National Update and Issues

1. National Update – Policy Issues, Directions & Dilemmas
2. National Update: Legal & Structural Developments
3. Analysis of Orders of ATE
4. Renewables for the Power Sector

National Update:
Policy Issues, Directions, & Dilemmas

Prayas Energy Group

Pune Workshop

22-23 Mar 2007

Girish Sant

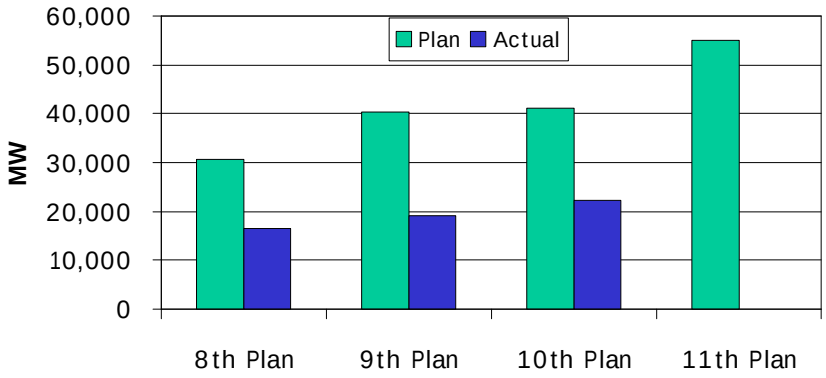
Index

- General observation
- Fuels
- Generation
- Transmission
- Distribution
- Rural Electrification

General Observation

- Desired results of E-Act: limited and slow
- Insufficient addition of generation, transmission in the pipeline
- Finances of State utilities – deterioration has halted. But only few states have reversed the trend…
  - Largely due to urban theft reduction
  - Rural distribution in serious trouble in most states
- Increasing public dissent on load shedding, quality of supply, tariff increase, etc.
- No clear model for distribution reforms

Capacity Addition: Targets v/s Actual



Power shortages are high. Scheduled load-shedding in rural areas is **excluded** from CEA data on shortage. The hidden capacity through R&M of old plants has mostly been used up => need for quick capacity addition, controlling demand…

Energy Hungry India: Wants it all…

- Gas: LNG import, Piped gas from West and East, Gas fields in other countries
- Hydro power: Import from Nepal and Bhutan
- Indian Hydro: New initiative for 50,000 MW hydro!
- Nuclear: Fuel, reactors from Russia, USA etc.
- Coal: Increase production, supplement with imports
- Oil: From anywhere, if supply is secure…
- Renewable energy: Promoted using public subsidy

Fuel Issues Affecting Sector

- Generation targets not met partly due to fuel related issues: Captive, SEB plants, as well as proposed IPP plants – all face these issues
  - Coal shortages continue (limited coal linkages)
  - Indigenous gas is limited, Imported gas is still distant dream (NG and LNG)
  - Oil price rise led to low output of plants
- Major changes underway in
  - Coal sector (captive and private coal mines, imports, acquiring foreign mines, etc…)
  - Coal transportation

Generation

- New generation on tariff based bidding (with small exceptions)
- MoP initiatives:
  - Ultra Mega Power Plants (UMPPs): several locations being discussed
  - Merchant Plants (with allocation of coal mines): Uncertain future
  - Conditions linked to Mega plants
- Large Captive Plants in pipeline

UMPP

- 800 x 5 (4000 MW) super-critical plants
- Competitive bidding on tariff
- No ForEx linkage to capacity charge
- Fuel cost is pass through, with pre-decided link to fuel index
- Low tariff (Rs 1.2 and Rs 2.3 /U for Indian and imported coal)
- No government guarantee
- Sasan developments…

Transmission

- Who should pay for the new capacity ?
- How to design tariff that is sensitive to direction and distance?
- Who should plan and who should call for tenders for those lines? (role conflict of Power Grid as CTU and a company)
- Which lines to be built on priority
- Environmental constraints (land acquisition)

Power Distribution

- Unbundling / Corporatisation à Privatization à Franchisee
- No clear direction despite these experiments
  - AP v/s other state owned companies
  - Delhi and Orissa (some success & several problems)
- MoP conditions linked to subsidy
  - Urban privatization or franchisee (Mega power policy)
  - Rural franchisee (RGGVY)

Dilemmas with Rural Electrification

- How to match affordability and cost ?
- Who will pay for revenue subsidy for rural households (and agriculture)
- What should be the institutional model for rural areas?
- Whether to promote distributed generation – if so whether to do it instead of grid supply?
- Whether RGGVY can build good quality of lines?
  - And who will supply and pay for peak power to feed in this extended grid?
  - Will it only increase hooking?

Power sector subsidy

- Revenue Subsidy in near future
  - Agricultural electricity ~ Rs. 15,000 Cr
  - Household electricity ~ Rs. 6,000 Cr
    (Assuming 50 million houses @ Rs 100 /month)
  - Compensating Utility Loss ~ Rs. ????? Cr
- Capital Subsidy
  - Rural electrification – Rs. 5,000 Cr

Total > Rs 25,000 Cr /yr

Energy efficiency

- Bureau of Energy Efficiency (BEE) is becoming active (standards, labeling, audits…)
- Some state regulators & utilities are promoting energy efficiency DSM
  - Especially CFL programs (Delhi, Bangalore, Maharashtra, Haryana, Surat, etc.)
  - Could be extended to other appliances soon
- But Integrated Resource Planning (IRP) still not part of planning

Other Issues

- Land requirement for power plants (R&R and local environmental issues)
- Global warming concerns
- Increase in fuel prices
- How to target and reach the real needy
- Implementation mechanisms to ensure true benefit of government subsidy?

Ø What are the bottlenecks for growth & poverty reduction?

Thank you …

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India Update: Legal & Structural Developments… 1

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Pune
March 22-23, 2007

Interaction Plan

- Rationale behind Electricity Act 2003
- Status of changes after E-Act
  - Structural changes
  - Generation, Transmission, Distribution
  - Policies & Plans
  - Towards Market

Rationale behind Electricity Act 2003

- Forcing a common framework across the country
  - Structural (Unbundling, trader, franchisee)
  - Regulatory systems
  - Theft and Consumer issues
- Enabling market operation
  - Delicensing generation, T&D open access, trading, parallel distribution license
- Introducing 'commercial' operation
  - Cross subsidy reduction
  - Encouraging captive

Status of changes after E-Act

- Structural changes
  - 13 SEBs unbundled (out of 29 states)
  - 27 SERCs
  - Appellate Tribunal Established 2005
  - Grievance Forum and Ombudsman in many States
  - Trader
  - Franchisee model for distribution

Status of changes after E-Act

- Generation à Later
  - Support to captive
  - Massive capacity addition plans; Thermal, Hydro, Nuclear, Ultra Mega, Coal sector changes
- Transmission
  - Joint Ventures (no private player yet)
  - Towards National Power Grid
  - Availability Based Tariff implementation
- Distribution
  - Franchisee models for rural and urban (Bhivandi – Torrent)
  - Restructuring of APDRP
  - Slow moves towards parallel licensee- Jamshedpur, Jharkhand

National Policies and Plans -1

- Guidelines for States – not mandatory
- National Electricity Policy and Tariff Policy (2005,2006)
  - For 'optimum utilization of resources'
  - In consultation with state government and CEA
- National Electricity Plan – CEA (2005)
  - Generation plant locations – to guide project developers
  - Transmission Plan
- Competitive bidding guidelines (2005)
  - Competitive, transparent power purchase by DISCOMs –Long (>7 yrs) and Medium (1-7 yrs)
  - Guideline for energy charge, capacity charge, bidding process

National Policies and Plans -2

- National Policy on electrification, rural areas, stand-alone systems(2006)
  - For distribution in rural areas through Panchayat Institutions, User associations, NGOs. etc.
  - To freely permit stand-alone systems in rural areas
- National Electricity Rules (2005)
  - Group captive definition, Grievance forum constitution
- Integrated Energy Policy (2006)
- Eleventh Five Year Plan (2007-12)

