The 45th Research Session

India's Energy Situation and Trends in New/Renewable Energy and Energy Conservation Policies

September 14, 2009

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Why the India Watch?

Rapid economic expansion and growth potential

Increasing energy demand, rising import dependency

Impacts on:

- Energy markets
- Climate Change

- India's energy supply/demand trends and policy development could have great impacts on the future of energy balances for Asia and the World, market stabilization, and the global environmental issues.

What are the challenges for India？

- Response to continuing upsurge of energy demand
- Antipoverty/rural living standard improvement
- Environmental issues (pollution & Climate Change)

- Bolstering means to address the challenges in a balanced way:
  - Nuclear power generation
  - New & renewable energy

  ⇒ to ensure & diversify energy supplies

  - Energy conservation ⇒ to reduce energy demand

Report Organization

- India overview:
  - Energy balance
  - Energy policies
- India's NRE* policies and solar photovoltaic generation: Part 2
  - NRE policies
  - Solar photovoltaic generation

* New & Renewable Energy

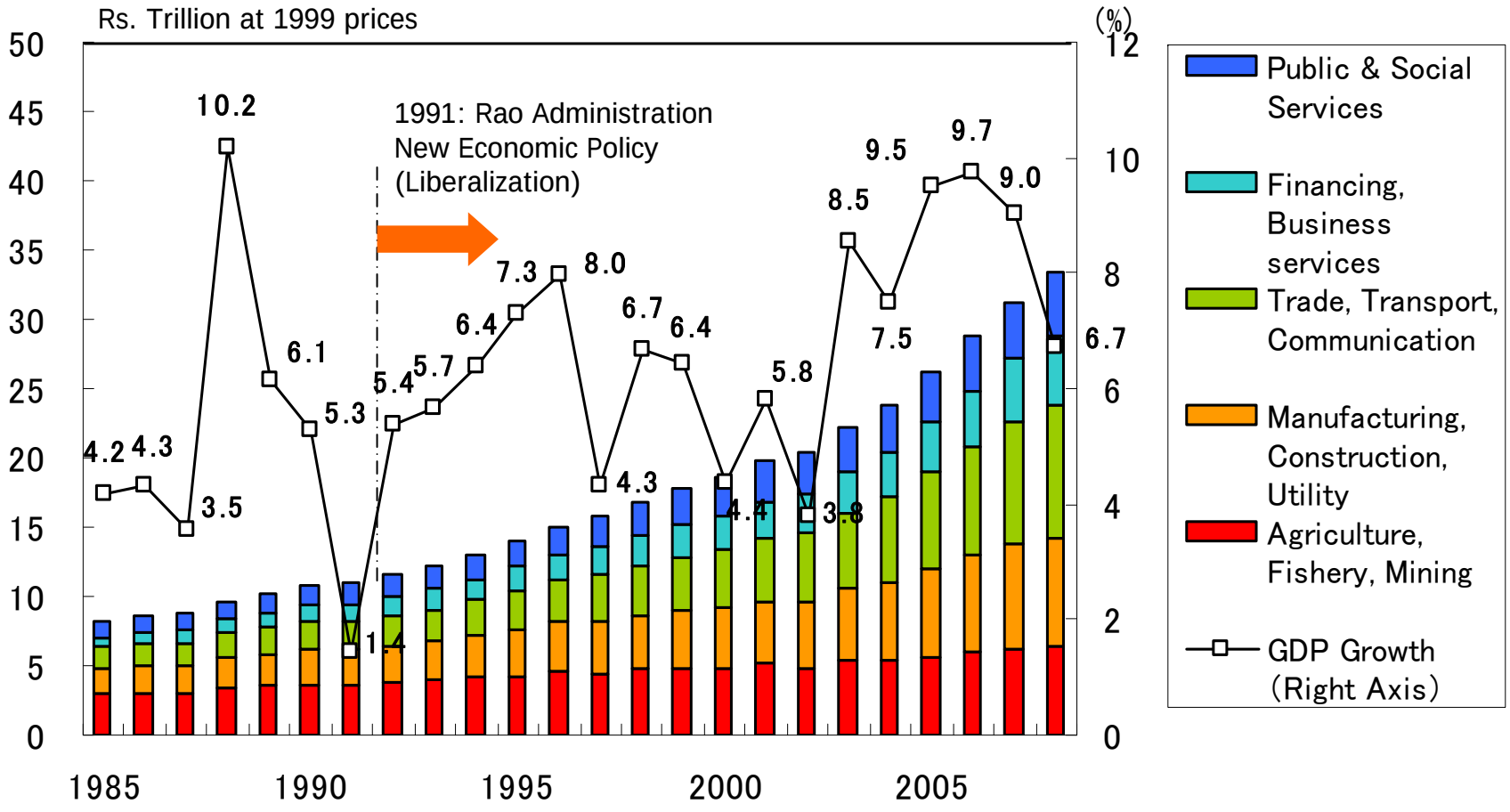
- India's energy conservation policies: Part 3
  - Energy efficiency status
  - Energy conservation policies
- Summary and implication:

- Energy Balance

(Reasons behind strengthened effort on nuclear power, NRE and energy conservation)

Economic Growth (GDP)

- High expansion expected to continue, after a slight dip in 2008

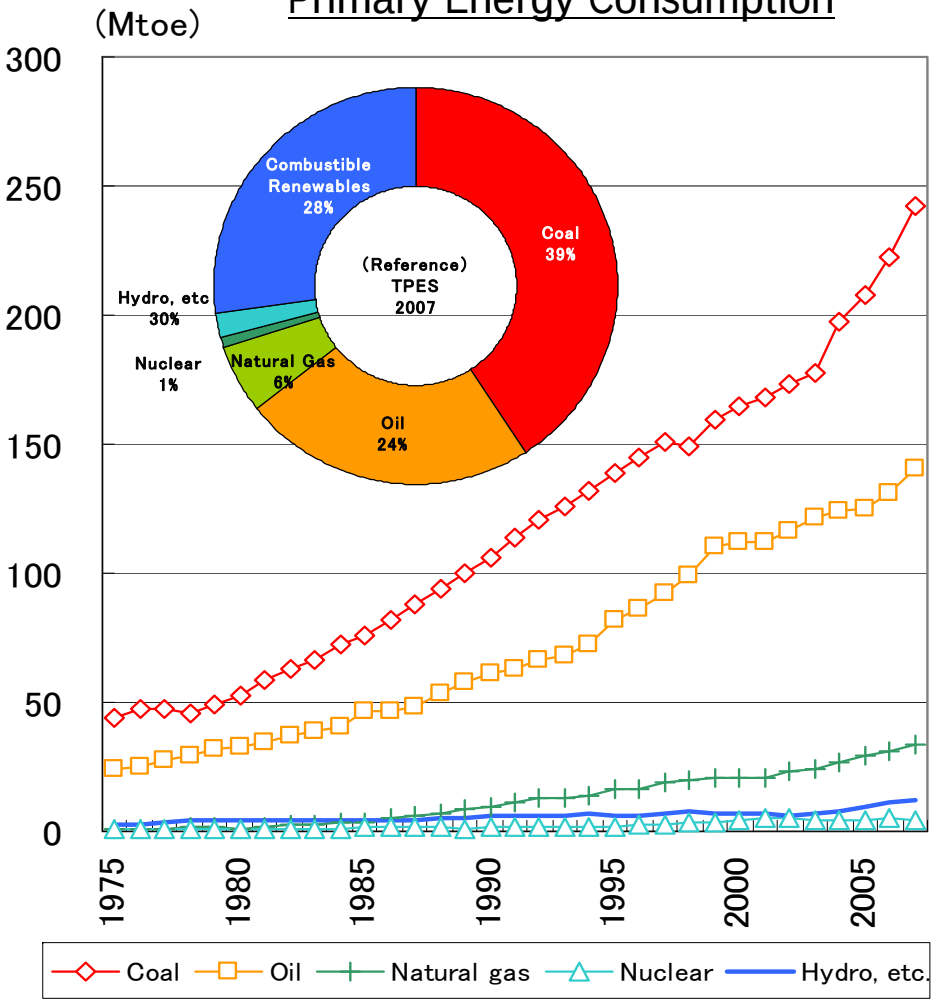


Source: Ministry of Statistics and Programme Implementation, National Account Statistics

Energy Consumption

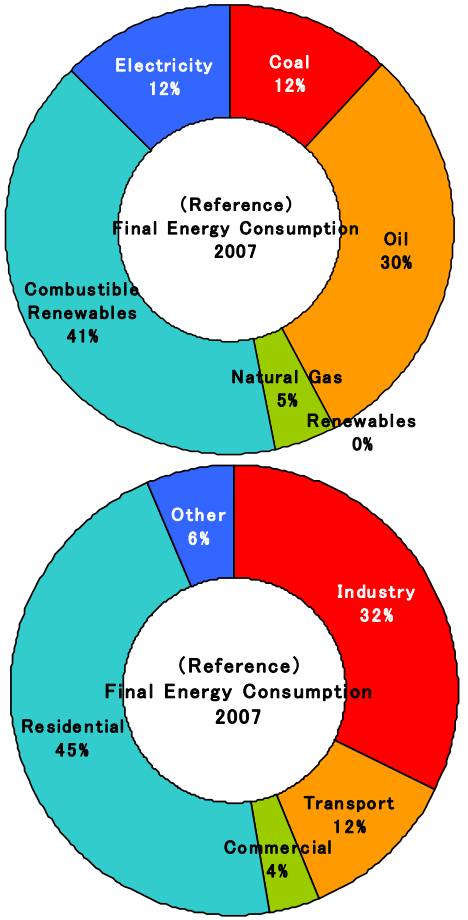
- Sharp rise in thermal coal, oil for cars and industry

Primary Energy Consumption



Source: IEA "*Energy Balance of non-OECD countries 2009*"

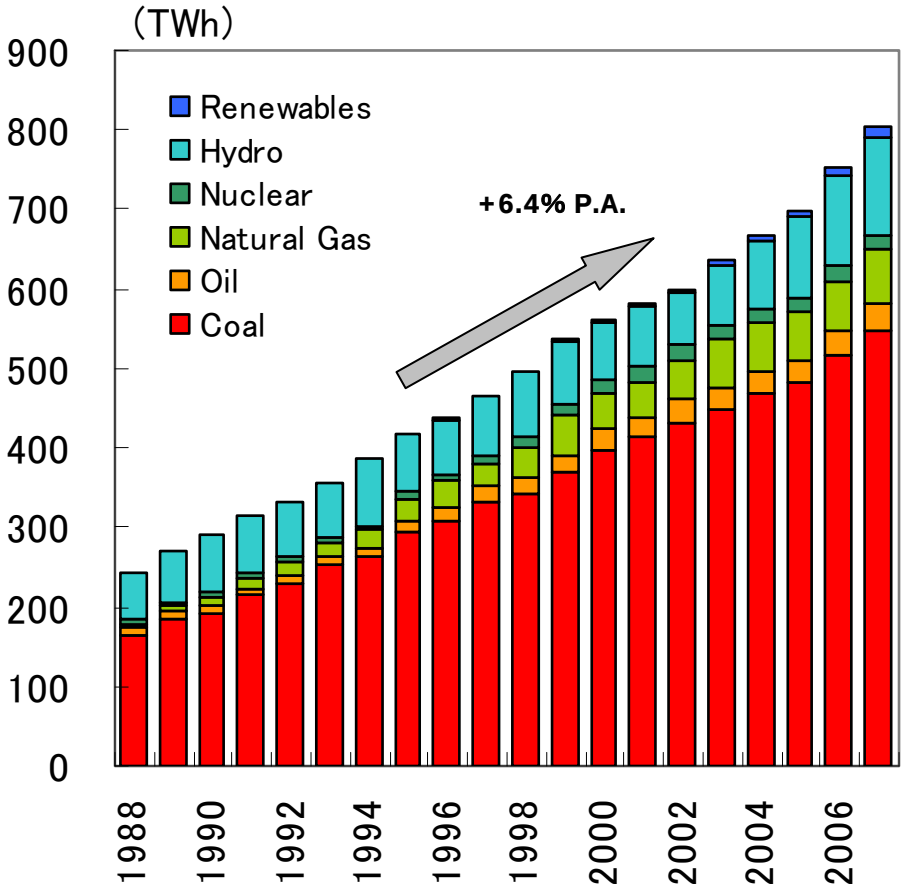
Final Energy Consumption



Electricity Demand

- Sharp increases call for new power source urgently

Electricity Generated



Source: IEA "*Energy Balance of non-OECD countries 2009*"

Installed Capacity [GW]

as of end-May, 2009

	Thermal	Nuclear	Hydro, etc.	Total
Central	36.3	4.1	8.6	49.0
State	47.0	–	29.3	76.4
Private	12.8	–	12.2	25.0
Total	96.0	4.1	50.2	150.3

Source: Central Electricity Authority

- Actual capacity addition during the 10th Five Year Plan (2002-06) period was 21.1GW against the plan of 41.1GW.
- Targeted capacity addition during the 11th Five Year Plan (2007-11) is 78.6MW, but actual 2-year results remain at 17.1MW.
- Average peak power deficit in FY 2008 was 11.9%, worst at 19% in Western Region.

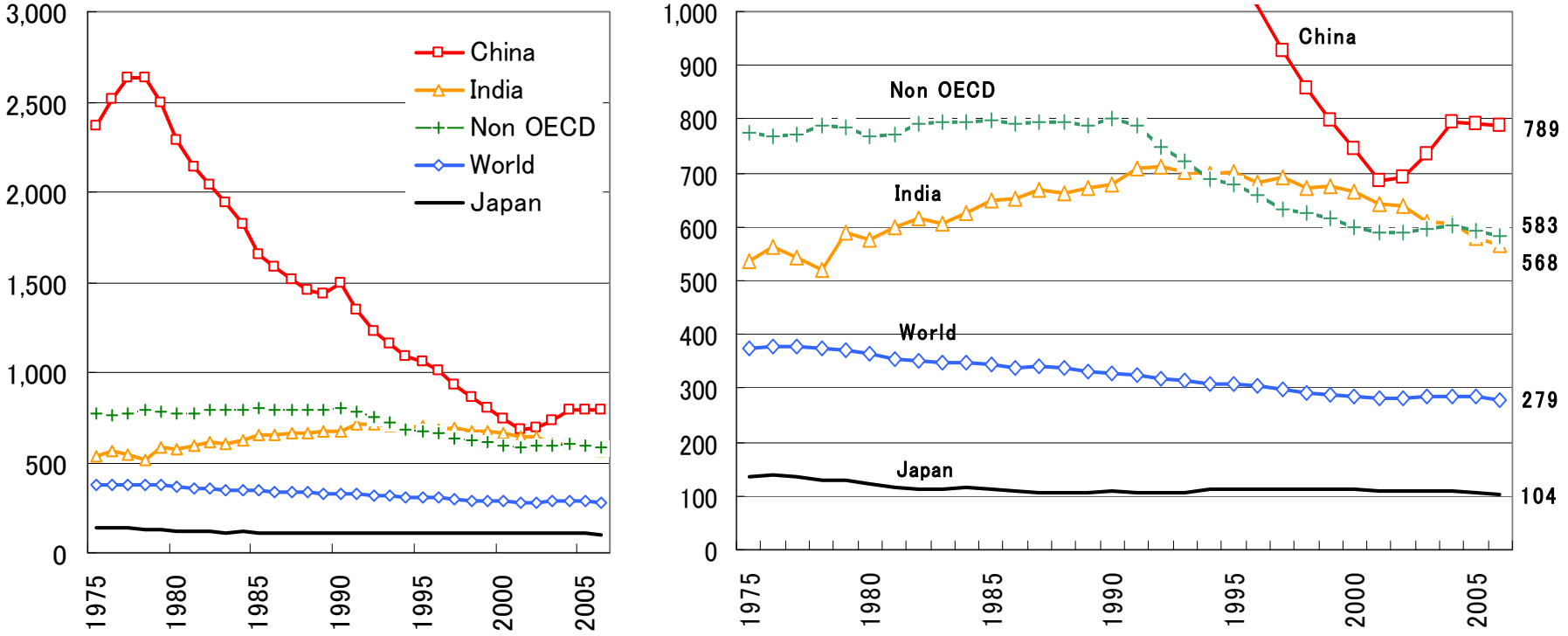
Solving power shortage now a critical task

Energy Intensity

- Despite gradual progress in energy saving, there remains a large room for improvements.

