

# **Energy security in the context of climate change**

## **Indian Scenario**

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# What is Global Warming ?

- Global warming is the increase in the average temperature of the Earth's near-surface air and oceans in recent decades and its projected continuation.
- Global average temperature = about 14 Degree Celsius
- Global warming is a result of the build-up of greenhouse gases in the atmosphere.
- As per IPCC Greenhouse gases include water vapor, carbon dioxide, methane, nitrous oxide, ozone, Tetrafluoromethane , Hexafluoroethane, Sulfur hexafluoride, .
- Released into the air by man-made activities such as fossil-fuel burning in power plants, vehicles, cutting trees, etc.
- GHG - very efficient trappers of the sun's heat and over the last century, have contributed to a rise in the average surface temperature of the earth.
- **IPCC estimate: by 2100 average global temperature will rise at 2 degrees C, with an expected range of 1 degree C to 3.5 degrees C.**
- **There is no longer any significant scientific uncertainty that the global warming is occurring.**

# The "Greenhouse effect"

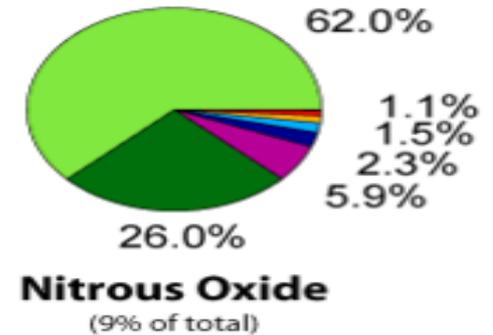
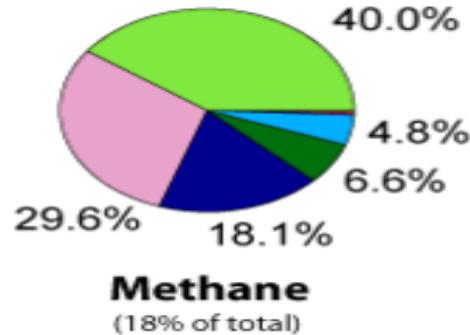
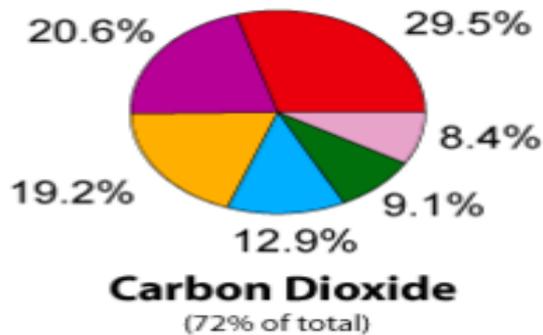
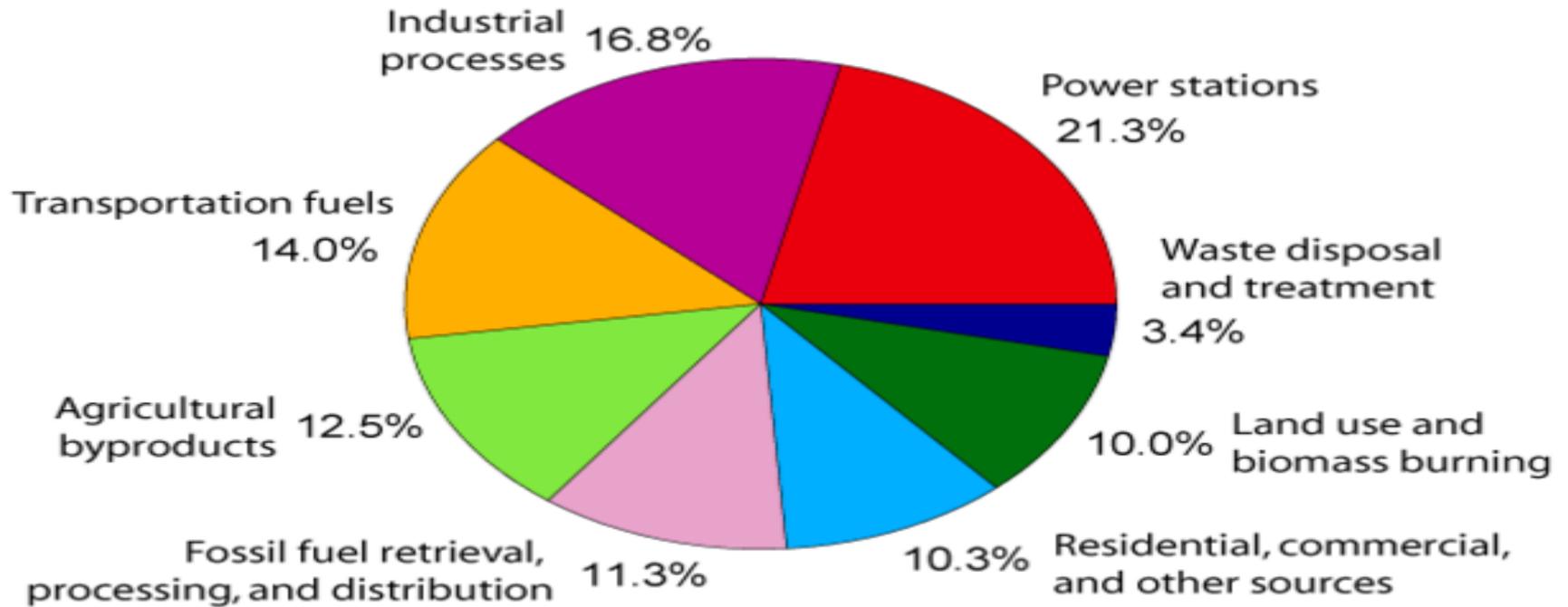
- When sunlight reaches the surface of the Earth, some of it is absorbed and warms the Earth.
- Because the Earth's surface is much cooler than the sun, it radiates energy at much longer wavelengths than does the sun.
- The atmosphere absorbs these longer wavelengths more effectively than it does the shorter wavelengths from the sun.
- Absorption of this long wave radiant energy warms the atmosphere; the atmosphere also is warmed by transfer of latent heat from the surface.
- Major atmospheric constituents (nitrogen and oxygen) are not greenhouse gases
- Current global average atmospheric concentration of CO<sub>2</sub> : 380 parts per million- 36 per cent more than the 280 ppm present in the pre-Industrial Revolution era.