National Electricity Policy 2005 -1

- Access
  - All households by 2010, Minimum lifeline consumption of 1 unit/day by 2012
- Demand
  - No shortages by 2012. Per capita consumption to be 1000 units
- **Tariff**
  - **Life line tariff (50% of average cost of supply) to those consuming < 30 units/month**
  - **Review after 5 years**
- Market
  - Part of generating capacity (~15%) outside long term PPAs
  - TRANSCOs not to trade
- **DSM measures**
- **Minimum area for parallel distribution license defined**

National Electricity Policy 2005 -2

- **New technologies like SCADA,HVDS with techno-economic consideration**
- Steps towards national grid. State level ABT
- **RCs to facilitate capacity building of consumer groups**
- Encouraging private investment in all sectors
- Quality of Supply & Service monitoring

National Tariff Policy 2006 - 1

- Objectives
  - Balance attracting investments and reasonable consumer tariff
  - Promote competition and efficiency
- DISCOMs
  - Power purchase through competitive bidding (5 year grace period for public sector)
  - Multi-Year Tariff (è later)
  - SERC to decide minimum purchase from renewables
- Subsidy
  - Direct State subsidy to the needy a better option
  - Only poor (<30 u/month) to get cross subsidy with tariff at 50% average cost of supply
  - SERC to prepare road map to reduce cross subsidy so that by 2011 difference between tariff and average cost of supply is 20%

National Tariff Policy 2006 - 2

- Cross subsidy surcharge by open access consumers
  - Difference between tariff and average cost of supply
- RC Roles
  - Monitor trading activities to prevent profiteering
  - Independent validation of data submitted by utilities
  - Monitor quality of supply & service
- Agriculture tariff can vary across a State
- Load limiter as an option to reduce procedural problems for small consumers

National Rural Electrification Policy-2006 -1

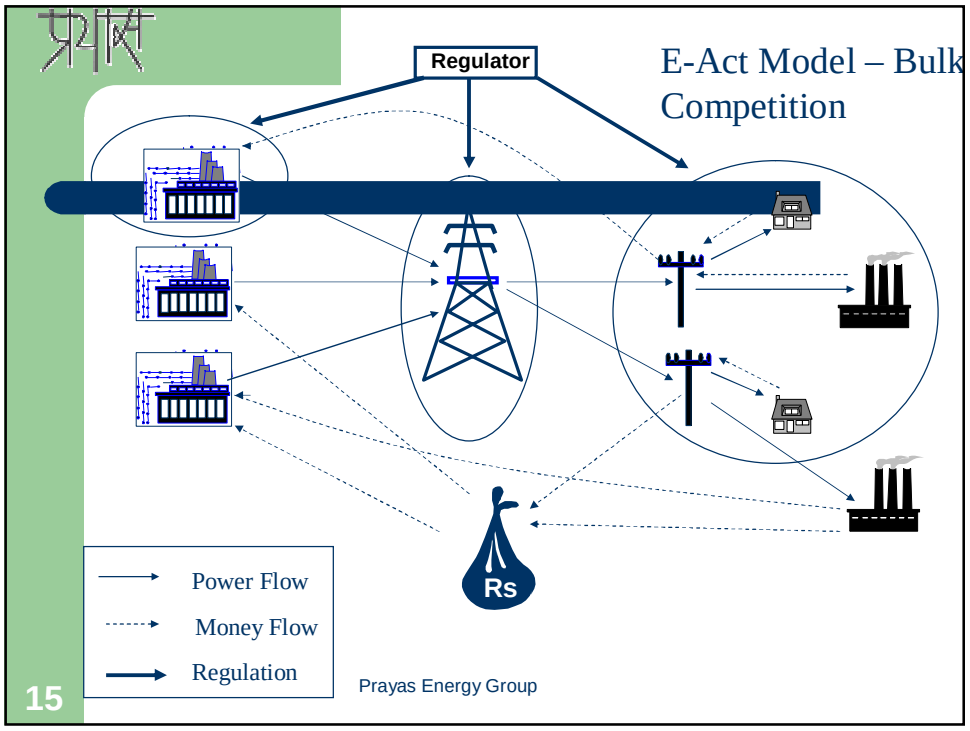
- Goals
  - Electrify all households by 2009
  - Quality & reliable power at reasonable rates
  - Minimum lifeline consumption of 1 unit/household/day for all by 2012
- States to prepare RE plan in 6 months
  - Grid extension or non-conventional stand alone
  - District Committees (done in few States)
  - Notify rural areas (done in few States)
- REC as a funding and implementation support agency

National Rural Electrification Policy- 2006 - 2

- RGGVY
  - Block level: Rural Electricity Distribution Backbone
  - Village Electricity Infrastructure
  - Cater to rural economic activities
  - House hold electrification
  - Conditions (for 90% grant)
    - Use of Franchisee model for beneficiary area
    - No discrimination to rural areas in terms of supply quality
- Promoting Franchisee models
  - User associations, NGOs, cooperatives, entrepreneurs; PRIs to oversee or even take up franchisee role
  - Many models: Bulk purchase and O&M of infrastructure is minimum. Can include capital expenditure also
  - Transparency in selection of franchisee
  - Tariffs could be decided by SERCs or by mutual agreement using SERC guidelines and District Committee oversight
  - Universal Service Obligation

National Rural Electrification Policy- 2006 - 3

- Village electrification
  - Distribution Transformer, Lines including to at least one Dalit Basti, where it exists
  - Public services (School, health centre etc) electrified
  - 10% households electrified
  - Village Panchayat to certify
- Stand alone systems in rural areas
  - Tariffs as mutually agreed; subsidy to be passed on to consumers
  - Technical and safety standards apply
  - No universal service obligation
- Energy Efficiency measures
  - State to take initiatives to increase awareness in PRI representatives
  - Campaigns and steps guided by Energy Conservation Act 2001



Towards Market

- Legal provisions in place
  - Central and State Regulations on Open Access, Trading, Cross subsidy surcharge
- Open Access & Trading started
  - Regulations in ~ 10 States
  - 20 inter state traders, 7 major
  - 14,000 MU (2%) traded in 2006 – mostly inter-regional
  - Price upto 600p/u.
  - Trade Margin fixed as 4p/unit (2006)- ATE-Supreme Court
- Balancing & Settlement code in some States

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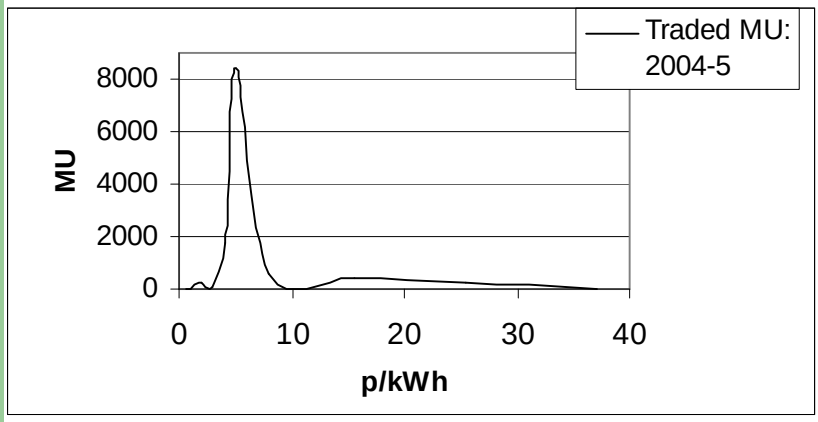
Trade Margin 2004-5