Primary Energy Consumption per GDP

(In TOE/Million US$ at 2000 prices)

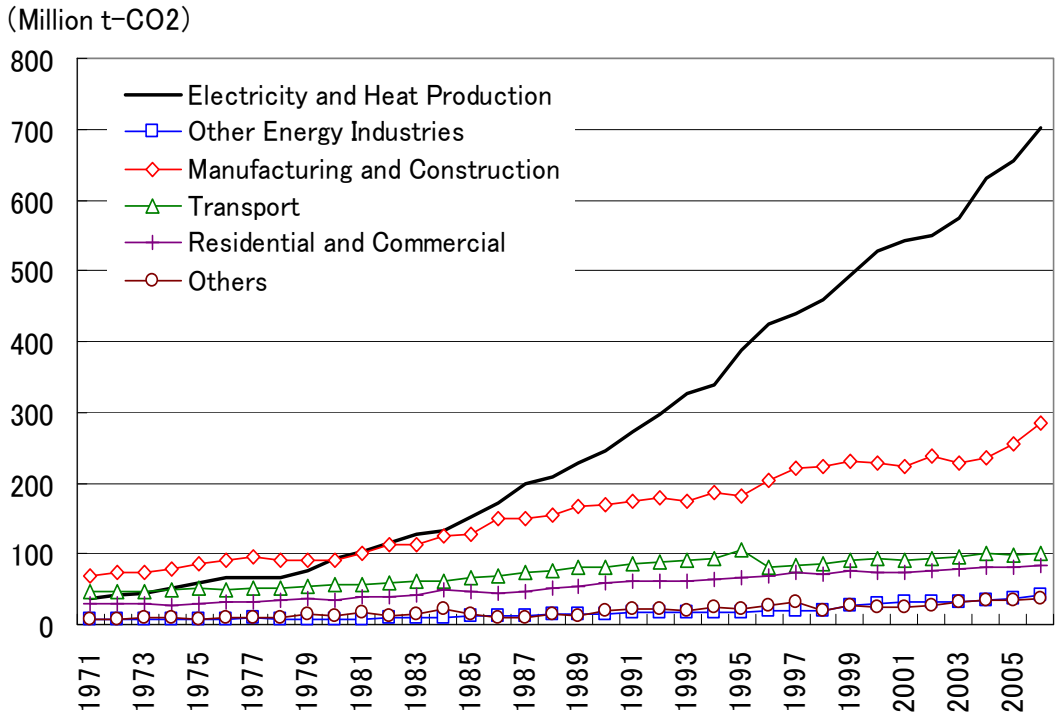


Source: IEEJ "*EDMC Handbook of Energy & Economic Database in Japan*"

Environmental Issues

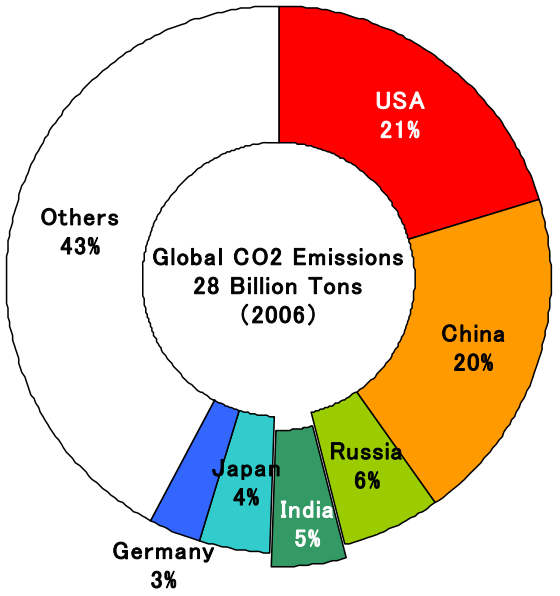
- Due to surging energy consumption, CO2 emissions are on a sharp rise mainly in the power sector.
- Air and water pollution is also aggravating.

India's CO2 Emissions by Sector



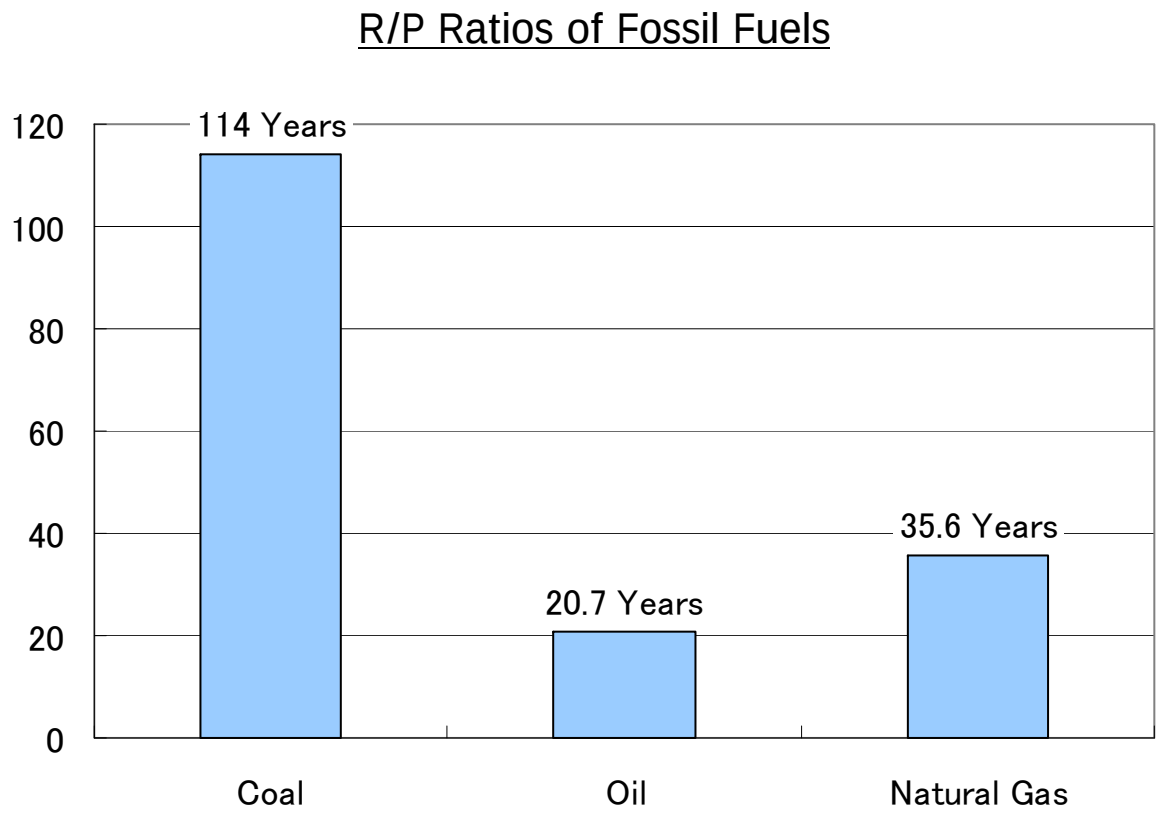
Source: IEA "CO_2 emission from fuel combustion 2008"

Global CO2 Emissions



Reserves/Production Ratios of Fossil Fuels

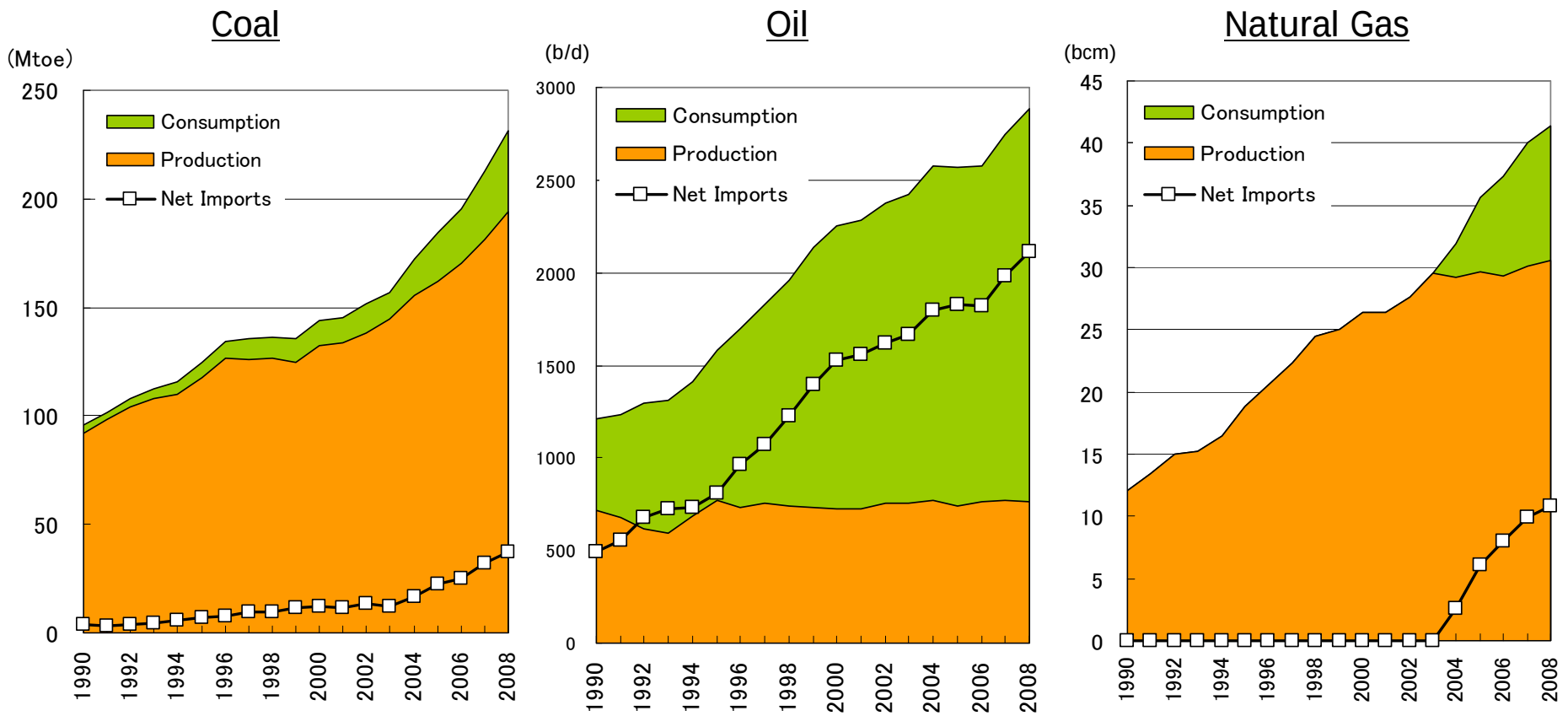
- There are coal and other fossil fuel reserves, but…



Source: BP "Statistical Review of World Energy 2009"

Export/Import by Energy Type

- Import dependency of fossil fuels is on the rise.

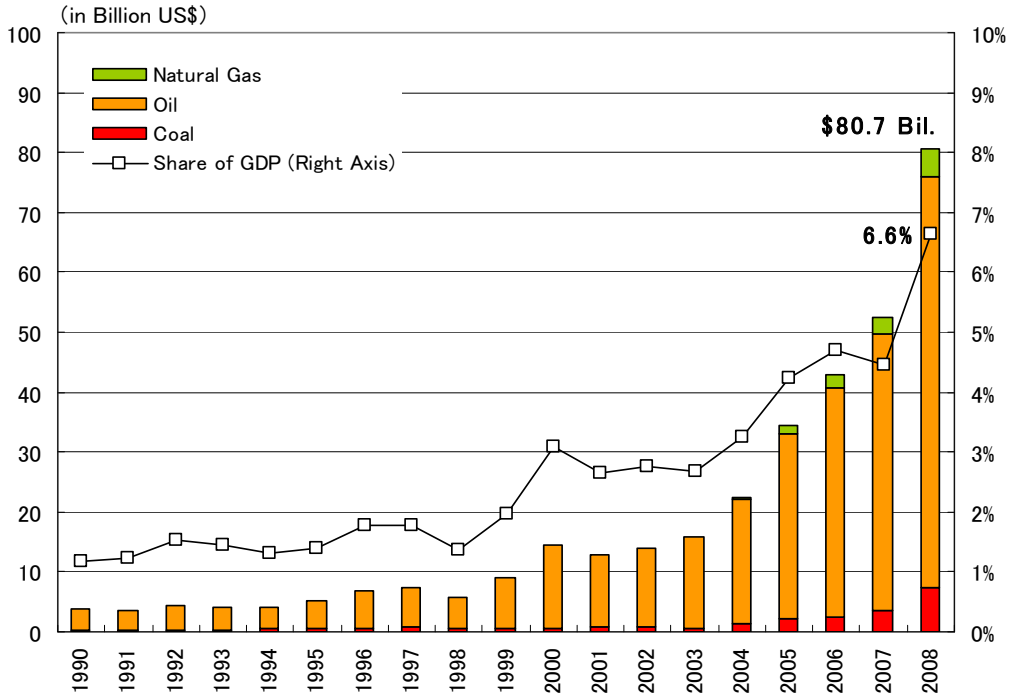


Source: BP "Statistical Review of World Energy June 2009"

Financial Burden of Energy Imports

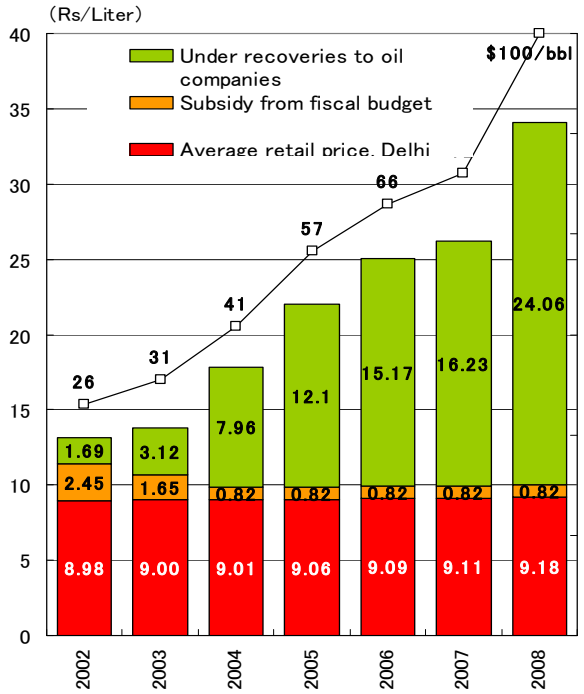
- Growing energy imports and inflationary prices are pushing up cost burdens.
  - Retail price hike difficult to effect on social policy grounds