# The "Greenhouse effect"

Main sources of greenhouse gases due to human activity:

- burning of [fossil fuels](#) and [deforestation](#) leading to higher carbon dioxide concentrations;
- [livestock](#) and paddy [rice](#) farming, land use and wetland changes, pipeline losses, and covered vented landfill emissions leading to higher methane atmospheric concentrations.
- use of chlorofluorocarbons (CFCs) in [refrigeration](#) systems, and use of CFCs and [halons](#) in [fire suppression](#) systems and manufacturing processes.
- agricultural activities, including the use of fertilizers, that lead to higher [nitrous oxide](#) concentrations.
- Greenhouse gas emissions from industry, transportation and agriculture are very likely the main cause of recently observed [global warming](#)

# Annual Greenhouse Gas Emissions by Sector



## How can Global Warming affect our lives?

- Last 10,000 years - Earth's average temperature hasn't varied by more than 1.0°C.
- Scientists assert - rise of 3 degrees would cause famine and drought and threaten millions of lives.
- Climatologists predict : unless something drastic is done to cut down fossil fuel emissions, the global average temperatures would rise to 3 to 6 degrees Celcius by 2100.
- Can cause a worldwide drop in crops of between 20 and 400 million tons, threatening 400 million more people with famine, and put up to 3 billion people at risk of flooding and without access to fresh water supplies.
- Few ecosystems could adapt to such a dramatic temperature change, resulting in the destruction of half the world's nature reserves and a fifth of coastal wetlands.
- Global sea levels could rise by more than 20 feet if the ice shelves in Greenland and Antarctica collapsed, which is a distinct possibility if temperatures continue to climb.

## How can Global Warming affect our lives? (contd..)

- Droughts and wildfires will occur more often.
- More than a million species worldwide could be driven to extinction by 2050.
- Significant effects on biodiversity and ecological productivity.
- Increase the potential for international conflicts, border disputes, war due to water and food shortages, forced migration, extreme weather events etc.
- Major economic studies – reduction in Gross Domestic Product in developing and tropical nations under most scenarios
- Huge impact on general health is likely
- Rainfall will increase sharply in higher latitudes and decrease in lower levels.

## How can Global Warming affect our lives? (contd..)

- The Earth's ecological sinks - its forests, oceans, soil, and vegetation-have the capacity to absorb the harmful gases.
- Global warming is caused only when GHG emissions exceed the cleansing capacity of these sinks.
- world has now crossed this limit; many times over.
- If drastic steps are not taken, the world can expect sea level to rise by 18-59 cm by 2100.
- Storms and hurricanes will become more frequent; so will heat waves and droughts.
- Threats ranging from cloudbursts, avalanches, landslides, to glacial lake outburst floods, mudflows and earthquakes will intensify.
- The IPCC report declares that the chances of human activities causing climate change is as high as 90 per cent.