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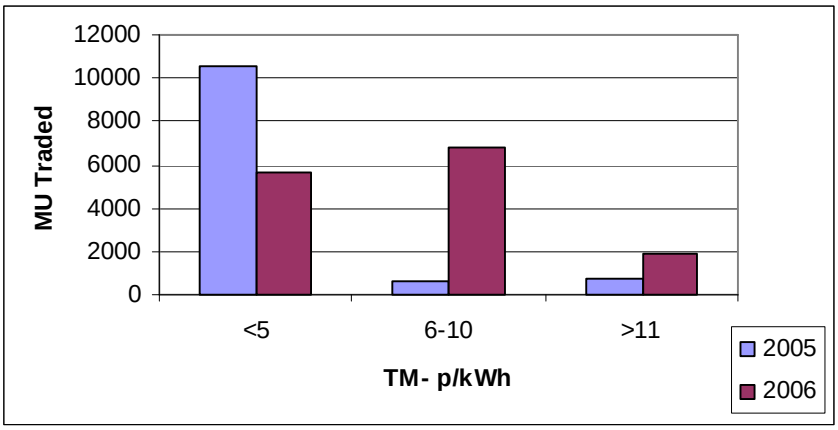
Trade Margin 2004-5 & 2005-6



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Towards Power Markets

- National Power Exchange (PX)
  - CERC Staff paper: August 2006
  - Public Hearing: December 2006
  - Guidelines on PX: Jan 2007
  - PX operational: 2007?
  - 10% power to be traded through PX by 2010?
- Merchant Power Plants (MPP)
  - 1000 MW plants without any long term contracts
  - 20 States planning 10-15,000 MW capacity in 11th plan?

Power Market

- Bulk (whole) sale of active power
- Retail market not planned
- Forward market
  - Day/Hour ahead: by Market Operator – Power Exchange
- Real Time/Spot/Balancing market
  - by System Operator – Load Dispatch

Towards Power Markets

- Forward Physical Contracts (Long-term)- Established;
- Moving from Regulated Cost-Plus PPAs to Tariff-bid based PPAs for new generating capacity
- Forward Physical Contracts (Short-term)- Established; but non-standard contracts
- Day ahead Spot Market through Power Exchange?
- Real Time Market (Substituted by UI mechanism)

Power Markets - Issues

- Peak Power Shortage (12.3%), Energy Shortage (8.5%) 2006
- Most generation capacity (57% State, 32% CGS, 11% Private) tied up with long term contracts. Only surplus can be traded.
- Access is a big challenge (44% households not electrified)
- Weak Market monitoring mechanisms
  - Technical
  - Management
- Mixed experiences of Power markets abroad
- India cannot afford irreversible, costly mistakes

India Update: Legal & Structural Developments… 2

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Prayas Workshop
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Regulatory Process: Emerging issues .1

- Debate on structural changes
  - Planning Commission (Haldea) Paper – August 2006
    - Uniform regulatory structure
    - Multi-sector regulators (at state and national level)
    - Accountability of regulators
- Selection of regulators è ??
- Increasing role of Forum of regulators
  - Intra-state ABT, Code of ethics
  - Limited transparency

Regulatory Process: Emerging issues .2

- Multi-year tariffs
  - Many states adopting MYT (AP, MH, Delhi)
  - Increased complexities and risks
- Large capital expenditure plans by Discoms and Transcos
  - Significant tariff impact
  - Challenge of optimization and prioritization
  - Difficulty in quantifying benefits
  - Regulatory approach and capacity

Regulatory Process: Emerging issues .3

- Quality of supply and quality of service
  - Legal and procedure framework in place
  - Key challenges
    - Monitoring of supply and service quality (regular and reliable reporting by utilities)
    - Enforcement of standards of performance (SoP) and penalty / compensation norms
    - Effective functioning of CGRF and Ombudsman (Infrastructure, Training)
- Low consumer awareness
  - SoP, Consumer Charter, Supply code
  - Tariff order, Schedule of charges

Analysis of orders by the Appellate Tribunal for Electricity

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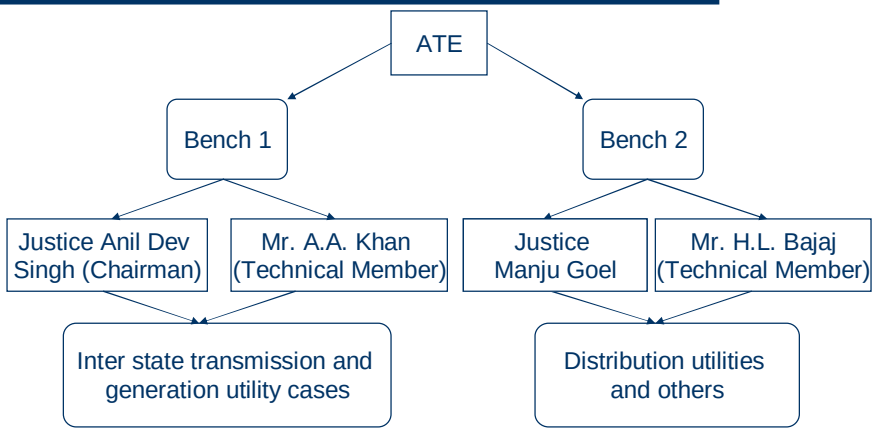
Reasons for the ATE

- SERC orders were being challenged in the High Courts
  - Turn-over time of the cases was long
- Scope of appeal was usually restricted to legal issues
- SERC orders were virtually not being challenged

Appellate Tribunal for Electricity (ATE)

- Established on 7th April, 2004 under sec 111 of E Act 2003
  - To hear appeals against the orders of CERC or SERCs or original petitions
  - Consists of a chairperson and three members
  - Every bench à one judicial member and one technical member

Benches of the ATE



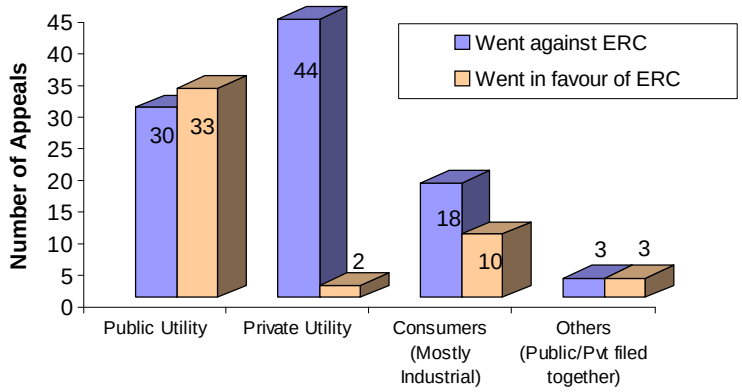
Part I

Statistical Overview

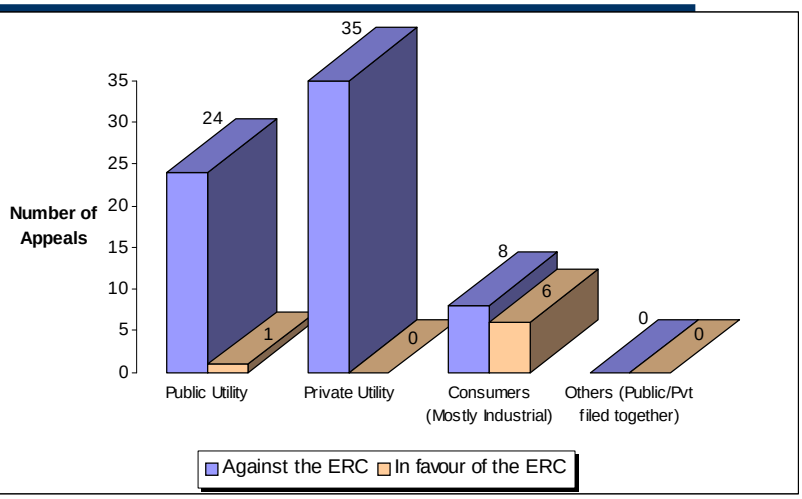
Overview of ATE decisions

- Total 170 orders so far
- The first 143 appeals (71 orders) analyzed
- Analysis divided into various categories based on
  - **Type of appeal**
    - Against tariff order of ERC
    - Questioning jurisdiction of ERC
    - Challenging the regulations of ERC
  - **Type of appellant**
    - Public or Private Utility
    - Consumers
    - Others