Cost of Energy Imports



Source: Calculated from BP "Statistical Review of World Energy June 2009"
GDP data by IEEJ "EDMC Handbook of Energy & Economic Database in Japan"

Price Subsidy on Kerosene

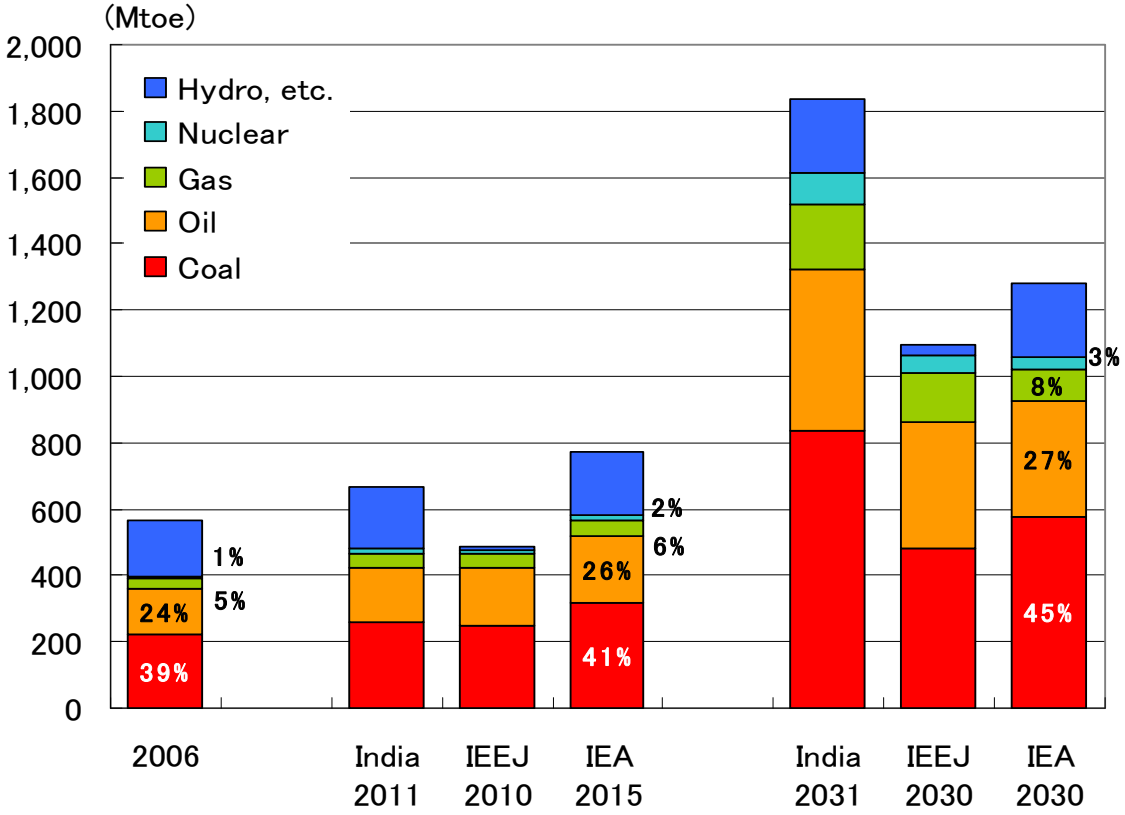


Source: PPAC

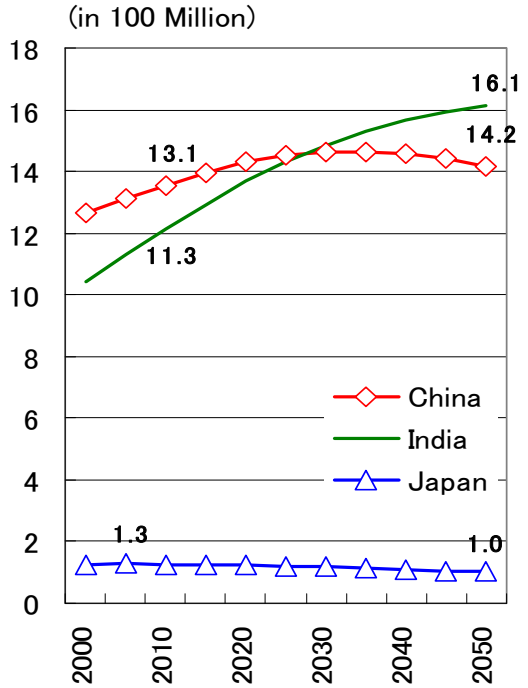
Energy Demand Outlook (1)

- Energy consumption projected to grow by 3.5% p.a. (IEA), with high growth (8.8% p.a.) for nuclear.

Primary Energy Consumption Forecasts



Population Projection

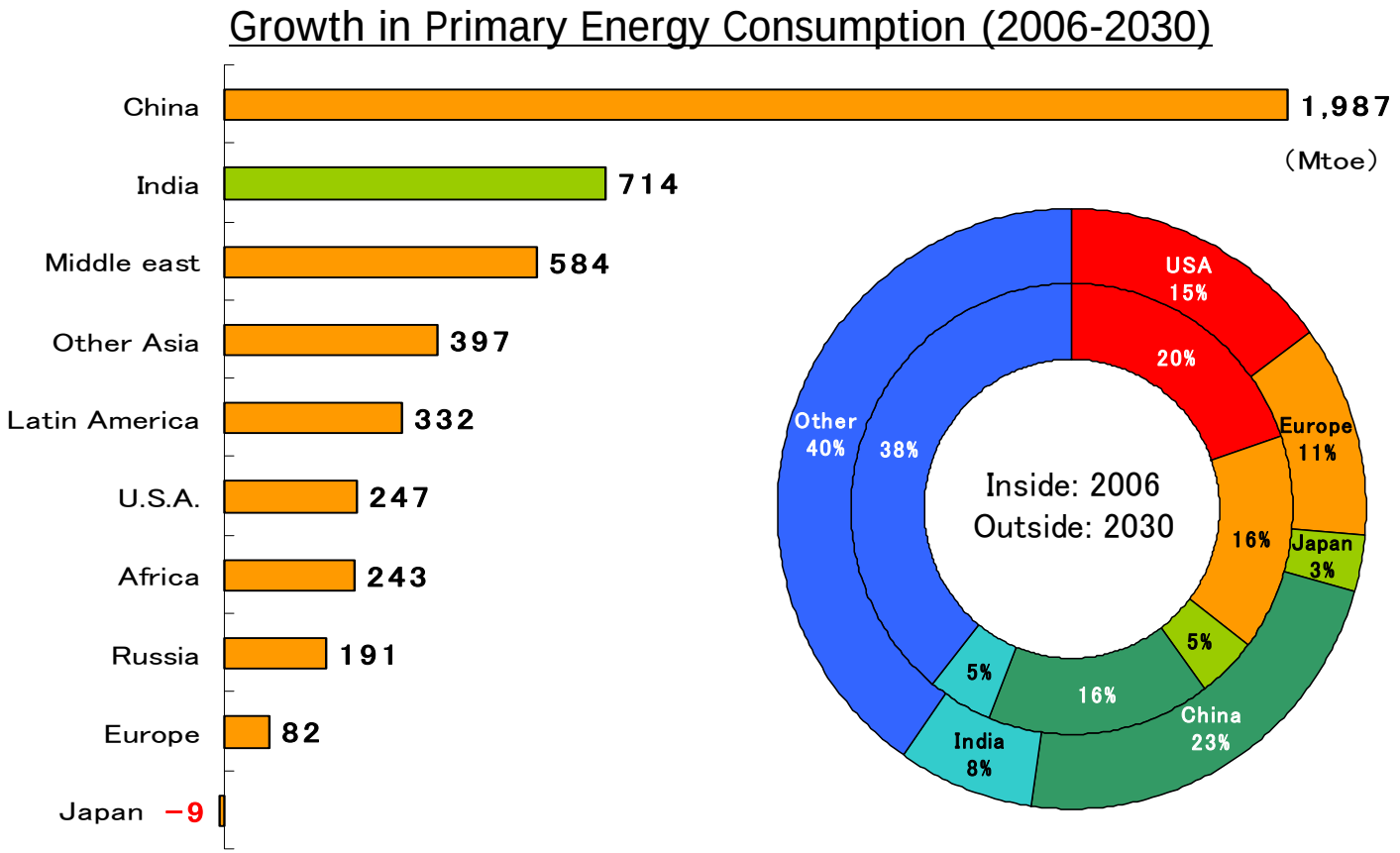


Source: UN, World population Prospects, 2008 revision, Medium Case projection

Sources: Government of India Planning Commission "Integrated Energy Policy" Aug. 2008, GDP growth at 8%, including non-commercial energy, IEA "World Energy Outlook 2008", Reference scenario, also for 2006 results, and IEEJ "Asia/World Energy Outlook 2007"

Energy Demand Outlook (2)

- India's share of the world energy demand is projected to increase further.



Source: IEA "World Energy Outlook 2008", Reference scenario

Energy Balance Summary

- Rising energy demand due to economic growth:
  - Sluggish power supply expansion, chronic shortage
  - Inferior energy efficiency compared to world norms
  - Rapid increase in CO2 emissions, worsening pollution
  - Soaring import dependency creating high cost burdens

- Heightened interest in energy security:
  - Stable supply
  - Reasonable price
  - Sustainability

Requiring supply assurance, demand control, and clean use of energy

Renewed efforts toward solutions

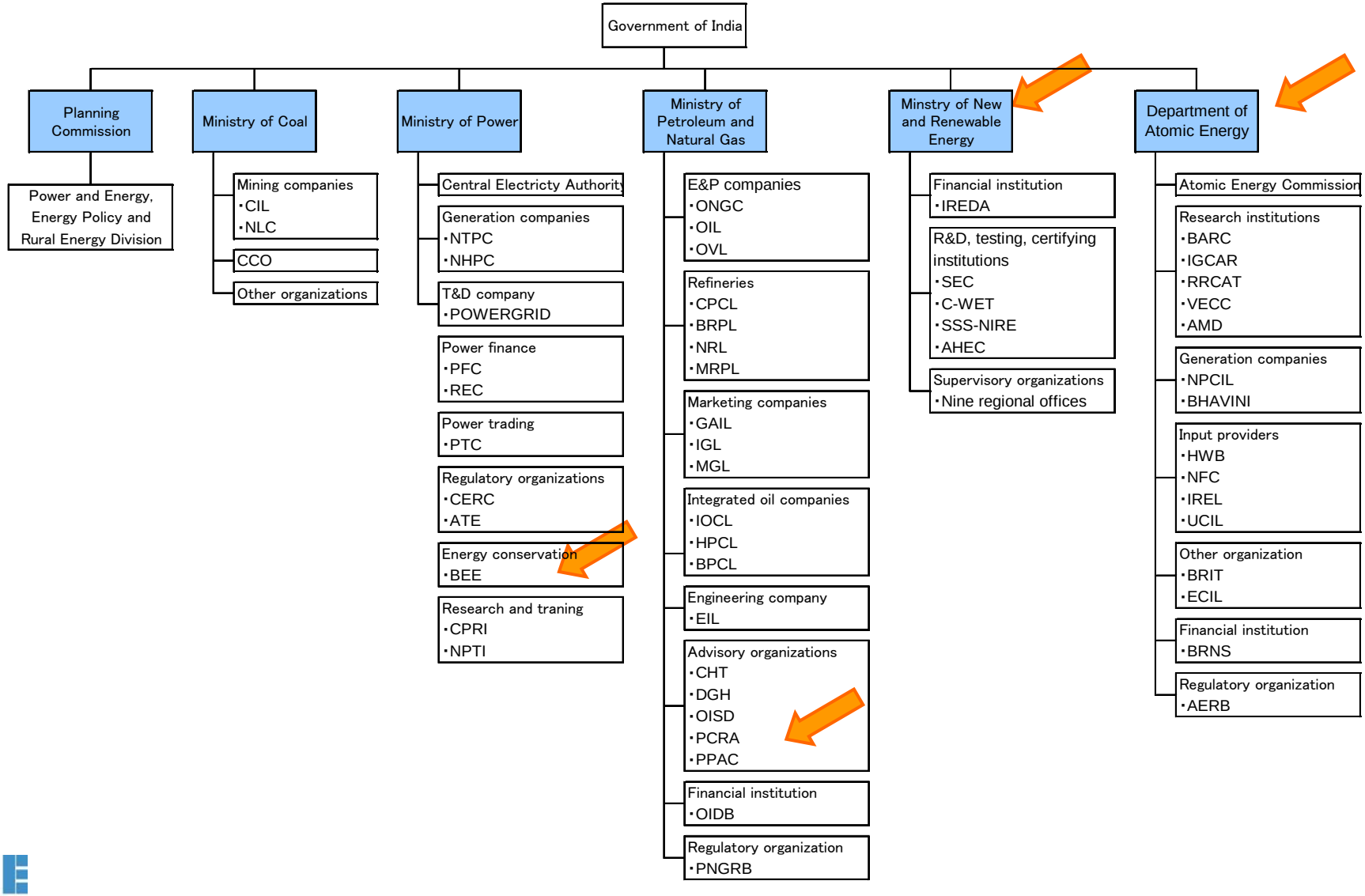
Nuclear power | NRE | EE&C

- Energy Policies

(Specific efforts on nuclear power, NRE and energy conservation)

Organization of the Energy Sector

- Segmented by energy types



The 11th Five Year Plan (2007-2011)

- Enhanced supplies, efficiency, NRE in main focus
  - Power development and state distribution system reforms
  - Increased coal production, infrastructure for imports
  - Enhanced exploration, acquisition of equity oil & gas abroad, more LNG imports, rationalized petroleum pricing
  - Energy sector reforms and deregulation
  - Energy conservation via Demand Side Management
  - Promotion of NRE to improve energy security, rural living standards, and environmental load
  - Research & Development
    Efficiency/Supplies/Environment
  - Integrated Policy

Budget Outlay by Ministries

(in Rs. Million)

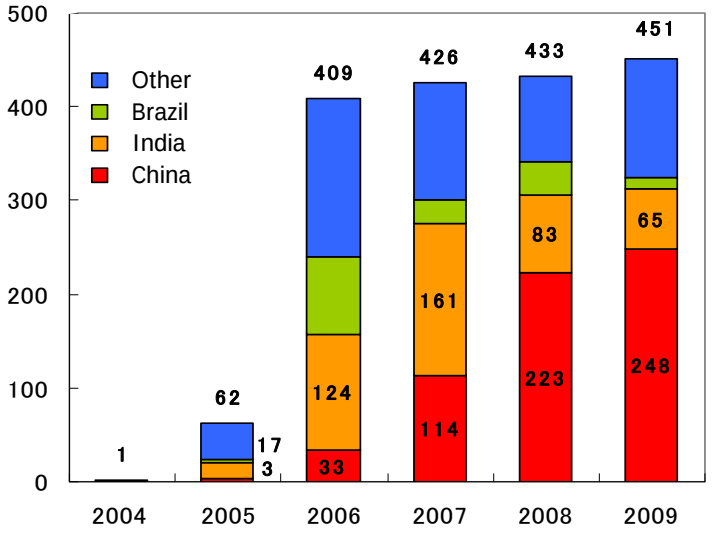
	2008 FY	2009 FY	Changes
Ministry of Coal	68,970	56,740	−17.7%
Ministry of PNG	465,650	575,010	23.5%
Ministry of Power	404,600	531,260	31.3%
Dept. of Atomic Energy	59,200	62,770	6.0%
Ministry of NRE	12,670	13,470	6.3%

Source: Ministry of Finance, Union Budget 2009-2010

National Action Plan on Climate Change

- Eight missions to concurrently address “economic growth” and “climate change issues”: (June 2008)
  - Solar energy for power & heat (Rural electrification, etc.)
  - Enhanced energy efficiency (Energy conservation in industries)
  - Sustainable habitat (Improved energy efficiency for buildings, waste management and recycling, shift to public transportation, etc.)
  - Water resources (Improved water use efficiency)
  - Sustaining Himalayan ecosystems
  - “Green India” (To promote afforestation)
  - Sustainable agriculture
    (Climate-resilient crops and practices)
  - Knowledge on climate change
    (Understanding climate science and socio-economic impacts)

Number of Registered CDM (8/24/09)



Compiled from Kyoto Mechanisms Information Platform

Electricity Policy

- 3 types of power utility enterprise: Central Gov't. (4), State Gov't. (109), Private companies (60)
  - Central: Large-scale generation (Coal, Hydro, Nuclear), trunk lines
  - State Electricity Boards: Manage 60% of source, 90% of distribution
- National Electricity Policy 2005
  - Main targets: Electrification of all household, solving shortages
- Irrational tariff systems
  - Pricing based largely on state policy
  - Pressing SEB* management and hampering investments for NRE or efficiency measures.