## Global Warming and India

- Snow fed Himalayan rivers: Ganga, Yamuna, Brahmaputra etc.; are seriously threatened;
- Initially there could be heavy floods, and then only seasonal rivers;
- Low lying costal areas on east coast (Orissa and West Bengal) facing submergence;
- Few places in Orissa and Sunderbans already submerged;
- There could be unpredictable weather; example of un-seasonal snow in Kashmir
- Storms and hurricanes will become more frequent; so will heat waves and droughts.
- Threats ranging from cloudbursts, avalanches, landslides, to glacial lake outburst floods, mudflows and earthquakes will intensify.
- Being a tropical country India faces much more problems;
- Decreased food production; increased tropical diseases;
- Many plant and animal species may get extinct;

# Can we curb our emissions of global warming pollution without hurting our economy?

- Being dirty and dangerous, coal and nuclear power plants are wildly expensive.
- Energy policy is presently terribly expensive, requiring large subsidies at huge cost to the society.
- Studies show that by investing in clean energy, such as renewable energy and energy efficiency, emissions of greenhouse gases can be reduced while creating new jobs and saving consumers money.
- And by making simple choices in the kinds of products we buy, such as Compact Florescent light bulbs and hybrid cars, we can all save money and protect the environment by consuming less energy.
- Reducing /stopping tropical deforestation is one of the least expensive options to fight climate change as proposed by the IPCC.

# Energy emergency at the global level

- 35% of all GHGs associated with energy sector
- 1.3 Billion people without electricity; many others have barely enough
- In US Thermoelectric energy (including coal, nuclear and natural gas) are
  - fastest growing use of freshwater resources i
    - **53% of fresh water usage in 2005**
- Large energy projects have
  - displaced millions of people,
  - destroyed ecosystems,
  - natural resources
  - fueled climate change
- Fossil fuels fast running out; but growing demand for energy
- Future of energy supply and demand
  - **Energy conservation, efficiency improvements and decentralized renewable energy**
  - best ways to reduce energy poverty
  - sustainable and climate resilient way

# Energy emergency at the global level

(as per OECD Projections)

- By 2050 world economy will be four times larger
  - will need 80% more energy without new policy action
- Global greenhouse gas (GHG) emissions projected to increase by 50%, primarily due to a 70% growth in energy-related CO<sub>2</sub> emissions.
- Terrestrial biodiversity is projected to decrease by a further 10% by 2050, with significant losses in Asia, Europe and Southern Africa.
- Globally, mature forest areas are projected to shrink by 13%.
- Air pollution is set to become the world's top environmental cause of premature mortality
- **Projection:** by 2050, 60-70% of energy usage likely to be as electricity
- Electricity is cause of 38% of GHG emission in India (53% of CO<sub>2</sub> emissions in India); [MoEF report of 2010]

# The Impact of Electricity Industry on Global Warming

- About 21% of annual GHG emission from the power stations
- About 42% of CO<sub>2</sub> emissions from fossil fuel power stations
- Coal power plants are largest polluters in power sector
- Nuclear power plants – life cycle energy input exacerbates global warming
- Large dams - tropical deforestation produces 20 per cent of all carbon emissions caused by humans, and destroys long-term carbon sinks
- Additionally – power stations consume a lot of natural resources; land, water, fossil fuel etc; displace people; atmospheric and ground water pollution;
- Transmission lines – large tracts of lands / forests required

Why focus on Power sector?

## Sector wise % GHG emission in India during 2007

(Source: MoEF Report in 2010)

	<b>Energy</b>	<b>Industry</b>	<b>Agriculture</b>	<b>Waste</b>
<b>Electricity</b>	37.8 %	-	-	-
<b>Transport</b>	7.5 %	-	-	-
<b>Domestic</b>	7.2 %	-	-	-
<b>Others</b>	5.3%	-	-	-
<b>Cement</b>	-	6.8%	-	-
<b>Iron &amp; Steel</b>	-	6.2%	-	-
<b>Other Industries</b>	-	8.7%	-	-
<b>Total</b>	<b>57.8 %</b>	<b>21.7%</b>	<b>17.6%</b>	<b>3.0%</b>

- within the energy sector electricity alone accounts for 65.4 % of all GHG emissions.
- About 53% of all CO<sub>2</sub> emissions in the country associated with electricity sector
- By 2050 about 60-70% of all energy usage can be through electricity

## Power saga in India

Installed generating capacity increased by about 220 times between 1947 and 2013

Between 1989 & 2013

Installed generating capacity increased from 58,012 MW to 2,25,800 MW ( + 389%)

Between 1992 & 2013

National per capita electricity production increased from 283 kWh to 800 kWh ( +283%)

But about 30% of the households have no access to electricity even in 2011.  
Many villages remain unelectrified; huge power cuts throughout the year;  
poor quality of supply; gross inefficiency; vulgar levels of inequity continues.

