th kL of ethanol and looks to be sufficient for 5% blend till 12 th plan
4. A growth of 3% in potable use and a 3.5% in chemical and other use has been assumed.

2. Biodiesel

- Utilization of Non-Edible Oil:

Plantation of *Jatropha curcas* and *Pongamia pinnata* on waste land of 4 lakh hectares under Demonstration Project started in the year 2003.

Production of oil from the crushed seeds of these plantations at Rs. 12/- per litre can be used for powering diesel pump sets and rural transport vehicles (cheaper than diesel).

Diesel & Biodiesel Demand, Area Required under Jatropha For Different Blending Rates

Year	Diesel Demand MMT	Bio-Diesel @ 5% MMT	Area for 5% Mha	Bio-Diesel @ 10% MMT	Area for 10% Mha	Bio-Diesel @20% MMT	Area for 20% Mha
2001-02	39.81	1.99	N.A.	3.98	N.A.	7.96	N.A
2006-07	52.33	2.62	2.19	5.23	4.38	10.47	8.76
2011-12	66.90	3.35	2.79	6.69	5.58	13.38	11.19

Biodiesel Demonstration Trials:

- The first successful trial run of the Amritsar Shatabdi express conducted by the Indian Railways using bio diesel.
- In the State of Karnataka, some remote villages in Tumkur district have been electrified using the oil from these plants.
- In Andhra Pradesh, oil based units are established in three tribal villages viz., Chalbadi, Powerguda and Kakadiboddi of Adilabad district by the Integrated Tribal Development Agency (ITDA) in 2001-02.

B. Biomass Power

- The current availability of biomass in India is estimated at about 120-150 million MT/annum covering agricultural and forestry residues corresponding to a potential of 16,000 MW.

- This apart, 5000 MW can be installed through bagasse cogeneration. Plantations on waste lands also provide significant opportunity - about 62,000 MW for grid-interactive power and another 15,000 MW for off-grid applications.

C. Biogas

India has a potential of generating 6.38 x 10^{10} m^3 of biogas from 980 million tones of cattle dung produced annually. The heat value of this gas amounts to 1.3 x 10^{12} MJ. In addition, 350 million tons of compost would also be produced.

Under National Biogas and Manure Management Programme 38.34 lakh family size and 3952 community biogas plants has been installed in the country.

The Year 2006 is being celebrated as Jubilee Year

Enriched Biogas

- Indian Institute of Technology Delhi developed and implemented a water absorption based biogas scrubbing and bottling technology.

- Demonstration of biogas enrichment technology in the field for better utilization of biogas as a substitute CNG fuel to achieve self sufficiency in energy requirements in Gaushalas/dairies as well as in automotive applications.
- A few demonstration plants have been installed in the field.

- A large area solar dish has been developed to provide process heat for milk pasteurization at a dairy of Maharashtra Rajya Sahakari Dugdh Mahasangh Maryadit (MRSDMM), Maharashtra under a R&D project sponsored by MNES. The technical specifications of the solar system are:
- Aperture Area 160 m^2
- Reflector area 123 m^2
- Thermal power (annual average) 50-70 kWth.
- Annual operating hours 3200-3350 hours/ year.
- Annual fuel savings (Furnace oil) 16 to 24 kilo litre/ year.
- Operating wind speed up to 54 kmph Survival wind speed up to 140 kmph.
- Aerial clear space required for the dish 25 m x 20 m x 18 m height Clear area required on ground / roof 3 m x 3 m Tracking power 500 W.

5. Wind Energy

- India now ranks 4th in the world after Germany, USA and Spain with a wind power installed capacity of 4434 MW. The 10th Plan aim at 1500 MW grid-interactive wind power has been exceeded as capacity deployed upto 31.12.2005 exceeded 2800 MW taking the cumulative deployment to over 4500 MW.
- India's wind power potential has been assessed at around 45,000 MW assuming 3% land availability for wind farms requiring @12 ha/MW in sites having wind power density in excess of 250W/sq.m. at 50 m hub-height. The potential for grid-interactive wind power would be less (around 15,000 MW) if sites having wind power density in excess of 300 W/sq.m. at 50 m hub-height.

7. New Energy Technology

1. HYDROGEN ENERGY & FUEL CELLS

- In view of the growing importance of hydrogen the Ministry had set up a National Hydrogen Energy Board during 2003-04 under the Chairmanship of the Minister of Non-Conventional Energy Sources to provide guidance for the preparation of a National Hydrogen Energy Road Map and its implementation. The National Hydrogen Energy Road Map, covering all aspects of hydrogen from production, storage, transport, delivery, applications, codes & standards, public awareness and capacity building has been prepared by a Steering Group of the National Hydrogen Energy Board under the Chairmanship of Shri Ratan Tata. In the Third Meeting of the National Hydrogen Energy Board held on 16 January 2006 under the Chairmanship of Hon'ble Minister (NES) the Road Map was endorsed.

2. GEOTHERMAL ENERGY

- Preliminary data of resource assessment has been generated for 340 hot springs in the country by the Geological Survey of India. Magneto telluric (MT) investigations have already been carried out at Puga Valley in Ladakh, and Tatta Pani, in Sarguja district, Chhattisgarh by the National Geophysic al Research Institute (NGRI), Hyderabad. Magneto tellur ic investigations for assessing the geothermal potential were continued in Satluj-Spiti, Beas and Parbati valley in Himachal Pradesh, Badrinath-Tapovan in Uttaranchal and Surajkund in Jharkhand through NGRI.

3. TIDAL ENERGY

- The Ministry supported an environmental impact assessment study for a 3.65 MW capacity tidal power plant at Durgaduani Creek in Sunderbans through the West Bengal Renewable Energy Development Agency (WBREDA). The Ministry had earlier sponsored a project for preparation of a detailed project report for the project to WBREDA. The West Bengal Pollution Control Board issued a No Objection Certificate for the project with the condition that the State Government clearance will be obtained from the State Environment Department . WBREDA have approached the Ministry of Environment and Forests, for Coastal Regulatory Zone (CRZ) clearance as the project falls under CRZ area. Currently, tidal energy is in technology demonstration phase and is not commercially viable.

Where do we go from here?