*State Electricity Board

Tariff Disparity by User Class

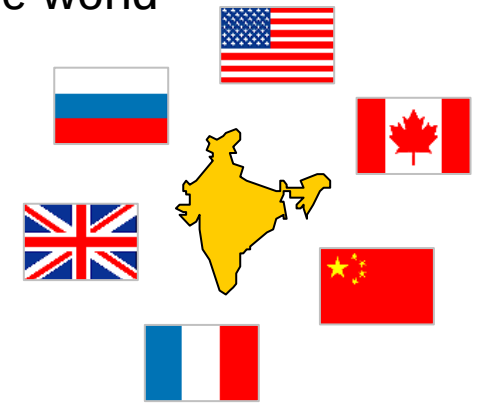
(Rs/kWh)

User Category	Highest		Lowest	
Domestic	5.8870	Gujarat	0.3180	Bihar
Commercial	9.6998	Kerala	0.3286	Bihar
Agriculture	3.2754	Gujarat	0.0000	Punjab & Tamil Nadu
Small Industries	5.6000	Delhi	1.5700	Jammu & Kashmir
Medium Industries	6.9241	Maharastra	1.5700	Jammu & Kashmir
Large Industries (11kV)	5.9305	Gujarat	0.7135	Mizoram
Large Industries (33kV)	5.9240	Gujarat	0.7135	Mizoram
Power Intensive Industries	4.5013	Himachal Pradesh	1.3554	Daman & Diu
Railways	5.7600	Delhi	2.8050	Bihar

Source: Central Electricity Authority

Nuclear Power Policy (1)

- Nuclear Power Corporation of India Ltd. (NPCIL) solely controls construction and operations of nuclear plants.
- History of development policies:
  - 1947: Nuclear R&D starts immediately after Independence
  - 1968: Refusal to sign Nuclear Non-Proliferation Treaty (NPT)
  - 1974: First nuclear test stops foreign support (except Russia)
    - Of 17 units in operation, 13 are indigenous PHWR (in July 2009)
    - Smaller unit output (160～540MW) compared to the world
  - 2005: Indo-U.S. Joint Statement (July 18)
  - 2008: Indo-U.S. Civilian Nuclear Deal (Oct. 4)
    - Agreements also with Russia, France, and China
    - Negotiations in progress with U.K. and Canada

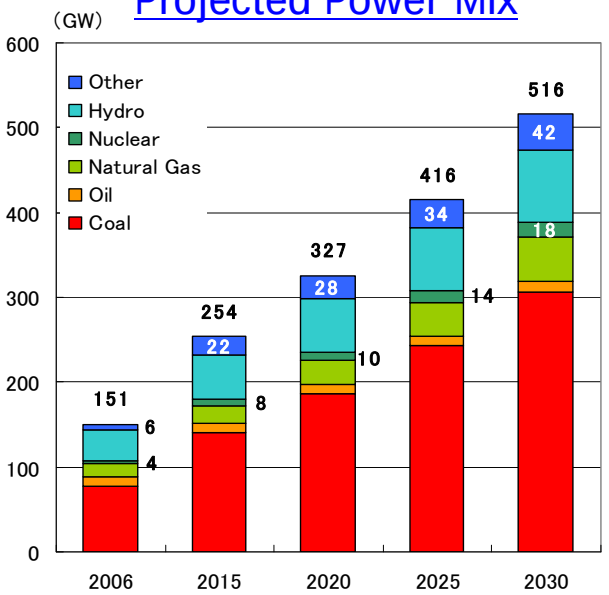


- Plans are shaping up to introduce foreign technology PWR

Nuclear Power Policy (2)

- Development plans: (as of Jan. 1, 2009)
  - In operation: 4.12GW (17 units)
  - Under construction: 3.16GW (6 units)
  - Planned: 6.80GW (8 units)

Projected Power Mix



Source: IEA, World Energy outlook 2008

- Development policy:
  - Combine foreign technology PWR with indigenous fast-breeder reactors to satisfy long-term electricity needs
  - Establish balanced supply/demand by 2050

- Evolvement of capacity targets:
  - 2002: Dept. of Atomic Energy (DAE): “20GW by 2020”
  - 2005: P.M. Singh, after Indo-US Agreement: “40GW by 2020”
  - July 2008: DAE: “Import 40GW of foreign technology PWR”
  - January 2009: “Bring installed capacity to 63GW by 2030”

Nuclear Power Policy (3)

- Requirements for achieving the goals:
  - Sustained economic growth that can attract foreign investments
  - Infrastructure for transmission lines, water lines, ports, roads
  - Plant construction and operations skills, capacity building:
    - Lowest capacity utilization factor among 31 nations in 2008
  - Assured uranium fuel supplies:
    - Frequent stoppages due to fuel shortage after 2000

- Policy/strategy for Japanese Gov't. and businesses
  - G-to-G cooperation agreement raises foreign policy issues (NPT):
    - Continued call for sign-up of NPT and IAEA Additional Protocols
  - Japanese business strategy in the absence of bilateral agreement?
    - For now, indirect market participation through business partners

NRE, Energy Conservation Policy

New & Renewable Energy

- Diverse and abundant potential exists.
- Target: 54GW by 2022 (excl. SPV*), 20GW SPV* by 2020
- Implementing various promotional measures like favors on foreign investments, financial support, Feed-in-Tariff

Part 2

Energy Conservation

- Large energy saving potential
- Target: 5% p.a. saving up to 2015 (≈ 100 MT reductions in CO2)
- Bureau of Energy Efficiency (BEE) leads industrial sector effort (Designated Consumer), Standards & Labeling, etc.

*SPV = Solar Photovoltaics

Part 3

Energy Policies Summary

- Responses to continuing upsurge of energy demand:
  - Energy conservation to hold energy demand down
  - Nuclear power and new & renewable energy to increase supply
  - Revising price system to expand investments and restrain demand
- Antipoverty/Rural living standard improvement:
  - Distributed NRE supplies for rural energy access
  - Price revision (= price hike) is necessary to expand investments and control demand, but…
- Responses to climate change issues:
  - Promotion of nuclear power generation and new and renewable energy as well as energy conservation

- Nuclear power generation, new and renewable energy and energy conservation are important on a mid- to long-term basis.

Reference: General Information (1)

- Name : Republic of India
- Population : 1.169 Billion (Mid 2007)
- No. of households : 188.2 Million (2001)
- Land area : 3.29 Million sq. km
- Capital : New Delhi
- Ethnic groups : Indo-Aryan 72%, Dravidian 25%, and others
- Religious groups : Hindu (80%), Muslims (14%) and others
- Head of State : President Pratibha Devisingh Patil
- Prime Minister : Manmohan Singh
- GDP : US$1,139.8 Billion (2007)
- Per capita GDP : US$975 (2007)
- GDP growth : 9.3% (2007)

(Reference) PRC
Population: 1.33 Billion
Area: 9.6 Mil. sq. km
GDP: US$4,299.2 Billion
Per capita GDP: $3,313

Reference: General Information (2)

- Oil reserves : 5.5 Billion Bbls. [0.4% of the world] (end of 2007)
- Gas reserves : 1.06 Trillion cu.m [0.6%] (end of 2007)
- Coal reserves : 56.5 Billion tons [6.7%] (end of 2007)
- Primary energy supply : 565 Million TOE [4.7%] (2006)
- Per capita primary energy supply : 0.51 TOE (2006)
- Primary energy supply per GDP : 0.80 TOE/000$ (2006)
- Energy-based CO2 emissions : 1.26 Billion t-CO_2 [4.6%] (2006)
- Import dependency of energy : 23.8% (2006)
- Import dependency of oil : 71.4% (2007)
- Middle-east dependency : 75.3% (2007)

(Reference) PRC
Oil reserves:15.5 Bil. bbls
Gas reserves:1.88 TCM
Coal res.:114.5 Bil. tons
TPES:1,880 Mil. TOE
Per capita PES:1.43 ton

Contact：report@tky.ieej.or.jp

The 45th Research Session

(Part 2)
India's New & Renewable Energy Policies and Solar Photovoltaic Generation

September 14, 2009

Toshiharu Yagi

Strategy and Industry Research Unit
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Contents

1. New and renewable energy* policies
2. Solar photovoltaic** generation
3. Summary

*Short form: “NRE”

** Short form: “SPV”

NRE Potentials in India

- Various and abundant renewable resource potentials exist.
- Estimated at 84.50 GW generation capacity excluding solar photovoltaics.
- Potentials for windpower and small hydro are conservatively estimated.

Source	Description	Estimated Potential
Biomass	Agricultural residues: from rice, wheat, corn, sugar cane, coconut, cotton, oil crops, beans, jute production	Potentials assessed at Taluka (county) levels Estimated availability: 500 Million tons p.a. Equivalent to 16,880 MW generation capacity
	Municipal solid waste	Estimated for each 5-year Plan period Available MSW in 2012: 210,000 TPD, equivalent to 3,650 MW capacity
Windpower	March to August: High winds for most of Subcontinent except East Coast. May to June: SW Monsoon October: NE Monsoon	Scientifically evaluated using the “Wind Resource Assessment Programme” Land-based potential: 45,190 MW Technically achievable: 12,880 MW
Solar PV	Clear sky on 250 to 300 days of the year	Capacity potential undisclosed by the Government Solar Energy Centre publishes radiation data. Annual global solar radiant exposure: 1,460 - 2,555kWh/m^2
Small hydro-power	Concentrated in the Southern part, but some available in dry North mountains	Candidate sites: 5,403 locations Estimated generation capacity: 15,000 MW

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New and Renewable Energy Initiatives in India

- Importance of NRE as a means to enhance energy self sufficiency was recognized after the oil crises of the 70's.
- From the needs for diversifying energy sources, expanding domestic energy options, and promoting the rural electrification, efforts have been undertaken from a long-term perspective.
- Targeting to raise the share of renewables to 5-6% in 2032

The 11th Five-Year Plan (2007～2012)
Proposed target: 14,500 MW, equivalent to 20% of newly installed capacity

	Rs. in Billion
Grid-interactive & distributed/off-grid renewable power	39.25
Renewable energy for rural applications	22.50
Renewable energy for urban, industrial & commercial applications	6.85
Research, design & development	15.00
Supporting programs	21.00
Total	104.60

Source: MNRE website

Government Agencies Related to NRE Policies

Federal Government

Policy, resource evaluation, R&D, demonstration, commercialization

Planning Commission

Electric power, energy, energy policies, and state energy administration

Ministry of New & Renewable Energy (MNRE)

Financing: Indian Renewable Energy Development Agency (IREDA)

R&D, Testing, Certification: Solar Energy Centre (SEC), Centre for Wind Energy Technology (C-WET), Sardar Swaran Singh National Institute of Renewable Energy (SSS-NIRE), Alternate Hydro Energy Centre (AHEC)

State Governments

Nodal Agencies for New and Renewable Energy

Ex.1: Gujarat Energy Development Agency (GEDA)

Ex. 2: Karnataka Renewable Energy Development Agency Ltd.

IREDA: Indian Renewable Energy Development Agency Ltd

SEC: Solar Energy Center

C-WET: Centre for Wind Energy Technology

SSS-NIRE: Sardar Swaran Singh National Institute of Renewable Energy

AHEC: Alternate Hydro Energy Centre

Source: Compiled from Teri Energy Data Directory & Yearbook (TEDDY) 2007

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NRE Deployment Programs

- Various programs have been undertaken based on the diverse characteristics of respective energy resources; now extended to 11th Five-Year Plan Period.

	Program Segments under 11th Five-Year Plan			
	Grid-interactive & off-grid NRE power	Distributed power source	Rural/remote villages	Urban Industry & commercial uses
Solar PV	Demonstration on a megawatt SPV plant (Economic analysis on effect of FIT incentive)		Subsidy for electrification, SHS, and home lighting by standalone systems	Municipality help on Solar Cities project Deployment of standalone system such as Roof-top systems, street lighting
Solar Thermal System	Demonstration on a solar thermal generation plant (Economic analysis on effect of FIT incentive)			Support to Solar Cities project, energy-saving buildings (Solar Buildings), use of hot water, waste heat and steam (households, buildings and plants)
Wind Power	Tax break, FIT, financing to private wind firms, support to commercially inviable wind firms (mainly public), wind condition survey	"Small Wind Energy and Hybrid System" (water pumping wind mills)		
Small Hydro	Grid-connected power (support for initial investment), support for development and improvement of watermills		Rural electrification, test project for rural integrated energy supply	
Biomass	Initial investment support, FIT, tax break, financing for grid-connected power and cogeneration projects	Non-bagasse cogeneration for industrial use as a response to demand increase in off-grid area (gasification), MW-class gasification power generation	Electrification (Gasification system), Bio-gasifyer and gas engines test project for rural integrated energy supply	Non-bagasse cogeneration for industrial use (repeated entry)
Biogas		Biogas generation based on forest, local industrial and kitchen wastes	Gas supplies for cooking and lighting, test project for rural integrated energy supply	
MSW	Demonstration of new technologies (anaerobic digestion, pyrolytic gasification, landfill gas recovery, pelletized fuel)			

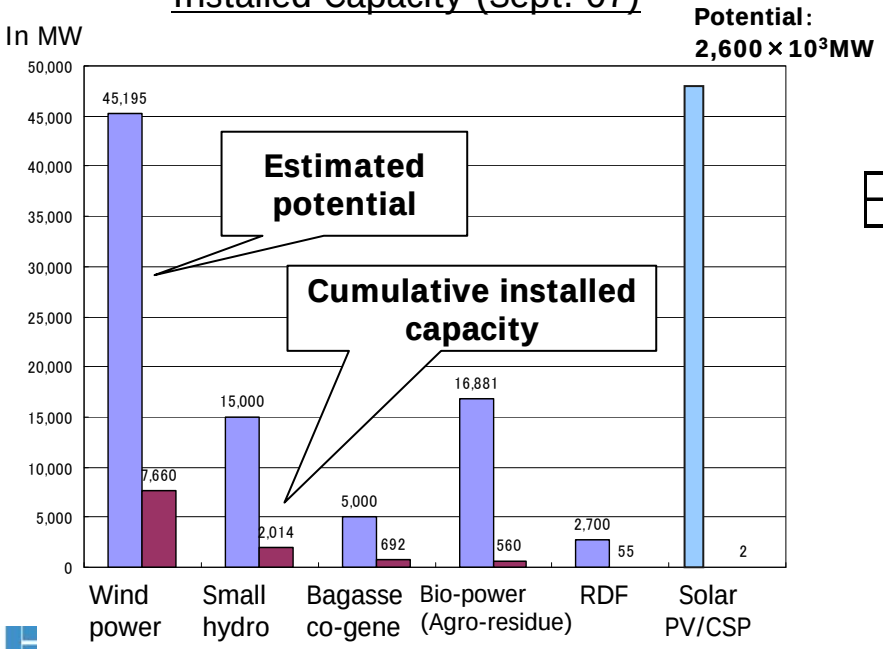
Source: MNRE website

Status of NRE Utilization in India

NRE utilization for grid-connected power

- On wind power and small hydro power, private sector is building generation plants utilizing the Generation Based Incentives (GBI). Commercialization of indigenous technology is in progress.
- For biomass, installation of bagasse-based power generation and combustion plants based on agro-residues is increasing.
- On Refuse Derived Fuel power generation, technical demonstration has just begun driven by environmental problems on MSW.
- On solar energy, full scale deployment will start from now. Enormous potential of 5,000 TWh p.a. exists although estimated potential is undisclosed.