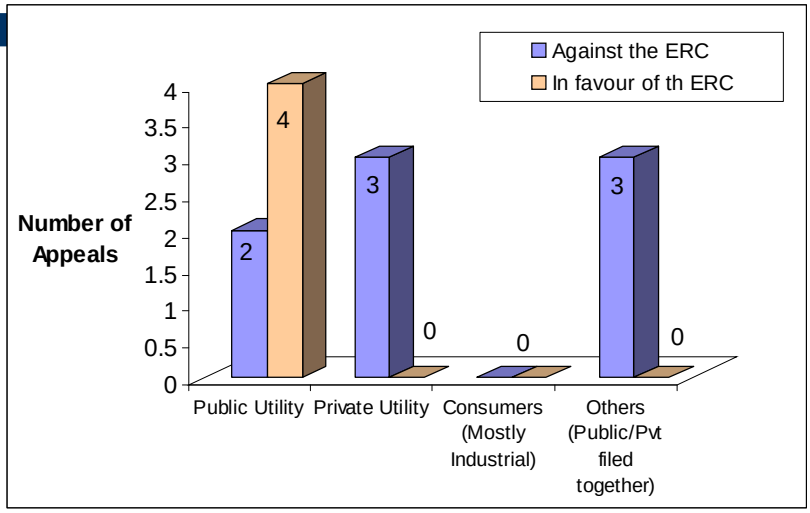
Appeals before ATE based on type of Appellant



Appeals before ATE against Tariff Orders of ERCs'



Appeals before ATE challenging the jurisdiction of ERCs'



Part II

Major Precedents from ATE orders

Billing disputes….1

- REL, MSEDCL,TPC vs. MERC
  (30, 164 of 2005 and 25 of 2006)
  - Supplementary/Amendment, average bills raised contrary to previous MERC directives
  - MERC directed utilities to return ~ Rs.200 crore (average bills) and ~ Rs.80 crore (supplementary / amendment bills)

Billing disputes….2

- ATE overturned the SERC order and held that
  - "…issue raised...is nothing but billing dispute between the licensee on one side and the consumer(s) on the other side"
  - "Be it a single or innumerable (consumers), with respect to grievance… regarding billing…it is the competent authority … which has to exercise the powers. There cannot be a special …direction merely because consumers are too many"
- All billing disputes should be addressed only by CGRF

Implications of ATE order

è SERC has no jurisdiction in a billing dispute even if number of consumers is large

è Every consumer will have to file a separate case in the CGRF (class action not possible in CGRF)

è Severe adverse impact on consumer interests

Jurisdiction of SERC….1

- KPTCL vs. KERC (84 of 2005)
  - KERC had engaged a team of experts to examine the prudence of the investment planned by KPTCL
  - It had capped the investment cost estimated by the utility for improvement and maintenance of its system

Jurisdiction of SERC…2

- ATE overturned the KERC order and held that
  - The functions of the RC do not include one that would enable it to slash the investment planned by a utility
  - It is a "commercial decision of the utility" and not liable to be interfered till the utility asked for return on such investment
  - Only after the investment can the RC do a prudence check
- The ATE observed that
  - "When technical experts …have applied their mind … it is nor for the Commission to examine by appointing another expert committee.. no expert agrees with another expert"

Impact of ATE orders

- Commission cannot cap the planned investment
- It has to allow interest on expenditure incurred on unsanctioned projects

è The Commission has no jurisdiction to regulate capital expenditure

Appeals against SERC tariff orders

- HPSEB vs. HPERC, HVPN vs. HERC
  (33 and 74 of 2005, 113 of 2005)
  - T&D losses allowed by the Commission overturned…
  - Interest expenditure, employee cost etc. overturned….
  - Almost entire tariff order overturned!
  - Public not consulted before the decision

è Tariff orders of RC can be entirely overturned without a public process

Some other quotable quotes

- "Consumers had no legal basis to file an appeal as they have no role in the internal administration of the utility" – KPTCL vs. KERC

- "The utility is managed by well qualified and experienced officials and all the actions or decisions …. if made dependent on consumers' likes and fancies, there could be no end to such grievances" – KPTCL vs. KERC

Conclusions

- The pro-consumer emphasis of the E-Act could be rendered ineffective due to many ATE orders
- Consumers are weakly or not represented in the ATE
  - Lack of access to lawyers
  - Distance of the ATE
  - Lack of other resources
- It is extremely necessary to address these important precedents of the ATE orders

Renewables for the Power Sector

Rangan Banerjee
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Talk delivered in Prayas Workshop at Pune on 22nd March 2007

Issues

#1 Sustainability Demand- Supply
Fossil fuel Reserves
Emissions

#2 Access to Rural Poor – Equity/Affordability

#3 Attractive for Investors ?

#4 Mainstreaming of renewables and efficiency

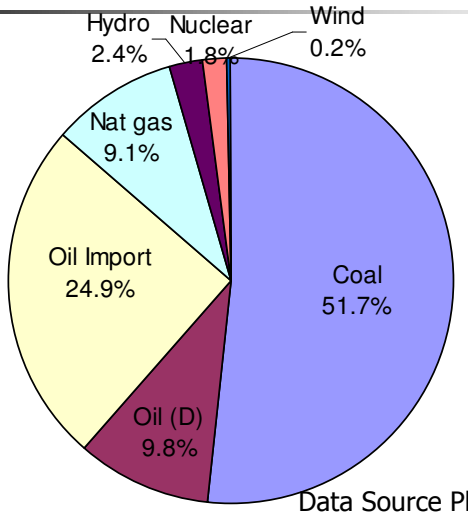
#5 Technology Development / Cost Reduction

Commercial Energy Supply in India (2003-4)

Source	Supply	Cal value	PJ
Coal	415 Mt	18.8 MJ/kg	7279
Oil(D) Imports	33 84	41.MJ/kg	1379 3511
Nat Gas	31.96 Bm3	9300	1282
Hydro	752420 MU	85% eff	339
Nuclear	17780 MU	25% eff	256
Wind	3402 MU	40% eff	30.6
Total			14078

#1 Sustainability

India- Primary Commercial Energy



2003-4

Total comm

14000 PJ

Biomass 6500 PJ (33%)