**Multiple crises continue !!!**

## Major issues with conventional technology power sources

	<b>Fossil Fuels</b> (coal, gas, diesel)	<b>Dam Based Hydro</b>	<b>Nuclear Power</b>
<b>Economic Issues</b>	Huge pressure on natural resources such as land, water and minerals; reduced agricultural production; fast depleting; increasing costs	Demands large tracts of forests and fertile land; water logging; increasing costs	Demands large tracts of forests and fertile land; Huge Capital costs; long term waste management costs; increasing costs
<b>Social Issues</b>	Peoples' displacement and health; inter-generational inequity	Peoples' displacement and health issues; inter-generational inequity	Peoples' displacement and health; inter-generational inequity
<b>Environmental Issues</b>	Global Warming; pollution of land and water and air; Acid rain	Methane emission, submersion and fragmentation of forests	Mining related pollution; radiation emission for centuries; the nuclear energy cycle itself consumes lot of energy;

**ASH POND OR ASH LAKE ?**



2005/01/03

**EFFECTS OF ACID RAIN on vegetation**  
**(WESTERN and EASTERN GHATS at RISK?)**



**Coastal Fisheries – loss estimated at Rs 65 crores /yr at Tuticorin**



## Present scenario - Problems are getting worse

- Chronic power cuts in almost all states; peak demand and annual energy
- dissatisfaction for all categories of consumers including the farmers
- gross inefficiency in the sector; massive inequity in electricity supply
- continued reliance on conventional power sources; fast depleting fossil fuels
- planning for huge additions in generation and transmission; ever increasing complexity of grid ;
- indifference to the natural limits to conventional energy sources; fast depleting natural resources; life threatening Climate Change
- **absence of long term view; lack of sustainability; lack of obligation to the future generations ; empty rhetoric on Global Warming**
- very poor financial conditions; cumulative loss > 150,000 Crores
- continued absence of professionalism; costs and benefits are not determined

In this background

Do we need more of large power projects  
- fossil fuel or large dam based or  
Nuclear ?

Are the risks associated with these technologies  
worthy of benefits to our communities ?

Since fossil fuel & dam based power projects contribute heavily to  
the global warming effect what suitable alternatives are  
available to us ?

Many Issues with grid based conventional  
power plants

- How efficient is the Electricity Industry ?
- Are all our existing facilities being used optimally?
- Have they met people' s expectations in 66 years ?
- Have they lead to equitable distribution of electricity?
- Why 30% of population still without access to electricity
- Can we reduce electricity demand without compromising the crucial economic activities?
- Can renewable energy sources in grid mode acceptable?
- If so can they be sustainable and cost effective?

## Electricity Industry Efficiency

- AT&C losses are about 35% {< 10% internationally, 10% in Bangalore}
- IP Sets consume about 38% of electricity; {50% of this wasted !!!}
- Demand Side Management has huge potential; {about 5 to 10%}
- End use efficiency (non-agricultural sector) – 5 to 10%
- Energy conservation – about 5 to 10%

**All these put together can provide equivalent of 40 - 50% more capacity.**

- Lighting consumes 19% electrical energy
- BEE Estimate – excess of 10,000 MW saving through CFL