Estimated Potential and Cumulative Installed Capacity (Sept. 07)



Rural Electrification

Villages and hamlets (ca. 9,000) outside the scope of electrification by Ministry of Power come under the responsibility of MNRE who will provide villagers with electricity via small hydro power, biomass gasification, biomass gas engines, or PV systems. If these are infeasible, solar lighting system (lanterns or Solar Home Systems) will be provided.

Applications in rural areas

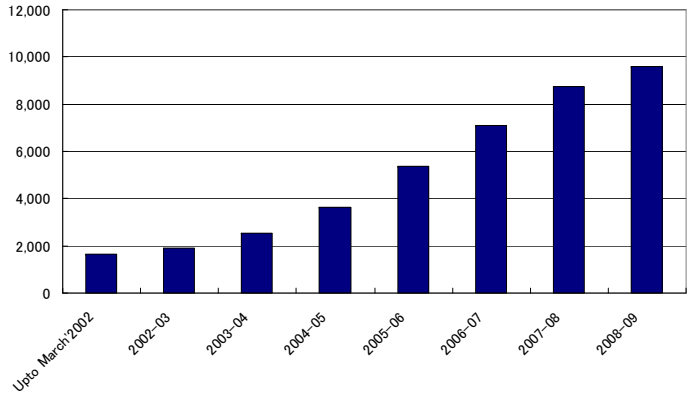
For the estimated potential of 12 million units, 3.93 million of home type biogas plants (for cooking and lighting) were installed so far.

Applications in urban, industry, commercial use

Water heaters, water-pumping windmills, aerogenerator/hybrid systems, solar PV water pumps, grid-connected roof-top SPV and others are installed.

Cumulative Installed Capacity of Windpower (Dec. 08)

Fiscal Year	Upto 2002	2002-03	2003-04	2004-05	2005-06	2006-07	2007-08	2008-09
Cumulative Total	1,667	1,909	2,524	3,636	5,352	7,094	8,757	9,587



Source: "*25 years of Renewable Energy in India*", MNRE, P12

Examples of NRE Utilization in India

- Wide applications: Lighting, cooking, heating, power buy-back, cogeneration, etc.

Family type biogas plant

Biomass Gasifyer unit

Windfarm

Solar cooker

Stand-alone solar generation plant

Biogas generation at dairy farms

Source: 2008 New & Renewable Energies･DOE Annual Report

①

NRE Deployment Targets, Feasibility and Impact

- The Government of India has set a target of achieving a total installed generation capacity of 54,000 MW to be obtained from NRE sources by 2022, excluding solar photovoltaics.

- The target seems to be highly achievable given the conservatively assessed amount of resource potential and the available level of commercialized technologies for wind power and small hydro power, which account for a major portion of the target.

- If the above target is achieved, the capacity will be equivalent to 1.6% of the primary energy consumption, or 14.5% of the total electricity demand in 2020 (against the IEA projection).

- For the solar photovoltaic power, a proposal is seeking Prime Minister's approval (*) to attain a total installed capacity of 20,000 MW by 2020. If this goal is achieved, the capacity will be equivalent to 6% of the overall power generation capacity projected by the IEA for 2020.

*National Solar Mission/National Action Plan on Climate Change 2008

②

Environment for Grid-connected Solar PV System

- Proactive posture on R&D, demonstration and deployment of NRE-related technologies.
- Endeavoring to develop NRE-related technologies under an integrated rural electrification policy.
- Actively pursuing grid connection of NRE to improve energy security under constant power shortage.
- Policy measures on SPV are being bolstered more than ever after the NAPCC was announced.

Policy framework

Strategy:

Solar National Mission

Measures:

Grid connection capability is being enhanced for PV as well.

Solar radiation/power generated (Technology)

- Abundant solar radiation (4-7kWh/m^2 ・day)
- Diverse climate ranging from equatorial belt in south to Himalayan mountains.
- Effect of Thar Desert with high D/G ratio monsoons.

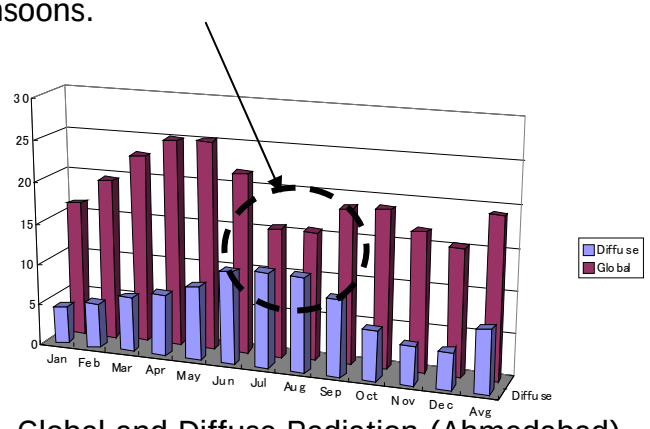
Economics:

Electricity tariff/supply situations

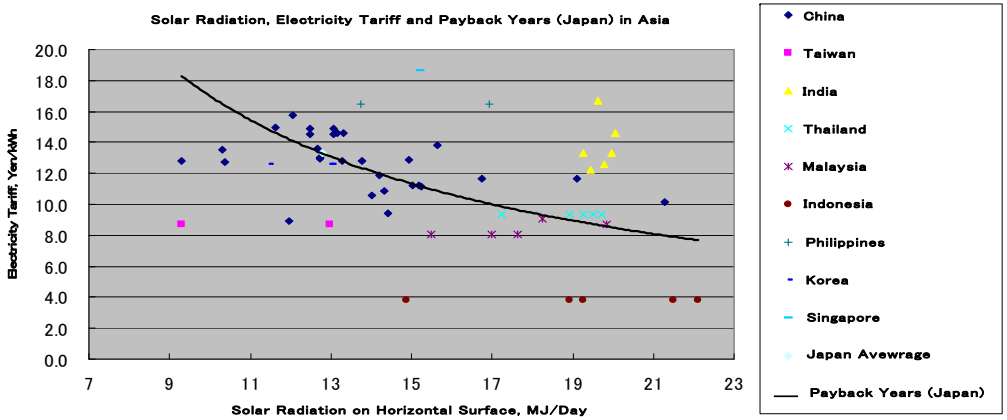
- Widely differ depending on user category and state:

Commercial rate in Kerala: 19Yen/kWh; agricultural use in Tamil Nadu or Punjab is free; generally rates for farmers are kept low for political reasons.

- Power shortage, fragile system, low electrification rate



Global and Diffuse Radiation (Ahmedabad)
By SEC *Solar Energy Handbook*



Solar Radiation, Electricity Tariff and Payback Years (Japan) in Asia, by IEEJ

②

Mega-solar Power Demonstration Projects

To accelerate development of large-sized grid interactive solar power stations, the MNRE announced a guideline based on the Generation Based Incentive (GBI) scheme in January 2008, and started a support program for demonstration projects to verify the economic viability of the concept.

Item	Description
Eligibility	Domestic or foreign listed corporations, central or state power generating companies, private or public SPV project developers
Scale	Minimum 1MW per site, up to 5MW for a project operator, up to 10MW per State, for a total program limit of 50MW during the 11th Five Year Plan period (2007年～2012).
Project Nature	Build, Own, and Operate (BOO) basis; excludes grid connection to or use as a private power generation facility.
Incentives	Max. Rs. 12/kWh for 10 years (plants commissioned before 12/31/09) Max. Rs. 11.4/kWh for 10 years (plants commissioned after 12/31/09)
Other	・Power purchase by utilities to continue after passage of the 10 years. ・The accelerated depreciation program is not applicable.

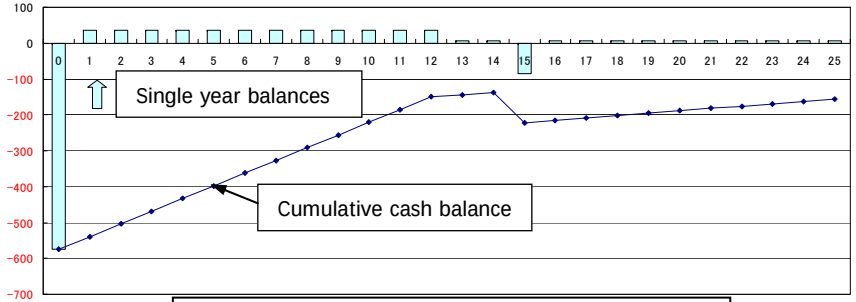
Source: MNRE website

②

Economics of Mega-solar Power Project

- A negative IRR based on GBI with estimated cost in NEDO Field Tests in Gujarat; an 11% IRR when the German package is applied to the same site with 70% higher solar radiation

1. Gujarat GBI on cost estimated from NEDO FT data

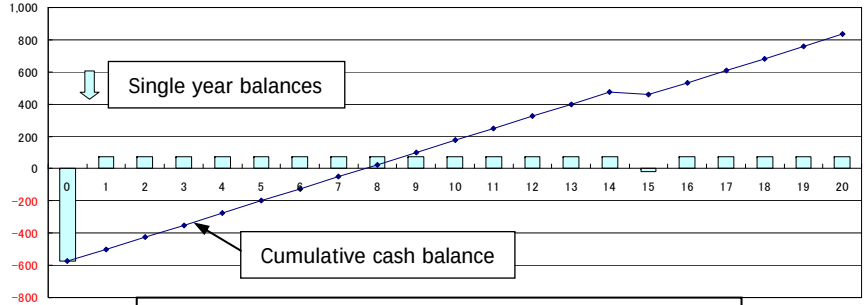


Estimated FT cash balance, Gujarat GBI, crystalline PV

13 Rs/kWh for 12 years; 3 Rs/kWh for 13 years
Initial investment: Yen 574 Million
Solar module cost: 374 Yen/Wp
Inverter cost: 91 Yen/Wp
O&M cost: Yen 0.68 Million/year
Land lease: Yen 0.72 Million/year
Annual solar radiation: 2,128kWh (25 deg. Angle)
Yearly ouput: 1,444,273kWh

IRR = -3.91%

2. German package on cost estimated from NEDO FT data



Estimated FT cash balance, German package, crystalline PV

0.4 €/kWh for 20 years

(Same as left)

IRR = 11.03%

Summary and Issues

1. Measures to accelerate introduction and diffusion of NRE:
   - Long history, ample experiences, and consistency worthy of respect
   - Wide scope covering various resource types, users, producers, investors, developers, and systems
   - Diverse support measures: Initial cost support/subsidy, finance, preferential taxes (duty exemption, VAT relief, accelerated depreciation), support for power purchase/sale, aid for power buy-back
   - Initiatives to promote introduction of mega-solar generation system, or grid-connected roof-top system are attracting interest both at home and abroad.
   - Issue1: Proper institutional setup for solar energy (purchase price, period, etc.)
2. Business and international cooperation opportunities for Japan:
   - Difficult to enter windpower, small hydropower, and biomass/bio gasification power fields as world-class enterprises grew backed by domestic markets.
   - Fledgling market for SPV and grid connection systems may offer opportunities.
   - Participation of or technology transfer from technologically advanced Japanese enterprises is welcome.
   - Issue2: Labor relations, complex tax systems, lack of infrastructure
   - Issue3: Skills gap: possible steps: OJT for technicians or laborers in manufacturing or installation/construction fields
   - Issue4: Lack of industry's economic might: possible steps: international finance

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The 45th Research Session

(Part 3)

India's Energy Conservation Policies

September 14, 2009

Mitsuru Motokura

Strategy and Industry Research Unit
The Institute of Energy Economics, Japan

Contents

- Significance of Energy Conservation in India
- Energy Efficiency in India
- Energy Conservation Policies in India
- International Cooperation for India's EE&C*
- Challenges for India's EE&C* Efforts
- Summary and Conclusion

*Energy Efficiency and Conservation

Significance of Energy Conservation in India

- To improve energy security under "Integrated Energy Policy" (Aug. 06):

1) Reduce Energy Requirements: Given the top priority as a policy option for energy security
   Perception: Securing energy supplies to satisfy ever increasing demand is difficult.
   Examples: Improving efficiency of coal power plants, shifting freight traffic to railways, promotion of public transport, demand-side management

2) Substitute Imported Energy by Domestic Alternatives:
   Example: Biofuels

3) Diversify Supply Sources:
   Example: Importing gas through pipelines or in the form of LNG, or hydropower from neighboring countries

4) Expand Resource Base and Develop Alternative Energy Sources:
   Examples: Developing nuclear energy, CBM, GTL, wind, solar, biomass fuels, etc. (Acquisition of equity resources from abroad is listed here although not a new or renewable energies)

5) Increase Ability to Withstand Supply Shocks and Interruptions:
   Example: Strategic reserve

6) Increase Ability to Import Energy and Face Market Risks :
   Example: Strengthening foreign currency reserves

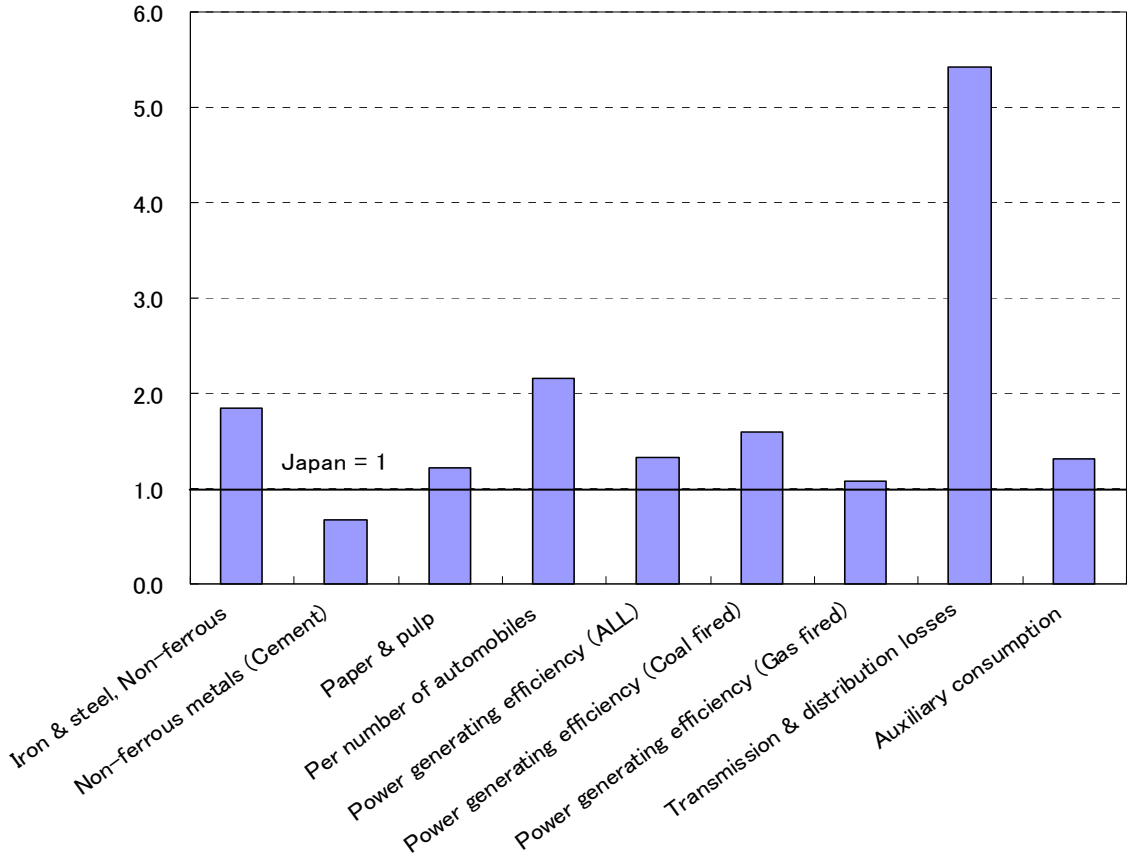
- To implement "National Action Plan on Climate Change" (June 2008):

Energy conservation is placed second of the eight missions **(The first is solar energy)**

The importance of energy conservation was also mentioned in the Independence Day speech by P.M. Manmohan Singh delivered on August 15, 2009.