Total

20500 PJ

19700 PJ (-non energy)

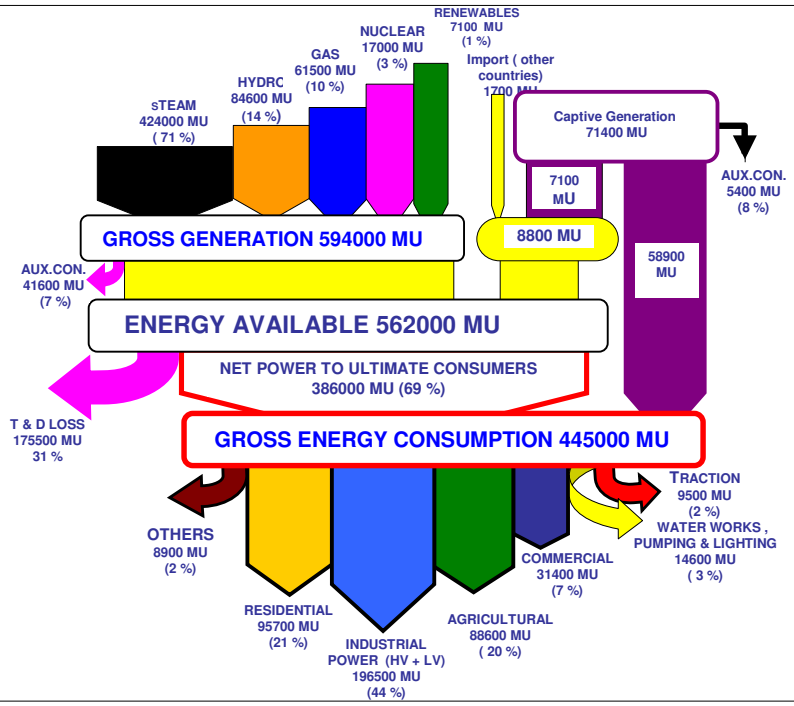
Data Source Plg Comm IEPC, 2006

#1 Sustainability

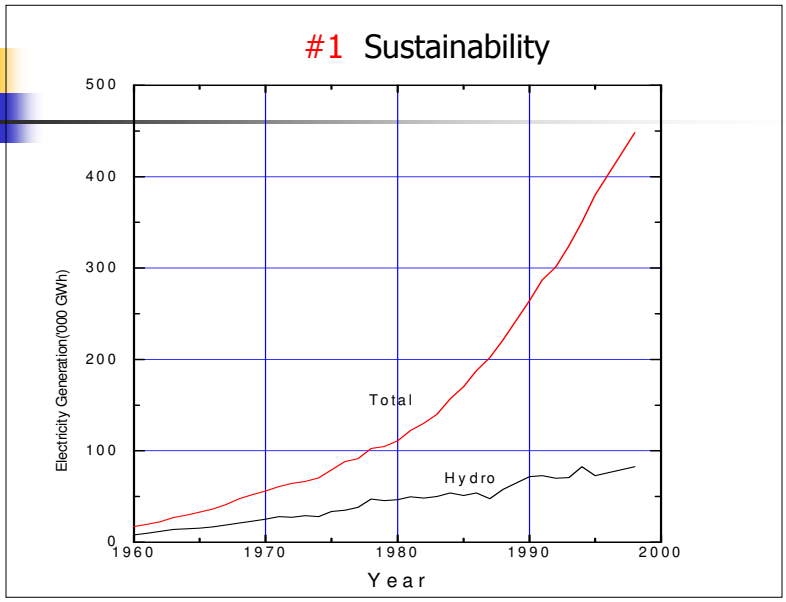
India - Fossil Fuel reserves

Fuel	Reserves	Prodn 2003-4	R/P ratio
Coal +Lignite (Million Tonnes)	34000	414	~83 (P) 140 P+I
Oil (Million Tonnes)	760	33 (117)	23 (7)
N.Gas Billion m3	920	32	29
Uranium Tonnes	61000	PHWR	~50 10GW

Data Source Plg Comm IEPC, 2006



#1 Sustainability



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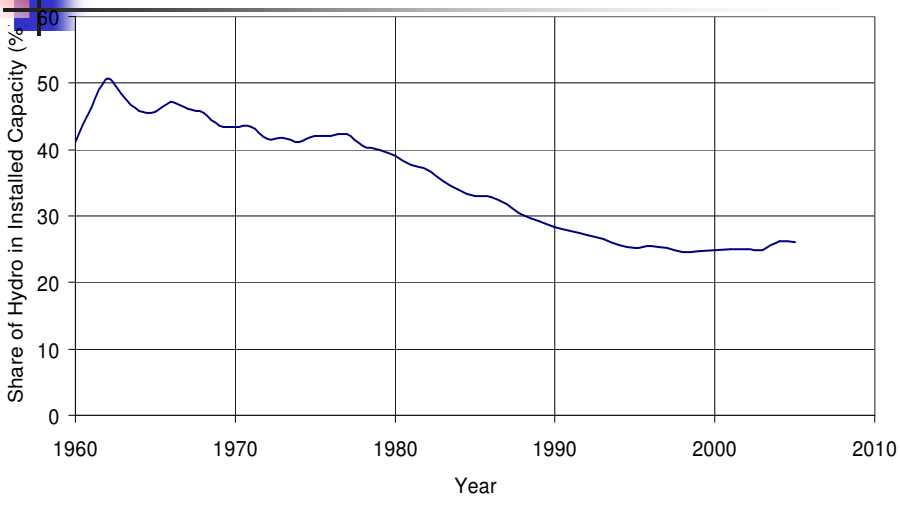
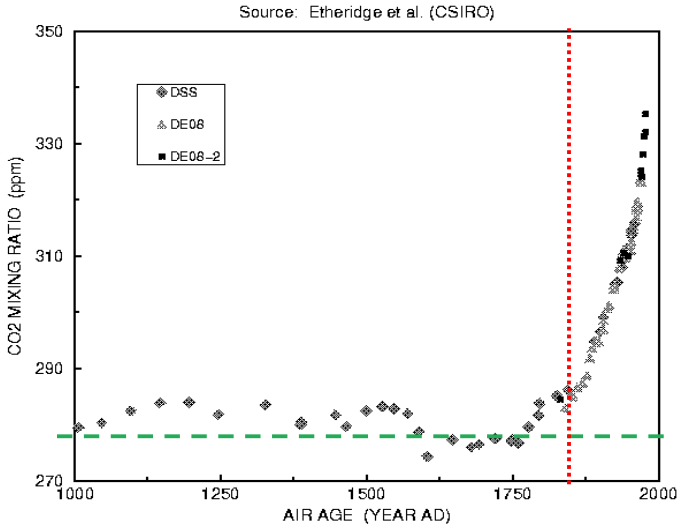


#1 Sustainability

Carbon Dioxide Concentrations

LAW DOME, ANTARCTICA ICE CORES

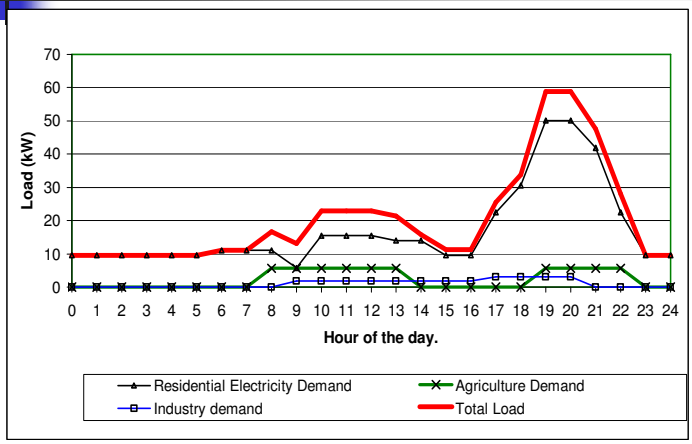


http://cdiac.ornl.gov/trends/co2/graphics/lawdome.gif

#1 Sustainability

- Present consumption pattern predominantly -fossil fuel
- Supply unable to meet demand
- Limited fossil reserves
- Adverse environmental impacts
- Unsustainable
- Need for transition to renewable energy systems, nuclear, efficiency

Typical Village Load Profile



Load Factor 28%

Rajamele

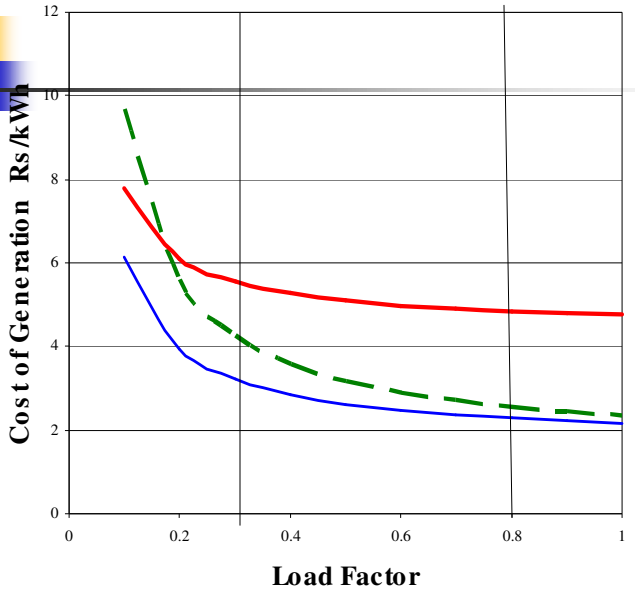
WB

#2 Access to Rural Poor

- Linkage between Energy Services & Quality of Life
- 56% rural households (78 million) 112,400 villages unelectrified –official estimates
- Affordability to rural poor
- Isolated systems – Load factor – Link with industry (economic activity)
- Revenue generation for supply companies
- Innovative institutional/cost recovery