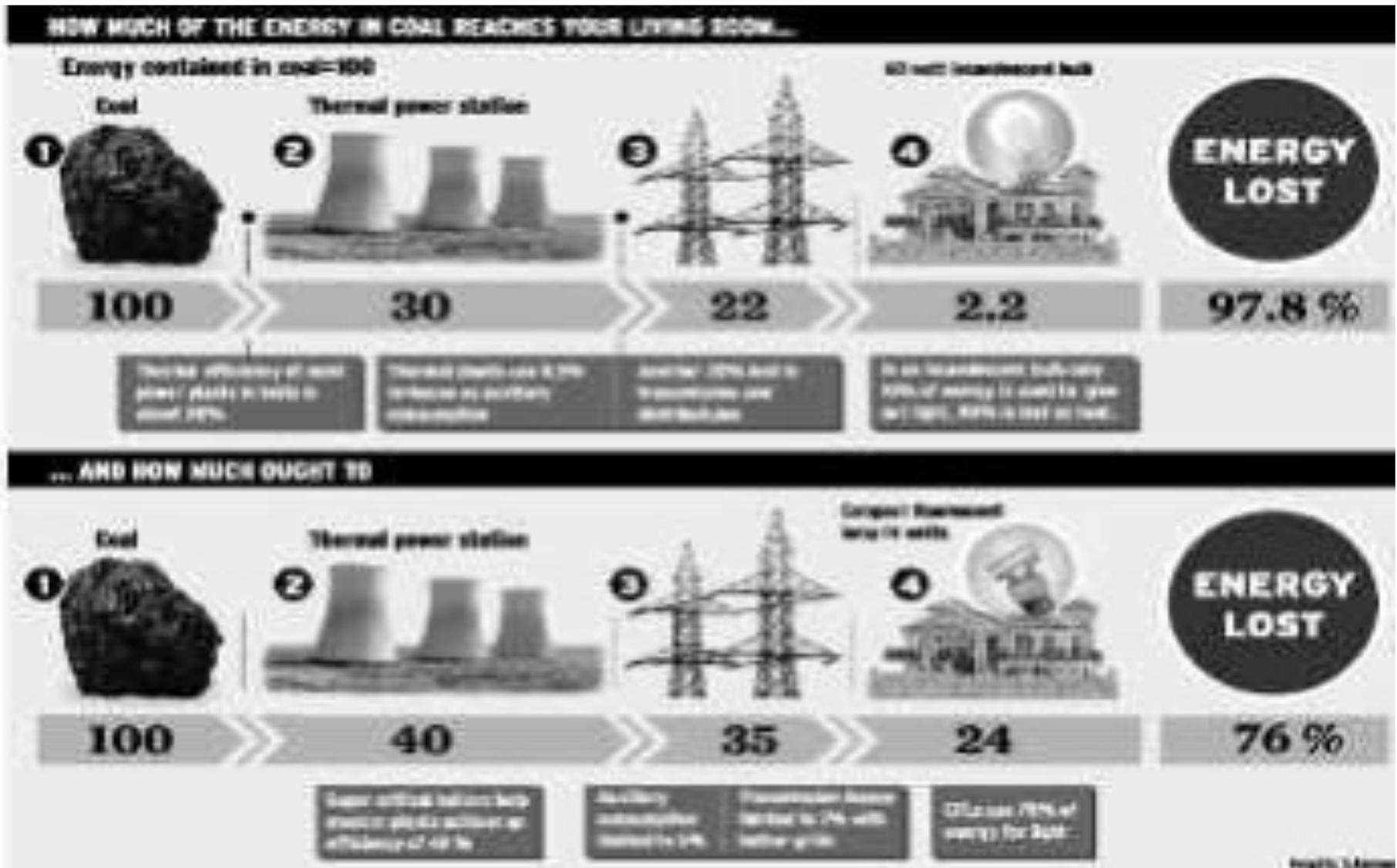
## Electricity Industry Efficiency

- **Annual PLF of thermal power stations – about 70%;**
  - many plants are of 90- 95%
- **Overall efficiency of coal energy to electricity end use – very poor**
- **Large dam based power stations**
  - **Reduced energy/MW of capacity**
  - **emit Methane at huge societal costs**
- **Nuclear power plants – have huge life-cycle energy footprint**

## Electricity Industry Efficiency

- **Gross inefficiency –leading to unsustainable policies**
- **Against peak demand shortages – base load stations are planned**
- **Coal power stations – coming up in ecologically sensitive areas**
  - **Coal fields below thick forests**
  - **Further eroding 20% forest & tree cover**
  - **Huge societal impact of coal power stations**
  - **GHG emissions; impact on agriculture and fisheries**
  - **Unsustainable pressure on land, water and minerals**
  - **Pollution of land, water and atmosphere**

## Efficiency of conventional coal energy conversion technologies



Even with the latest technologies losses will be quite high

- Gross inefficiencies leading to plan 50% more capacity than needed
- Inefficiency in managing the existing capacity is prime reason for the power cuts each year
- Planning for more of base load stations where as deficit is largely during peak hours
- @ Rs. 8 to 10 Crore/MW needed for additional generating capacity
  - huge burden on the state finances
- Other infrastructure areas like poverty alleviation, education and health are suffering due to reduced budget allocation
- States are known to be incurring huge loss each year in electricity
- National level loss >> Rs. 150,000 Crores

- Serious concerns about massive damage to the fragile ecology and biodiversity
- Large quantity of fresh water will be required for coal power plants
- Stressed water bodies; rivers and wetlands
- Huge stress on fresh water resources (many states are already in stressed state)
- No objective analysis of the real costs (both direct/indirect) to society and projected benefits

# Economics of Climate Change

## **Stern Review – ‘Economics of Climate Change’ AND IPCC 4<sup>th</sup> Assessment Report**

- India may suffer economic costs of about 20% of its future GDP
- Mitigation now at a cost of about 1% of present GDP
- The more delay in addressing the Global Warming, the higher cost of mitigation in future

## **Stern warning:**

**“Emissions have been, and continue to be driven, by economic growth; yet stabilization of greenhouse-gas concentrations in the atmosphere is feasible and consistent with continued growth.”**

**“Emissions from deforestation are very significant – they are estimated to represent more than 18% of global emissions”**

**“Curbing deforestation is a highly cost-effective way of reducing greenhouse gas emissions.”**

*What our society is doing at present is to supply inefficiently derived energy from limited conventional sources at subsidized rates for highly inefficient and / wasteful end uses, for which the real subsidy cost will be passed on to future generations.*

# Legal Obligations

Sections 48 (a) and 51 (a) (g) of our Constitution

**“ it is the duty of the STATE and every citizen to make honest efforts to protect and improve our environment by protecting and improving rivers, lakes, forests and living beings”**

UN Convention on Biological Diversity (1992).