Energy Efficiency in India (Comparison with Japan)

Comparisons for major sectors (Estimates)



Power sector seems to have a high energy saving potential.

In industry sector, Iron & Steel shows a good potential.

(Note) This graph has been prepared based on a trial calculation using the IEA Energy Balance Tables (2005 data) and production statistics available for comparisons. Since the IEA data does not provide industry-wise breakdowns for gas and electricity consumption in the industry sector, the gas and power consumption figures have been apportioned to respective industries based on GDP value-added data on a provisional basis. Thus, the picture given here could differ from international comparison performed by other organizations.

Energy Efficiency in India (Electric Power 1)

Main characteristics of Indian power sector:

Both Central and State governments operate power utility enterprises.

State power utilities vary by states (vertical integration ~ unbundling).

Distribution is mainly handled by states.

Main fuel is coal (transported chiefly by rail).

Power industry structure in India

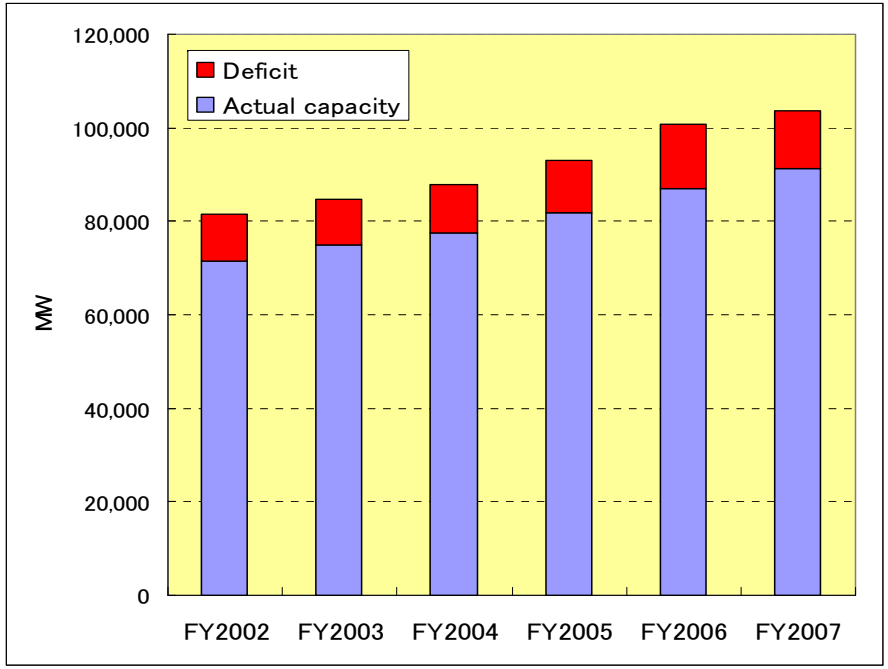
Many problems for India's power sector exist in the state-run power utilities.

	Central Government	State Governments	Private
Generation	Large thermal power Large hydropower Nuclear	Medium/small thermal Medium/small hydro	○
Transmission	○	○	–
Distribution	–	○	○

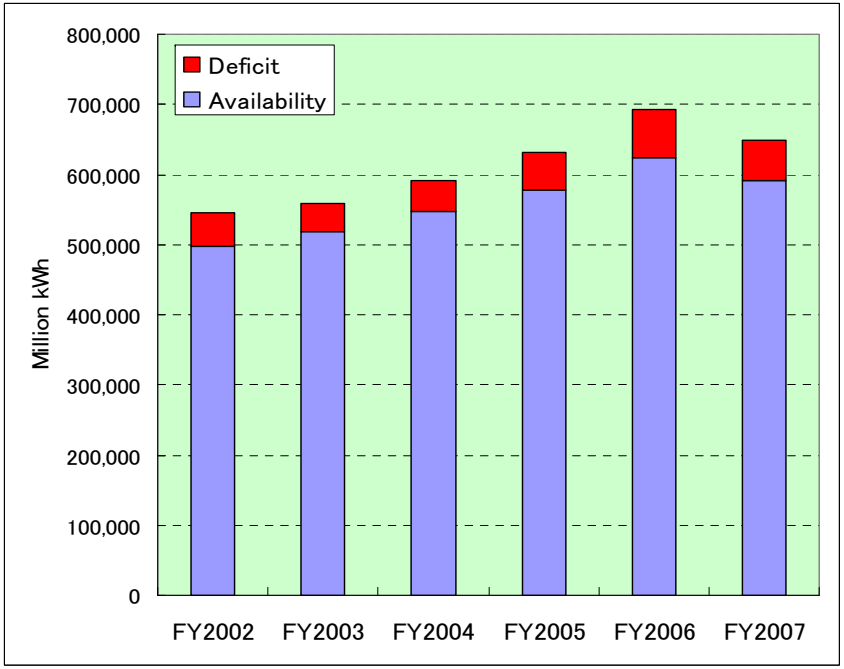
Energy Efficiency in India (Electric Power 2)

Serious power shortages:

Peak Power Deficit



Generated Power Deficit



Source: Prepared from India Ministry of Power (CEA) data

Both peak power and generated power are in deficit by about 10%.

Energy Efficiency in India (Coal Transport)

- Coal is produced in eastern to central regions:

  Coal power plants spread nationwide (some inland).

  Coal transport is mainly via railways.

- Indigenous thermal coal has high ash content:

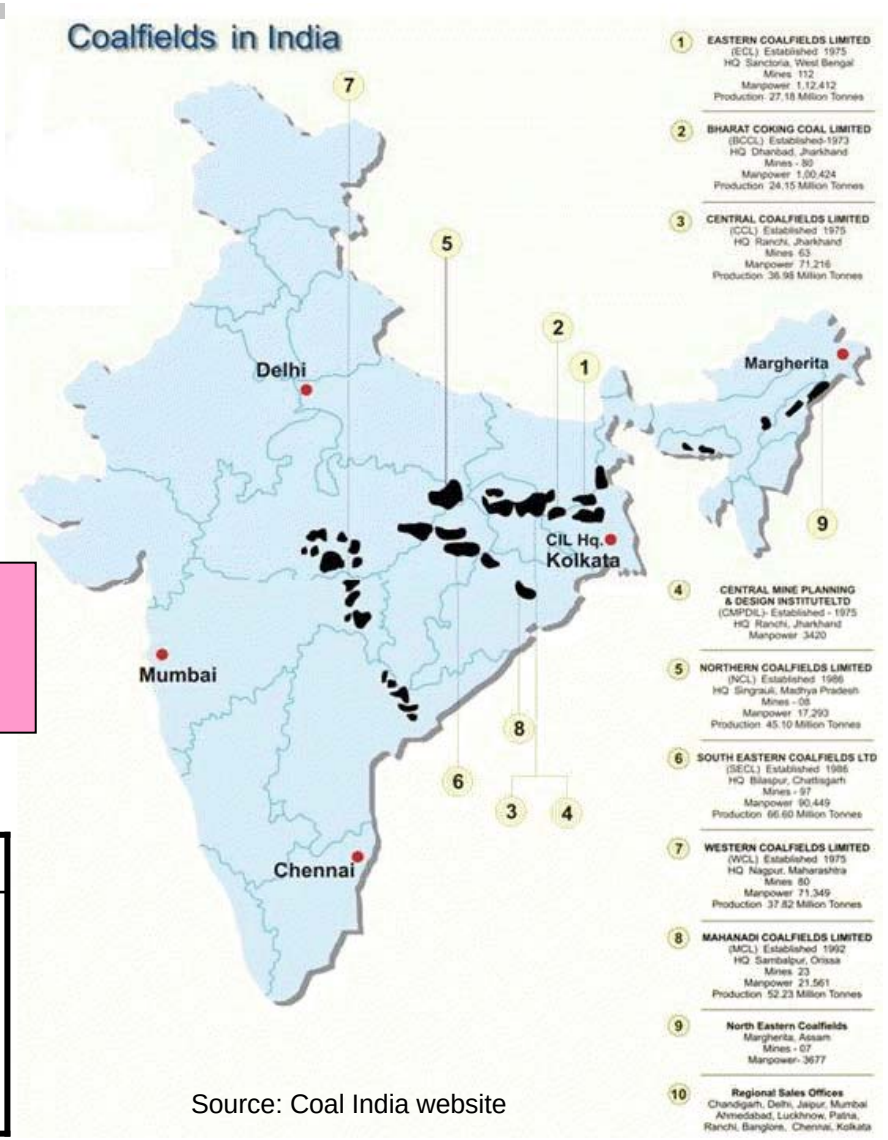
  Ash in raw coal: 40～50% (Australian imports ≒ 10%)

- Ash limit 34% regulation (from June 2002)

  Applied if power station is more than 1,000km away, but washing capacity is insufficient.

About 40% of railway transportation is taken by coal, about 70% of which is for power plants.

→ Hauling large quantity of useless ash



Source: Coal India website

(Reference) Thermal Coal Demand by Haul Distance (10^6T)

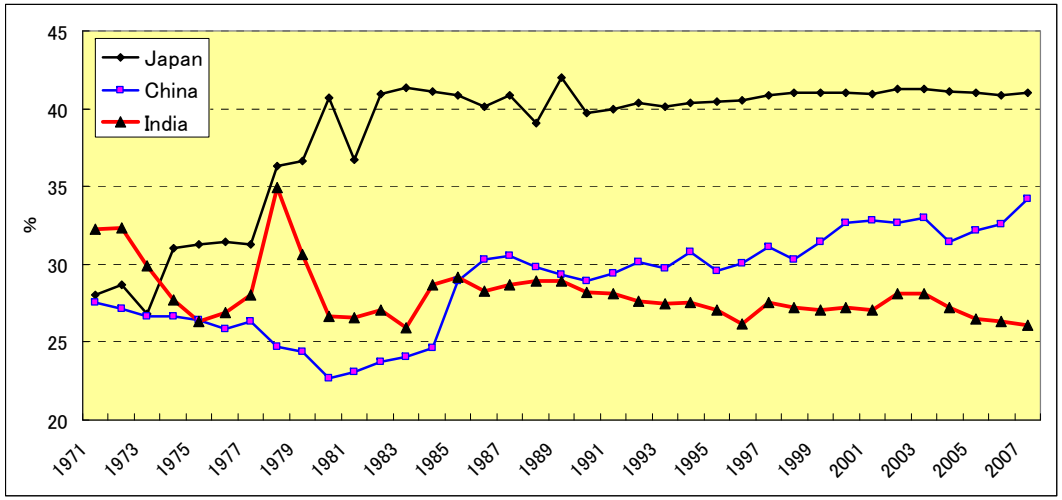
Distance	FY1996	FY2001	FY2006	FY2011
Pithead	70	89	99	155
～500km	54	51	55	70
500～1,000km	35	30	43	60
1,000km～	**55**	**95**	**148**	**216**
Total	214	265	345	501

Source: TERI data An average distance of 2000km was mentioned in an MoP interview

Energy Efficiency in India (Power generation)

Power generating efficiency of coal-fired power plants (Utilities)

Efficiency is considerably lower than Japan, although difference in coal quality prevents simple comparisons.

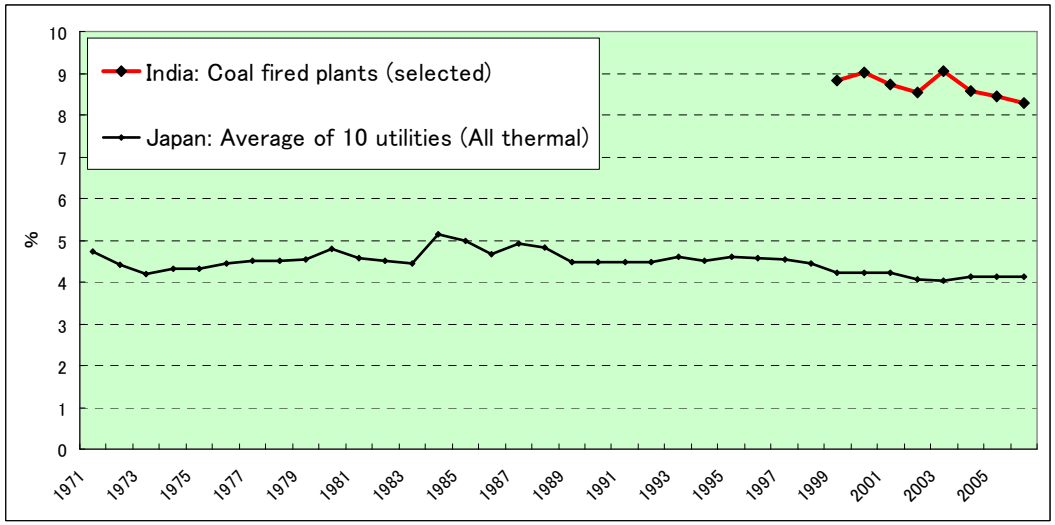


Source: Prepared from IEA Energy Balance Tables

Auxiliary Power Consumption

Although comparison bases are not even, in-house energy consumption appears higher than Japan.

Possible causes for low thermal efficiency and high in-house consumption at India's thermal power plants seem to be: inadequate thermal efficiency and facility management, existence of many plants that are 20 years or older or with small generating capacities, and the quality of coal with low heat value and high ash content.