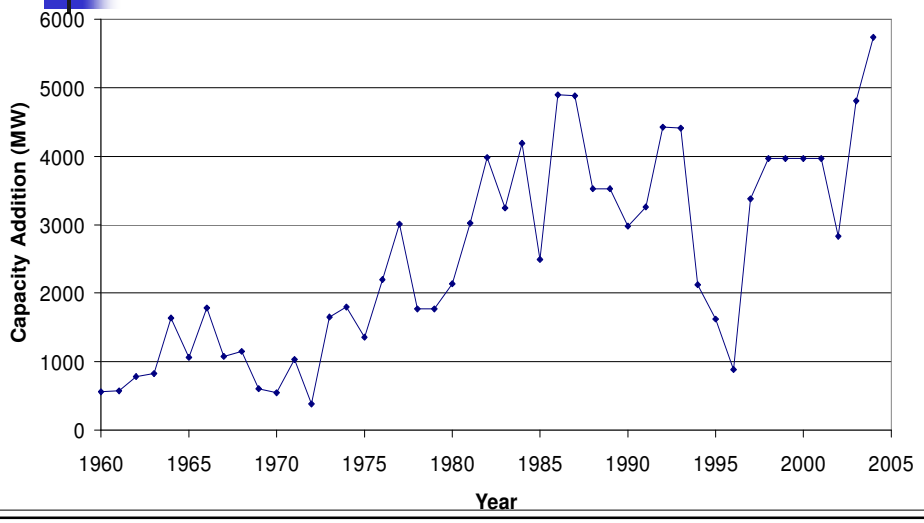
Isolated Systems

#2 Access to Rural Poor

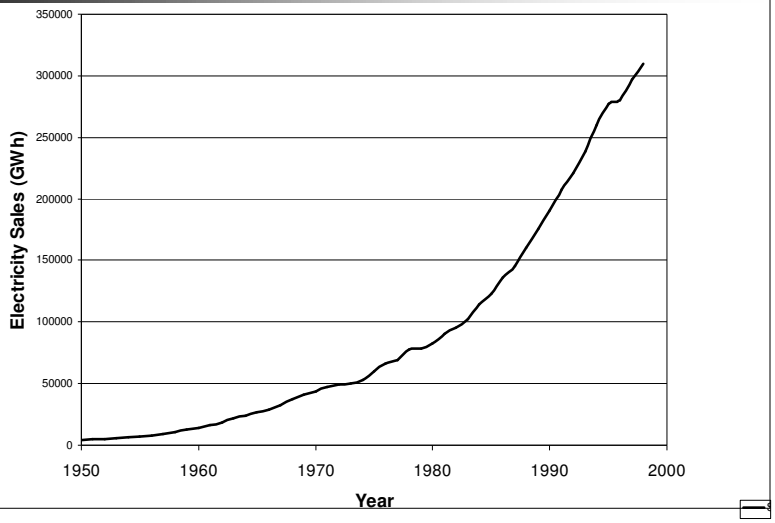


Impact of Load factor

Annual Capacity Additions



India - Electricity Sales

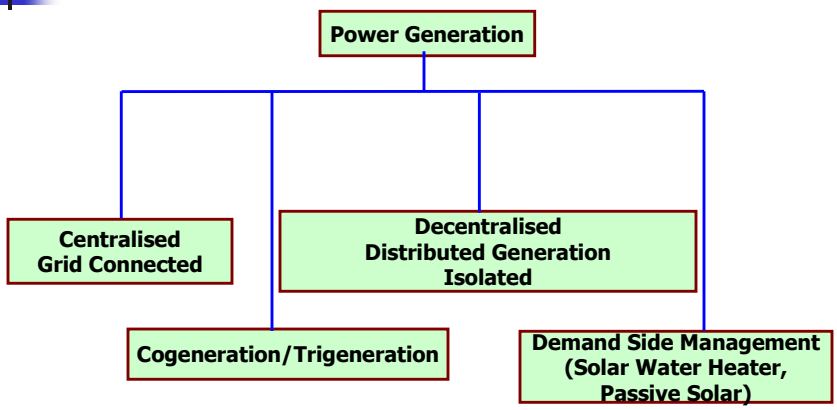


#3 Attractive to Investors?

- Evolving Appropriate Revenue Models for electricity sector to be viable
- Subsidised electricity to agriculture, low usage residential, Gap >90p/kWh revenue + cost of supply
- Establishing fair and transparent processes for private participation
- Countering "NIMBY" opposition , Evolving attractive resettlement packages
- Changing Investor Perceptions about risk
- Attracting Foreign Investments , without permitting "gold-plated" power plants

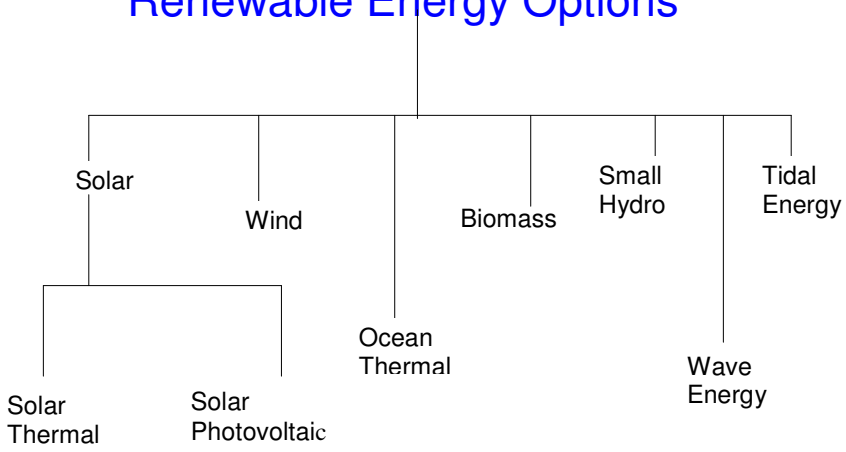
#4 Mainstreaming of renewables and efficiency

Power Generation Options



#4 Mainstreaming of renewables and efficiency

Renewable Energy Options



#4 Mainstreaming of renewables and efficiency

Renewables in Power

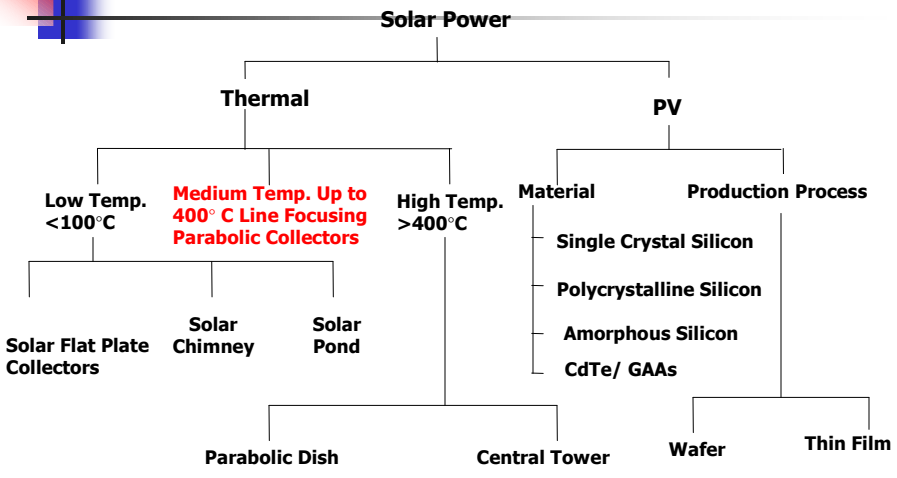
- Power generation 6500 PJ -46% of Comm Energy, 33% of total
- Installed Capacity 130,000 MW (2004), Nuclear 2720 MW(2004)