**“ ... conservation of various components of biological diversity, the sustainable use of its components, and the fair and equitable sharing of the benefits arising out of the utilisataion of genetic resources..”**

The Precautionary Principle (UN Convention on Biological Diversity (1992).

**“ .. those activities which are likely to pose significant risk to nature shall be preceded by an exhaustive examination; their proponents shall demonstrate that the expected benefits outweigh potential damage to nature, and where potential adverse effects are not fully understood, the activities should not proceed.”**

- IEP' s projection
  - total power capacity should increase from about 160,000 MW in 2006 to about 800,000 MW in 2031.
  - coal power from 80,000 MW to 400,000 MW
  
- More than 700,000 MW of thermal power in pipeline (Prayas report)

## Power Corridors in India

### Existing Coal Power Corridors

- Singrauli, Rihand, Neyveli, Chandrapur etc.

### Proposed Coal Power Corridors

- Coastal Andhra Pradesh; about 70 projects in 5 districts;
  - 70, 000 MW
  
- Vidarbha: about 25 projects totaling about 40, 000 MW
  
- Chattisgarh and Madhya Pradesh; Nuclear power park at Jaitapura
  
- Orissa and Coastal Tamil Nadu; Cheyyur

- Even with all the proposed power plants will all our demands be met?
- As economists say pouring huge money into these projects will be akin to pour water into a bucket with a big hole without efficiency improvement in the whole industry.
- Where / when do we stop adding to power production capacity?
- But the devastation to general environment, sensitive ecology, people' s displacement, fast depletion of resources is certain.
- Is such a situation sustainable and in the long term interest of the society?

# The future pathway

- **Emphasis on all -round efficiency improvement and energy conservation, and effective Demand Side Management (DSM)**
- **Integrated Resource Management Planning with a holistic approach to the society' s overall needs**
- **Strict adherence to commercial viability of every project, when viewed with objective analysis of various societal costs**
- **All-round innovativeness, accountability and professionalism**
- **Suitable regulatory measures, tariff policies and effective public participation**
- **Adoption of international best practices**
- **Effective public consultations**

## The road ahead – what official agencies say

**Planning Commission** estimates that CO<sub>2</sub> generated from energy use can be reduced by 35% through effective deployment of efficiency, DSM measures and renewable energy sources.

Planning Commission's main action recommendation for energy security is to: "... relentlessly pursue energy efficiency and energy conservation as the most important virtual source of domestic energy".

**Integrated Energy Policy** (Planning Commission) :

"India's conventional energy reserves are limited and we must develop all available and economic alternatives. ... Clearly over the next 25 years energy efficiency and conservation are the most important virtual energy supply sources that India possesses."

**Bureau of Energy Efficiency** has estimated: at the prevailing cost of additional energy generation, it costs a unit of energy about one fourth the cost to save than to produce it with new capacity.

## The National Electricity Policy states

- Power Sector will remain unviable until T&D losses are brought down significantly and rapidly
- many states have losses of over 40%
- such losses are unsustainable and imply decline of power sector operations.
- continuation of the present level of losses would pose a threat to the power sector operations
- jeopardize the growth prospects of the economy as a whole
- no reforms can succeed in the midst of such large pilferages on a continuing basis

**Efficiency, DSM and conservation will certainly help to overcome the shortages for next few years.**

**How can the future electricity demand be met ?**

**Can N&RE sources be the answer?**

## N&RE potential in India

(Primary Source: MNRE, Govt. of India)

	<b>Potential</b> (Grid interactive power only)
1. Wind energy	50,000 MW (Onshore only) / <b>(100,000 MW as per WISE) / 748,000 to 976,000 MW as per a recent study in 2011)</b>
2. Small hydro	15,000 MW
3. Solar	Over 5,000 trillion kWh/year Potential (estimated to be many times more than the total energy needs of the country) / <b>(200,000 MW of CSP as per WISE)</b>
4. Bio-mass	> 50,000 MW
5. Ocean based Energy	With about 7,000 km of coastal line potential must be huge, but no estimates available
6. Geo-thermal	Estimated to be considerable

# New & renewable energy sources

- **European Union has a plan to meet 20% of all its energy needs by 2020 AD through N&RES**
- **Israel is reported to be targeting 50%**
- **Greenpeace has come up with plans to meet 100% & 50% of energy needs of New Zealand and India**
- **There are many time tested and techno-economically viable sources**
- **Diverse geography of India is highly suitable to harness renewable energy sources**