Source: Prepared based on MoP data, *Denki-Jigyo-Binran* (Japan Electricity Data Book)

Energy Efficiency in India (Power T&D*-1)

*Transmission & distribution

- India's transmission network is roughly divided into five segments.
- Almost one-half of capacity is covered by the transmission utility owned by the Central Government ("POWERGRID"), with the balance covered by state electricity utilities.
- The wide expanse of land and high ambient temperatures tend to cause high T&D losses.

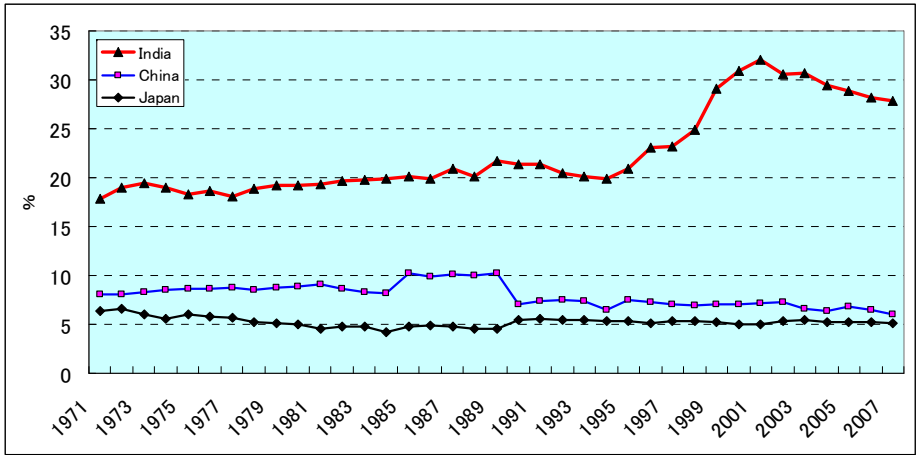
Energy Efficiency in India (Power T&D*-2)

*Transmission & distribution

Transmission & Distribution Losses

Because of problems such as power theft, un-metered supply or others as described below it is difficult to capture India's T&D losses purely from a technical ground. The T&D losses given in the right chart may include those non-technical losses, suggesting that the real technical T&D losses may be much lower than the picture given.

National Action Plan on Climate Change (June '06) estimates India's T&D losses to be between **16 to 19%**.



Source: Prepared from IEA Energy Balance Tables

Aggregate Technical and Commercial Losses (AT&C Losses)

Since there are problems such as power-theft, metering errors, meter tampering, un-metered power supplies, erroneous entry or bribery by the meter reader, uncollected invoices, etc. in the distribution sector, it is difficult to measure the T&D losses purely on a technical ground.

These losses caused by human-related factors are referred to as commercial loss and, put together with technically caused losses, they are termed an AT&C (Aggregate Technical and Commercial) Losses.

As AT&C Losses are captured on a **monetary basis**, a straightforward comparison between the T&D and AT&C losses is not possible.

Fiscal Year	Total India
2002	36.64%
2003	34.90%
2004	34.33%
2005	34.34%

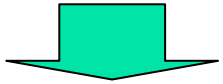
Source: TERI

Energy Efficiency in India (Summary - Power Sector)

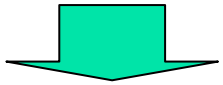
Low generation efficiency

High in-house power consumption

High rate of T&D and commercial losses



Deteriorated state power utility finance



Insufficient investment for improvements

Well recognized by the Ministry of Power

Energy Efficiency in India (Power sector reform)

The Ministry of Power programs for improving state power utilities:

- Thermal power generation:
  - Renovation & Modernization Programme (R&M)
  - Life Extension Programme (LE)
  - Efficiency improvement through energy audits
  - Training of low performance power plants by high performance plants
  - Accelerated Generation and Supply Programme (AG&SP)
  - Introduction of state-of-the-art technologies
- Distribution
  - Accelerated Power Development and Reforms Programme (APDRP)
    - → The Central Government providing incentives to curb AT&C losses

A degree of achievement is noted, but pace is slow.

Energy Efficiency in India (Iron & Steel)

Energy efficiency of 4 integrated steel makers (FY2006)

Company and Plant	Crude Steel Production ('000T)	Specific Energy Consumption (Gcal/T-crude)	Energy Consumption ('000TOE)
SAIL/ BSP	4,799	6.82	3,273
SAIL/ DSP	1,869	7.07	1,321
SAIL/ RSP	1,990	7.98	1,588
SAIL/ BSL	4,067	7.09	2,884
SAIL/ISP	472	8.91	387
SAIL Total	13,197	7.16	9,449
RINL	3,497	6.53	2,284
JSW (Private)	2,643	6.10	1,612
TSL (Private)	5,174	6.717	4,475
Total	24,511	**6.86**	16,815

Source: Prepared from Ministry of Steel Annual Report, JPC "Annual Statistics"

Steel Industry in India

Type	Size	Companies, Numbers
Steel	Main	Steel Authority of India Ltd.
		Rashtriya Ispat Nigram Ltd.
	Major	TATA Steel Ltd.
		JSW Steel Ltd.
		ESSAR Steel Ltd.
		Ispat Industries Ltd.
		Jindal Steel & power Ltd.
	Other	Arc furnace 33 plants
		Induction furnace 970 plants
		MBF-ETF 2 plants
Sponge iron	Gas	ESSAR Steel Ltd.
		Ispat Industries Ltd.
		Vikram Ispat Ltd.
	Coal	321 plants

Crude steel production: 50.817 Million tons

(5th in the world)

Ministry of Steel: World standard : 4.5-5 Gcal/t-crude steel

India's target: 5.5-6 Gcal/t-crude steel

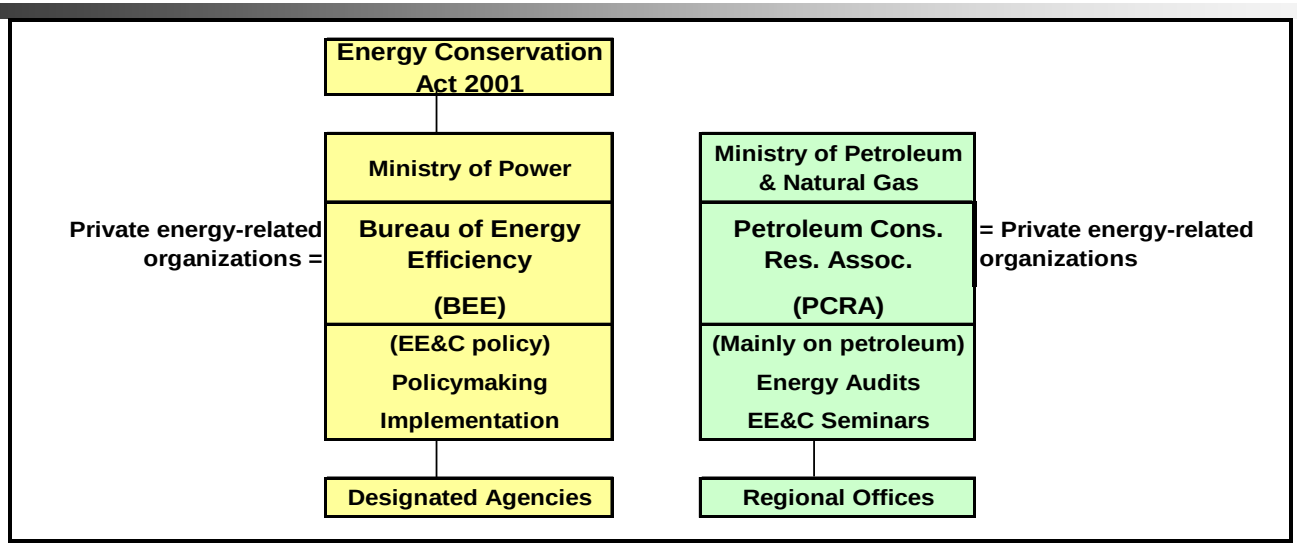
(Because of inferior raw materials quality)

Energy saving potential when the target is achieved : 3.33 Million TOE

(0.8% of Total Primary Energy Supply in 2006)

(3.3% of Industry Sector Energy Consumption in 2006)

Energy Conservation Policies (Promoting Organs)



BEE (Bureau of Energy Efficiency)

Government organization established in the Ministry of Power based on the Energy Conservation Act 2001

Responsible for policy-making and implementation of all energy efficiency and conservation matters

Problem: Staffed with only a limited number of experts

PCRA (Petroleum Conservation Research Association)

Government agency established in the Ministry of Petroleum & Natural Gas in **1978**

Promotes practical energy efficiency and conservation exercises including energy audits for industry, transport and domestic sectors. Staffed with personnel seconded from related government agencies and oil companies. (Ref. Slide #19 for details)

Problem: Activities are mainly concerned with petroleum conservation.

Energy Conservation Policies (Legislation)

Energy Conservation Act 2001:

(Law stipulating organization, authority, and duties for energy conservation measures)

Compared to Japanese legislation, more emphasis is placed on administrative institutions.

Main points of Energy Conservation Act:

1) Establishes the Bureau of Energy Efficiency (BEE) under the MoP as the main organ for formulating and implementing energy conservation policies covering all types of energy;

2) Sets forth functions and authority of BEE;

3) Clarifies authorities of Central and State governments;

4) Designates 15 energy-intensive industries (by listing);

EE&C starts from organization

Aluminium, Fertilizers, Iron and steel, Cement. Pulp and paper, Chlor Alkali, Sugar, Textile, Chemicals, Railways, Port Trust, Transport Sector (industries and services), Petrochemicals and petroleum refineries, Thermal power stations and power transmission and distribution companies, Commercial buildings or establishments

Specific action plans are developed by BEE:

(Policy formulation is assisted by private energy research organs.)

Energy Conservation Policies (Thrust areas-1)

1) Energy conservation in industry sector: Designated consumers in 9 industries:

   Requirements for energy audit, plant-wise energy consumption report

   Thermal power plants, Fertilizer, Cement, Steel, Alkali, Aluminium, Railway, Textiles, Paper and pulp

2) Demand Side Management:

   Targets on agriculture sector and local autonomies

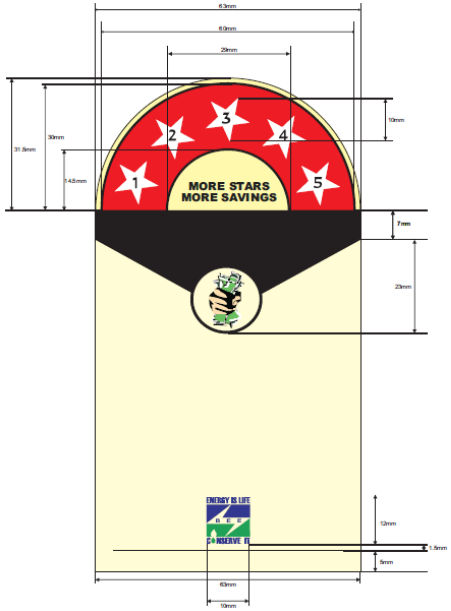
3) Energy Efficiency Standards and Labeling Programme:

   Currently, 11 appliances are listed:

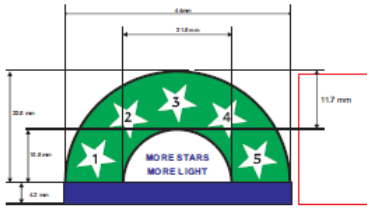
1) Frost Free (No-frost) Refrigerators, 2) Tubular Fluorescent Lamps, 3) Room Air Conditioners, 4) Direct Cool Refrigerator, 5) Distribution Transformers, 6) Induction Motors, 7) Agricultural Pump Sets, 8) Ceiling Fans, 9) LPG Stoves, 10) Electric Water Heaters, 11) Color TV Sets

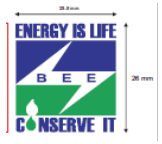
Large Format

Dimensions



Small Format





Energy Conservation Policies (Thrust areas -2)

4) Energy Efficient Buildings and Establishments:
A "Star Rating Programme" for office buildings based on the actual energy performance of a building, in terms of its specific energy usage per area.

5) Energy Conservation Building Codes;
6) Professional Certification and Accreditation;
Examination for Energy Managers & Energy Auditors (from 2004)
7) Energy Conservation Manuals and Codes
8) Energy Efficiency Policy Research Programme
9) School Education on Energy Conservation
Yearly painting competition for 4th and 5th graders
10) Delivery Mechanisms for Energy Efficiency Services (e.g. ESCO businesses)
37 enterprises registered and published as ESCO

From 2002 coordinates the National Energy Conservation Awards (with PCRA's cooperation)

Energy Conservation Policies (NAPCC*)

*National Action Plan on Climate Change

National Mission on Enhanced Energy Efficiency

(Approved on Aug. 24, 2009 by P.M. Manmohan Singh)

To save 5% of annual energy consumption by 2015

(= Reduction of 100 Million Tons CO2 every year)

Data: India's CO2 emissions in 2006 was 1,250 Million Tons

Four main initiatives:

1) Establishment of Energy Savings Certificates (a.k.a ESCerts);

Allowing energy intensive industries to purchase ESCerts to meet their energy saving targets. (A domestic system in India: unrelated to international emissions trading system)

2) Shift towards more energy efficient equipment and appliances;

Supply of inexpensive equipment thru expanded use of the carbon market, CDM, etc.

3) Funding support for energy efficiency projects;

Promotion of ESCO business, Partial Risk Guaranty Facility to reduce risks

4) Financial policy instrument (Energy-efficient economy);

Venture Capital Fund, investment incentives, preferential taxes, etc.

Energy Conservation Policies (PCRA actions)

Sector	Main Activities
Industry	Energy audits, seminars/technical meetings, development of low-air-pressure industrial burners (Not necessarily limited to petroleum usage) Sponsors Best Energy Auditor Award, Best ESCO Award;
Trans-portation	Drivers Training Program, Model Depot Projects, Model Garages, Emission Check Program, engine replacement scheme → a fuel saving potential of 20%
Agri-culture	Replacement of inefficient foot valves, repairing lift irrigation pumps, education of farmers on efficient use of petroleum（Not including electric pumps which are under the jurisdiction of Ministry of Power） Workshops on biodiesel;
Domestic	Education on good driving habits, development of fuel efficient kerosene and LPG stoves, promotion of use of bio-gas, solar heaters, etc., education of housewives on good cooking habits: Tips：Improved cooking methods may save kerosene and LPG up to 30%: Fire stoves only after ingredients are ready, use pressure cookers, do not use excessive water, reduce the flame after boiling, soak cereals before cooking, use shallow wide vessels, put a lid on cooking vessels, use small burners, clean the burners, use high performance stoves, use clean vessels, thaw frozen food before cooking, time meals for all family together; Tips：Good driving habits: Drive between 45 to 55km/hour to save fuel by 40% from running at 80km/hour; Good engine maintenance could save fuel consumption by 6%; Driving in correct gear could save fuel by 20%;

Energy audits are conducted by private Approved Energy Auditors

International Cooperation for India's EE&C

Major Cooperation Programs for Energy Efficiency & Conservation:

Germany: IGEN (Indo-German Energy Programme)

Concluded between GTZ of Germany and BEE in 2003;
Resident consultants stationed at BEE;

Promoting CDM projects;

U.S.A.: USAID (United States Agency for International Development)

Energy efficient buildings, etc.

Switzerland: Concluded between Swiss Government/SDC and GoI/TERI*

Targets at energy-intensive SME's (foundry, glass, bricks, etc.)