  Renewables 7855(2006)
- Gross Generation 633000GWh (2003-4)

  Nuclear 17780 GWh(2003-4), ~19000 GWh

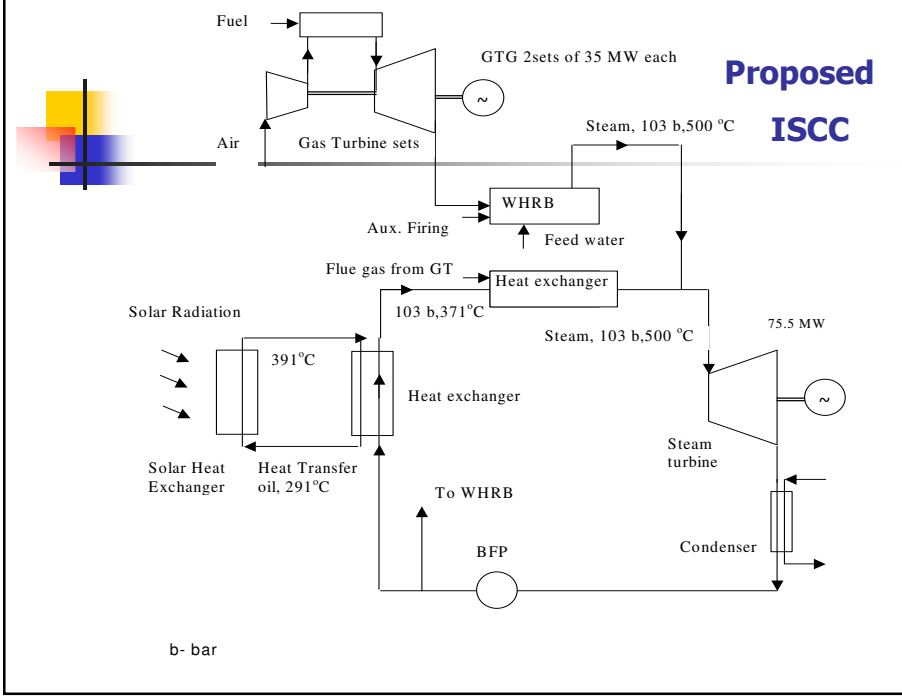
  Renewables 19950 GWh (2006)
- Renewables ~ 6% of Capacity and 2-3% of generation

Technology Options for Solar power



Comparison of Solar Thermal Power Generation Technologies

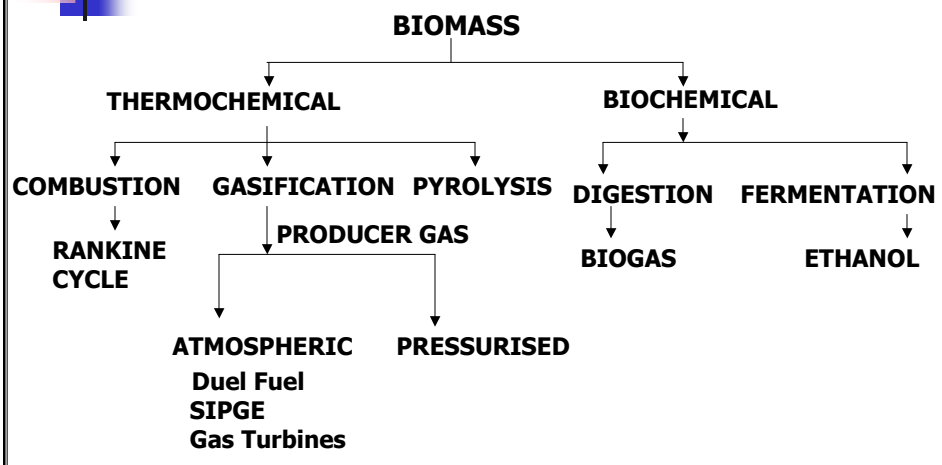
Technology	Efficiency	Indian Experience	Status	Capital Cost (Rs/kW)	Electricity (Rs/kWh)
Solar Flat Plate Collectors	2%	10 kW exptl unit at IITM 80s	D	Rs. 300.000	_
Solar Chimney	1 %	No experience 50 kW Spain	D	Rs. 200,000 ($4600/kW)	_
Solar Pond	1-2%	Experience for hot water Bhuj (Israel power 5MW)	D		
Line focussing Parabolic	Peak 20% Average 11-14%	50 kW system in SEC Planned 35MW solar in 140 MW ISCC at Mathania	C	Rs. 140,000 ($3000/kW) ~390 MW of operating plants	15 -20c/kWh Rs. 6-10/kWh
Paraboloid Dish	29% peak 12-18%	Demo unit 10 kW Vellore	D	Rs. 250,000	
Central Tower	23% peak 7-14%	No experience	D	~Rs. 300,000 ($4700/kW)	



Geothermal/OTEC/Tidal/Wave

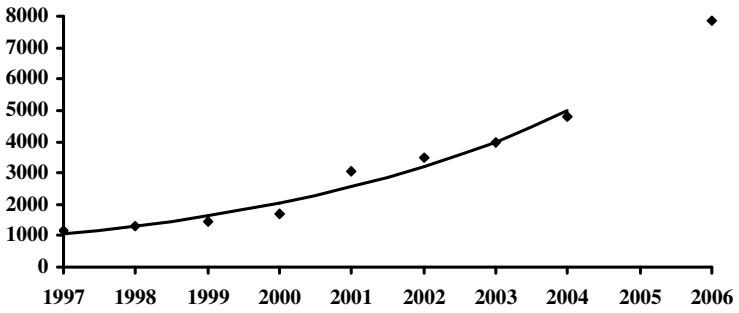
		World	Cost Estimates
Geothermal	COMMERCIAL	8240 MW	4c/kWh $2000/kW No Indian experience 50 MW plant J & K planned
Tidal	PROTOTYPE	240 MW FRANCE	LF 20% No Indian experience
OTEC	PROTOTYPE	50 kW 210 kW NELHA	India 1MW gross plant under construction
Wave Energy	PROTOTYPE	< 1MW Grid Connected	India 150kW plant Thiruvananthpuram

BIOMASS CONVERSION ROUTES



#4 Mainstreaming of renewables and efficiency

Renewable Power Generation



- ***Each data point corresponds to installed capacity as on March of that year***

Source: MNES, NEW DELHI

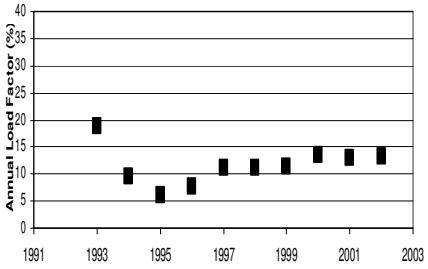
#4 Mainstreaming of renewables and efficiency

Wind Power

- 5000 MW installed
- Single machine upto 2.1 MW
- Average capacity factor 14%
- Capital cost Rs 4-5crores/MW, Rs 2-3/kWh (cost effective if site CF >20%)
- India 45000 /13000 MW potential estimated

32%/ year (5 year growth rate)