# New & renewable energy sources

## Concerns:

- Two most common concerns on new and renewable energy sources
  - they are not firm power
  - comparable cost with conventional energy sources is high

## Reality:

- Many applications do not require 24 hours supply – can be backed up by battery banks
- Cost from the conventional energy sources is increasing while that of N&RE sources are decreasing.
- Cost of conventional energy sources is unreal – many hidden costs and subsidies
- N&RE s have many other benefits; overall costs and benefits are much in favour

## Distributed type of RE sources

- greatly reduction in effective demand on power grid
- drastic reduction in T&D losses
- vast improvement in power supply to off grid consumers
- much better voltage profile and to much reduced spending on grid management
- drastic reduction in need for conventional power plants
- assists in drastically reducing the GHG emissions and other pollutants
- provides a sustainable, environmental and people friendly energy supply model
- accelerates rural electrification due to shorter gestation period of individual projects
- leads to increase in rural employment opportunities and reduced urban migration
- requires negligible or nil additional resources such as land and water
- minimum impact on environment, and inexhaustible
- avoided costs of recurring fuel expenditure and of peak load power stations
- absence of the need for people's displacement.

# **Integrated resource management approach for sustainable development**

- **Integrated Resource Management and a holistic approach to the needs of the society - essential for ensuring energy security on a sustainable basis**
- **True welfare of every section of society**
- **End consumers not concerned - whether it is grid electricity or not**
- **They seek quality and reliable energy at affordable price**
- **Many credible ways of achieving this**

# **A serious introspection is needed at societal level**

## **Link between development and energy: context of electricity**

- **No issues about the need for energy for development of weaker sections of society**
- **Is per capita consumption a good indicator of development?**

**But the question should be:**

**How much energy?**

**At what cost ??**

**How to get it on a sustainable basis???**

**Must our forests, rivers and bio-diversity become expendable in order to meet the uncontrolled demand for electricity?**

# We need to honestly seek answers to:

- **What importance we, as a society, attach to forests and rivers ?**
- **how much more of forests and how many more of rivers can be compromised?**
- **have we considered the long term impacts of forest destruction at the present rate?**
- **do we have any obligations to future generations?**
- **are the various provisions of law just to be consigned to books?**

**How much of fossil fuel reserve do we have?**

**Shall we dam all the rivers? What after that?**

**Where will we get nuclear fuel for the growing number of power plants?**

**Shall we depend on import?**

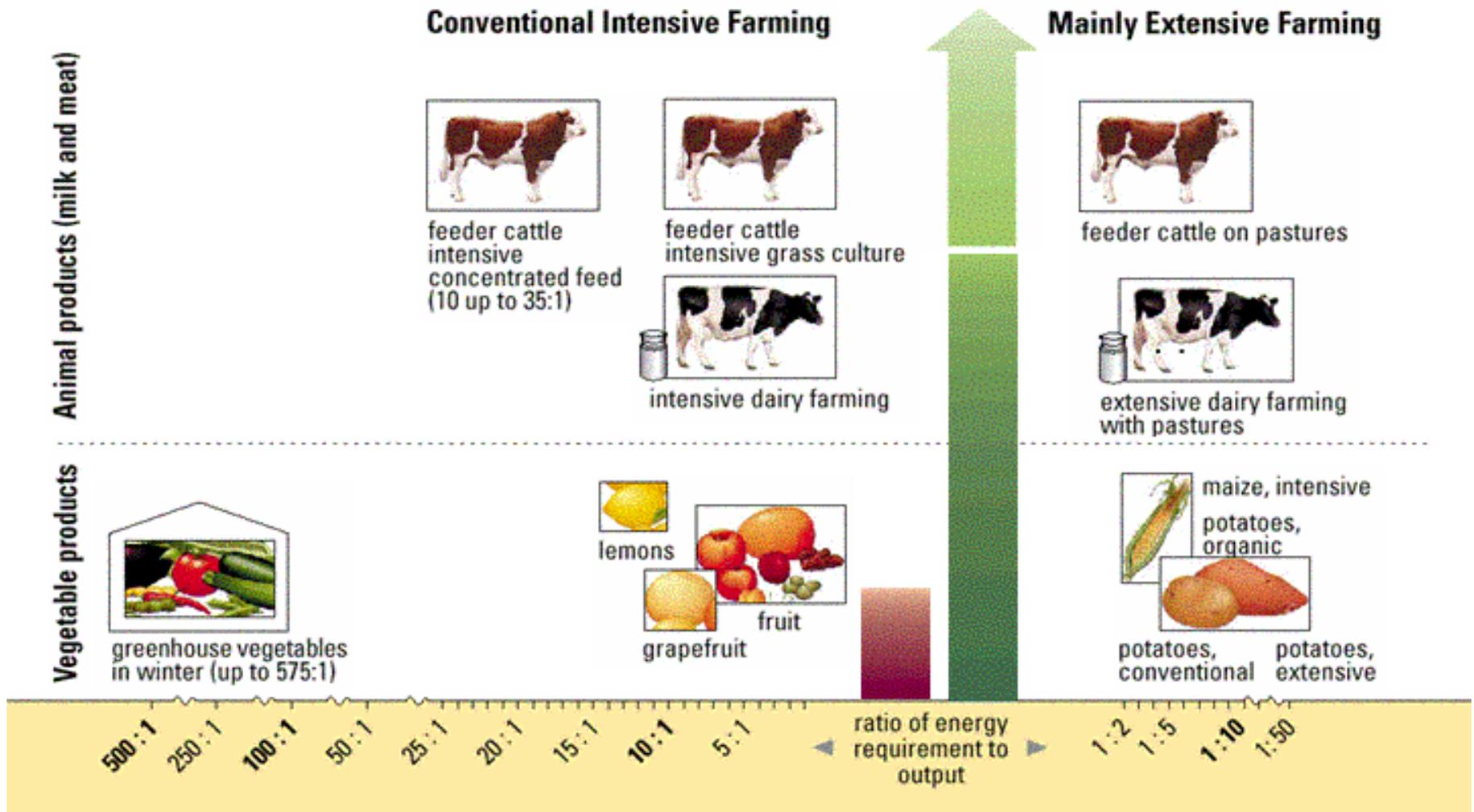
**Is there an issue of energy security in import dependence?**