Japan: Group training by JICA (inviting trainees to Japan)

Dispatch of experts

Other organs such as ADB, World Bank Group, UN are also cooperating.

*TERI: The Energy and Resources Institute (Private energy research organ in India, led by Rajendra Pachauri, present head of the IPCC)

Challenges for India's EE&C Efforts

1) Insufficient availability of data and information on energy consumption pictures;
2) There are 5 ministries and agencies charged with energy matters, making the energy administration including energy conservation inconsistent;
3) Energy price controlled at a low level spoils energy conserving incentives, and deters popularization of energy-efficient equipment and appliances;

   (Especially farmers and SME's benefited from the inexpensive controlled prices)
4) Poor cost-consciousness at national/state enterprises hinders energy conservation efforts.
5) General tendency to focus on initial costs only, prone for cheap but inefficient equipment to be installed.
6) Lack of awareness for maintenance allows deterioration of energy efficiency in aged equipment. The use of cheap, locally made components instead of authentic parts for repairs leads to even worse efficiency.
7) Lack of fund to renew facilities to introduce energy-efficient equipment.
8) Energy efficiency improvements require not just hardware but also adequate operation and exercises, where uneven educational levels caused by social systems and customs could hamper proper implementation.

Summary and Conclusion

- India has large energy saving potentials;
  (Particularly in Power Sector and electric equipment and appliances)

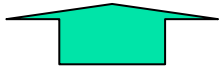
  Taming energy requirement growth will contribute to stabilizing the world energy balance.

- India's priorities;
  (By overcoming constraints, barriers, and difficulties in reality)

  ・Accelerate improvement in efficiency and restructuring of the power sector:

  New power projects are based on high efficiency coal-firing; more emphasis on new & renewable energy or nuclear if CO2 emissions are to be considered.

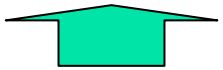
  ・Review price controls and low energy prices (for energy conservation incentives)



This is beyond the scope of energy efficiency, requiring comprehensive efforts incorporating infrastructure, energy administration, industrial, agricultural, and social policy elements.

  ・Understanding of energy consumption picture:

  Nine designated energy intensive industries have reporting requirements: performance is key.
  Additionally, an energy consumption statistics mandate is under consideration.

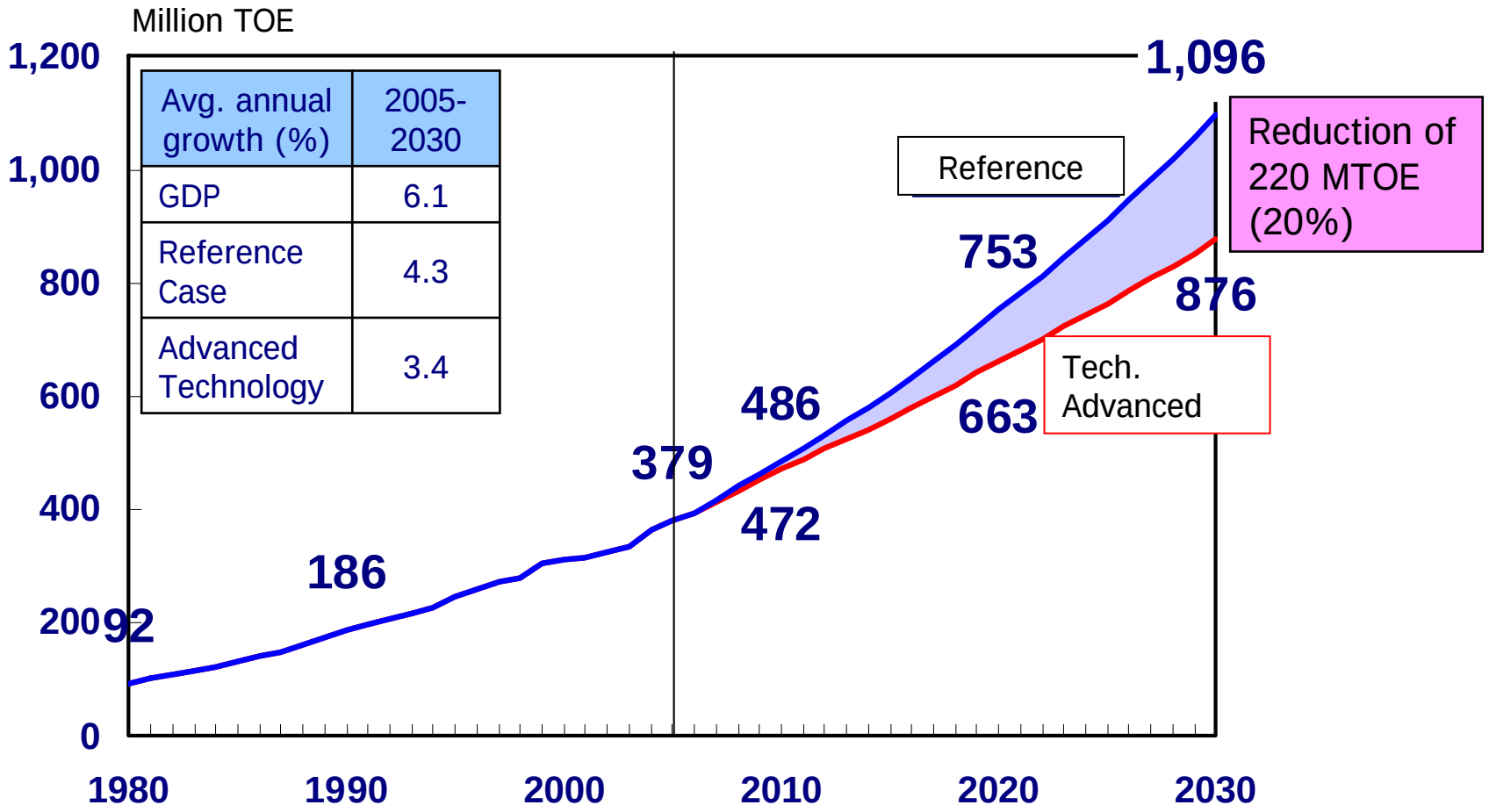


Cooperation and contribution from Japan is important

Reference: Energy Saving Potentials in India

- Total Primary Energy Supply Projection for India:

(A Comparison between the Reference Scenario and an Technology Advanced Scenario)



Source: IEEJ *"Asia/World Energy Outlook 2007"*

Reference: Energy Balance for India

As prepared by TERI (a private energy research organ)

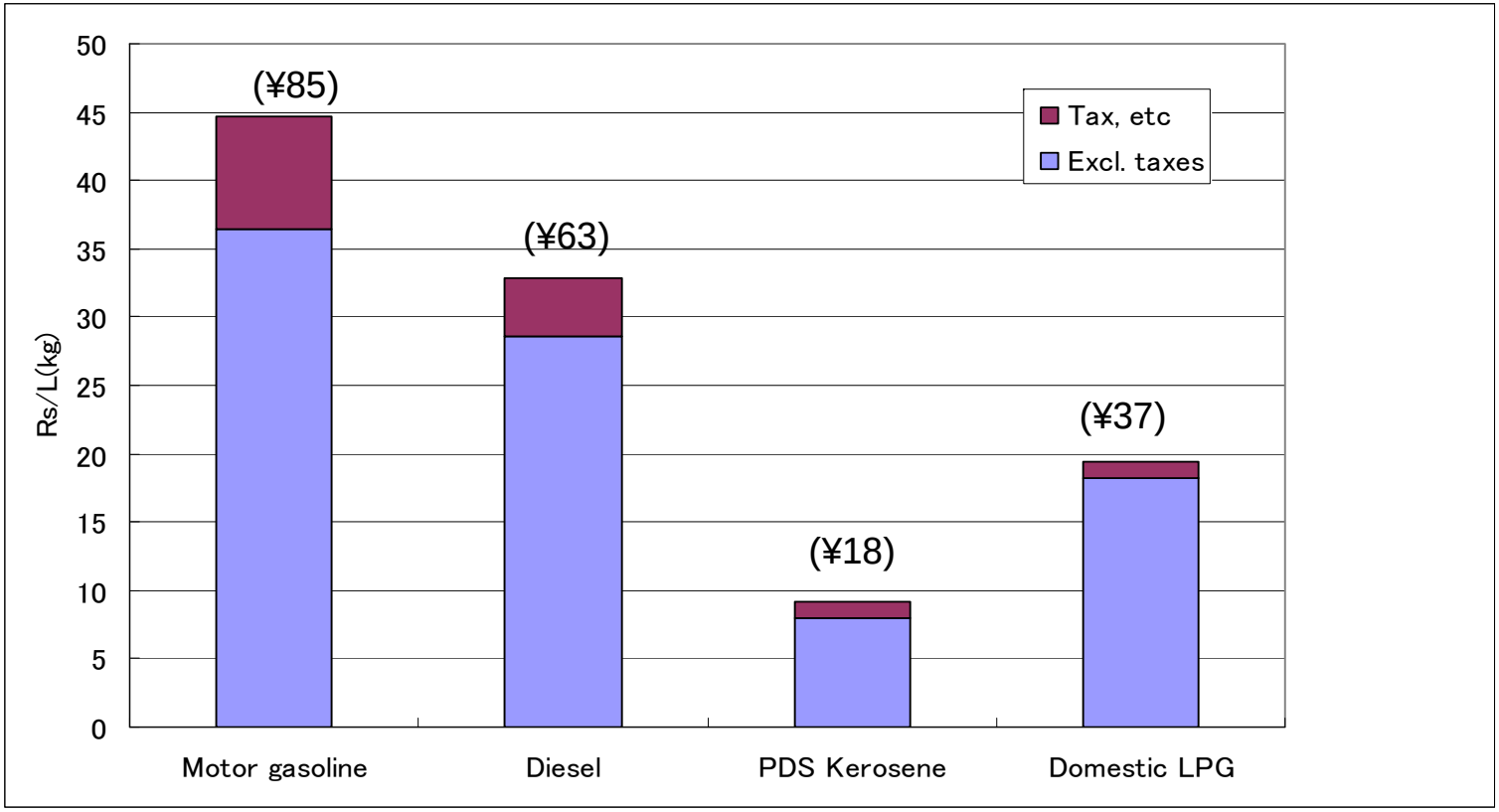
Commercial energy balance (million tonnes of oil equivalent): 2005/06

	Primary energy						Secondary energy											
	Coal and lignite	Hydro power	Nuclear power	renewable energy sources	Natural gas	Crude oil	LPG	Naphtha	Motor gasoline	Aviation turbine fuel	Kerosene	High-speed diesel	Light diesel oil	Fuel oil	Other petroleum products	Total petroleum products	Thermal power	Total power
Supply																		
Production	161.10	8.75	1.49	0.68	28.98	32.19												10.91
Imports	24.59					99.41	3.07	2.66	0.52	0.00	0.92	0.76		0.78	2.42	11.13		0.15
Exports	1.17					0.00	0.06	5.37	2.43	2.98	0.13	8.76		1.77	0.69	22.18		0.02
Stock changes	-3.90					-1.49	-0.09	0.30	-0.07	-0.13	-0.48	0.29	-0.04	-0.52	0.39	-0.36		
Availability	180.61	8.75	1.49	0.68	28.98	130.11	11.63	10.24	9.25	3.53	9.80	38.75	0.85	11.72	9.64	105.40		
Petroleum refining						130.11	6.27	15.60	11.24	6.63	9.49	49.24	0.96	14.09	7.51	120.99		
Own use	0.40				2.07	9.13												
LPG extraction					2.47		2.47									2.47		
Power generation	121.68	8.75	1.49	0.68	10.69		0.00	2.94				2.64	0.06	0.87		6.52	138.89	149.80
Conversion loss in power generation	81.37				6.19							1.47	0.04	0.48		1.99	89.56	89.56
Auxiliary consumption in	3.49				0.11							0.04	0.00	0.01		0.05	3.66	3.89
Transmission and distribution losses		0.06	0.17	0.00														15.49
Flaring of natural gas					0.79													
Coal washery rejects	1.41																	
Conversion	121.68				16.02	130.11	8.71	12.65	11.24	6.63	9.49	46.46	0.89	13.24	7.51	116.82	93.21	108.93
Net availability	57.12	8.69	1.32	0.68	12.96	120.99	11.63	10.24	9.25	3.53	9.80	38.75	0.85	11.72	9.64	105.40	45.68	41.01
Consumption	57.12				12.96		11.63	10.24	9.25	3.53	9.80	37.75	0.85	11.72	9.64	105.40		41.01
Agriculture					0.14		0.00					7.17	0.03	0.00		7.19		7.76
Industry	57.12				3.40		0.51	0.06				2.63	0.44	3.80	9.64	17.07		18.63
Transport							0.00		9.25	3.53		22.33	0.05	0.47		35.63		0.86
Residential					0.07		11.10				9.69					20.78		8.61
Commercial							0.00				0.03					0.03		3.09
Other energy uses					1.28		0.02	0.79			0.09	6.63	0.33	7.46		15.31		2.07
Non-energy uses					8.08			9.39								9.39		

The simple energy balance above is a result of using only data published by Government of India.

Reference: Petroleum Product Prices in India

Latest Petroleum Product Prices in Delhi (4 controlled price items)



Note: Conversion to Japanese Yen at 1 Rs.= 1.9 Yen; Taxes and levies are estimated

Source: Prepared from MPNG PPAC data

Although price controls on gasoline and diesel were abolished in 2002, de facto price controls are in effect through state-run oil enterprises.

A problem is also noted where subsidized PDS kerosene being diverted to black market adulteration.

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- Summary and Implication

Summary and Implication (1)

- India's energy demand and dependence on imports are projected to surge further due to its robust economic expansion and continuing population growth.

- Not only for India's own sustainable economic development, but also from the standpoint of stabilizing the international energy market and mitigating global warming, it is essential to further strengthen the efforts in expanded deployment of new and renewable energy, as well as promotion of energy conservation.

- While various programs are in place concerning the above areas, there also are a number of known obstacles. It is therefore required to take effective policy measures forward without delay to achieve the goals.

Japan-India Energy Dialogue

- Agreed in the "Joint Statement Towards Japan-India Strategic and Global Partnership" between then PM Shinzo Abe and Indian PM Manmohan Singh, in December 2006. (Discussions on related topics below)
  - 1st Meeting (April 2007):
    - Confirmed a comprehensive cooperation in the energy sector
    - Set up 5 Working Groups
      (Power, Energy Conservation, Oil & Gas, Coal, Renewable energy)
  - 2nd Meeting (July 2007):
    - Developed specific cooperation programs for energy conservation field
      (Energy audit, model projects, HR development, experts mission)
    - Explored methods for expanding cooperation in renewable energy field.
  - 3rd Meeting (September 2008):
    - Confirmed details of cooperation programs in energy conservation field.
    - Discussed possible collaboration concerning solar energy, biomass, etc.
    - Agreed to exchange information and views on nuclear policies of the two nations.

Summary and Implication (2)

- Since Japan possesses world-class technological standard in the field of nuclear power, new and renewable energy as well as in energy conservation, it can make contribution through collaborative effort in these fields to help India address the energy and environmental issues.

- Such cooperation and support could lead to an effect of stabilizing the international oil market or mitigating the climate change problem as well as revitalizing Japan's energy related industries through increased business opportunities in the Indian markets. For this reason, Japan should take the subject proactively and constructively work hard on it.

Thank you very much for your attention !!

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