# Better Options for Electricity Sector

- **Minimise losses; manage demand side & conserve energy**
  - potential for savings >> 30-35%
- **Go for smaller hydro power**
  - considerable potential
- **Harness solar energy to the maximum**
  - huge potential
- **Use wind energy where ever possible**
  - small size wind turbines most suitable for rural areas
- **Invest on wave energy too when technology becomes available**
  - 7,000 kM of coast line has enormous potential
- **Adopt effective public consultation**
  - essential part of democratic process

# Selection of Foods and their Input-Output Energy Balance

High values correspond to low energy efficiency. For greenhouse vegetables in winter we expend over 500 calories of foreign energy for one calorie of food.



# ANNUAL SOLAR ENERGY

Solar energy for wind

Exploitable wind energy

Hydropower

Solar energy for evaporation of water

Solar energy for photosynthesis

Renewable geothermal energy

Uranium for "breeder" nuclear reactors

Total geothermal energy down to a depth of 10 km.

Uranium for conventional nuclear reactors

# ANNUAL ENERGY CONSUMPTION OF THE WORLD

Total coal reserves

Exploitable oil shale

Exploitable coal reserves

Exploitable gas reserves

Total oil reserves

Total gas reserves

Exploitable oil reserves



# Conclusions

- ❖ Being part of a tropical country the state is highly vulnerable for impacts of global warming; geographical and climatic constraints need careful considerations
- ❖ even without the threat of Global Warming state requires a paradigm shift in its developmental approach
- ❖ need to move away from a regime of heavy demand for land, energy, water, minerals, and other natural resources
- ❖ high GSDP growth driven paradigm cannot be sustainable as experienced in the accelerated depletion of nature's reserve ; example of China
- ❖ must adopt sustainable practices predominantly aiming at poverty alleviation and careful harnessing of natural resources
- ❖ traditional knowledge base and effective public consultation must be used.

## Ten Things we can do curb global warming (Picked up from a website)

- 1. Drive Smart! Save fuel. Use public transportation as much as possible.**
- 2. Write to our political leaders. Urge them to raise fuel economy standards.**
- 3. Support clean, renewable energy**
- 4. Replace incandescent light bulbs with compact fluorescent bulbs**
- 5. Saving energy is good for the environment and for self**

- 6. Become a smart water consumer; minimise wastage**
- 8. Buy energy-efficient electronics and appliances**
- 10. Plant trees; protect forests, rivers and lakes**
- 12. Reduce! Reuse! Recycle! Reduce consumerism !**
- 10. Mount a local campaign against global warming**

## **Global Warming and Climate Change**

- **must be addressed; can be minimised**
- **needs concerted efforts by all**
- **change in life style : one of low material and energy consumption**
- **deep appreciation of sensitive link between human and nature**
- **let us mount a local campaign for global welfare**

Let us persuade the govt. to demonstrate real concern in this regard; not just empty assurances.

Because there will be no tomorrow if we are complacent today.

Global warming is existential threat for the man kind.

Thank you !!!