Satara, Maharashtra



#4 Mainstreaming of renewables and efficiency

Small Hydro Power

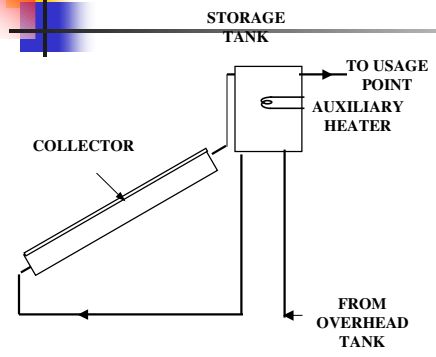
- Classification - Capacity
  -Micro less than 100 kW
  Mini 100 kW - 3 MW
  Small 3 MW - 15 MW
- Micro and Mini - usually isolated,
  Small grid connected
- Heads as low as 3 m viable
- Capital Cost Rs 5-6crores/MW ,
  Rs 1.50-2.50/kWh
- 1846 MW (7%/year)

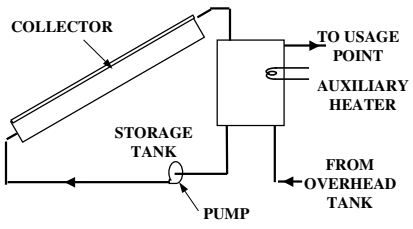
200 kW Chizami village, Nagaland

Aleo (3MW) Himachal Pradesh

#4 Mainstreaming of renewables and efficiency

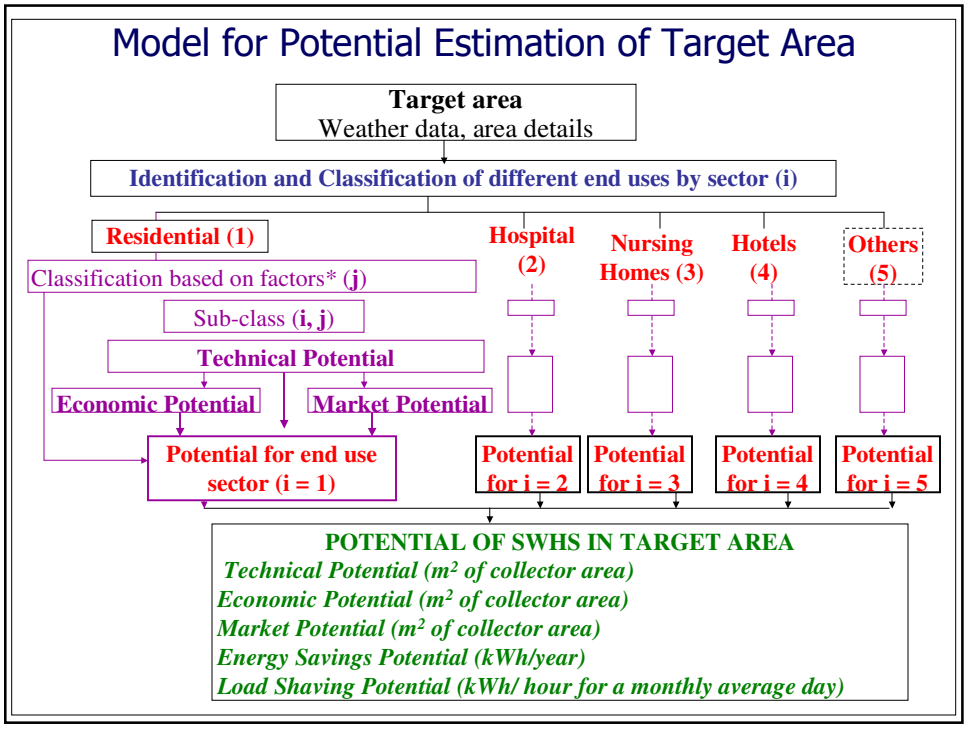
Solar Water Heating System

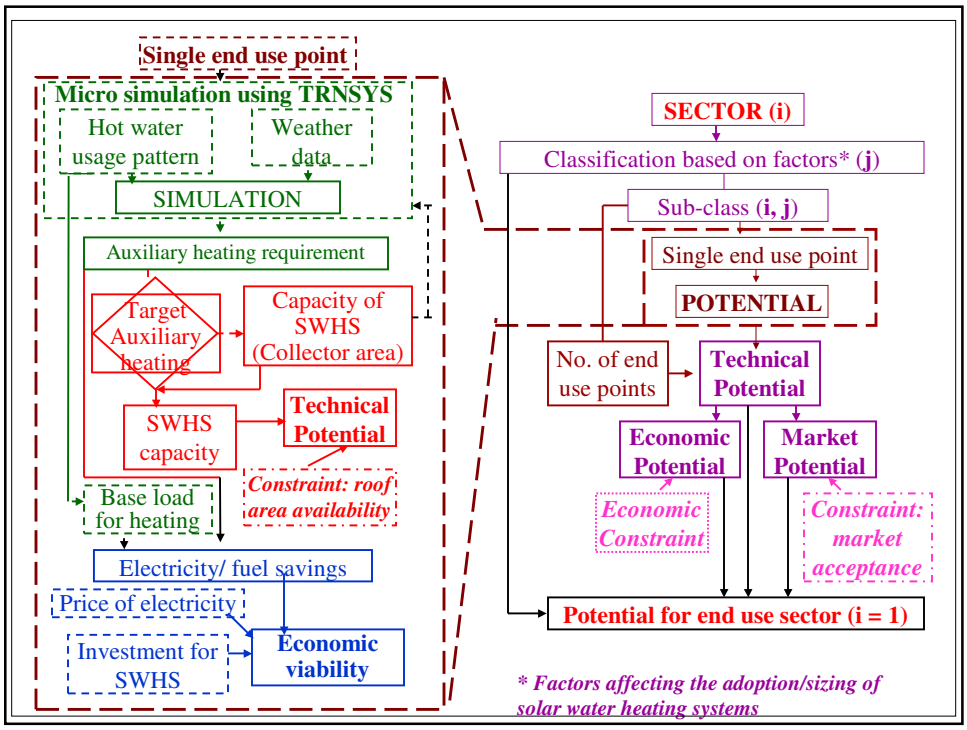




Schematic of solar water heating system

- **Solar Water Heating Systems in India**
  - Installed Capacity = 1.5 million sq. m. (0.8% of estimated potential)

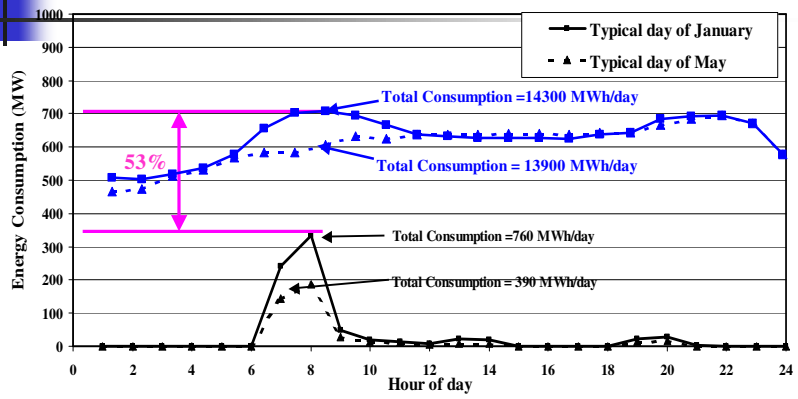

Model for Potential Estimation of Target Area
Target area
Weather data, area details
Identification and Classification of different end uses by sector (i)
Residential (1)
Hospital (2)
Nursing Homes (3)
Hotels (4)
Others (5)
Classification based on factors* (j)
Sub-class (i, j)
Technical Potential
Economic Potential
Market Potential
Potential for end use sector (i = 1)
Potential for i = 2
Potential for i = 3
Potential for i = 4
Potential for i = 5
POTENTIAL OF SWHS IN TARGET AREA
Technical Potential (m² of collector area)
Economic Potential (m² of collector area)
Market Potential (m² of collector area)
Energy Savings Potential (kWh/year)
Load Shaving Potential (kWh/ hour for a monthly average day)


Single end use point
Micro simulation using TRNSYS
Hot water usage pattern
Weather data
SIMULATION
Auxiliary heating requirement
Target Auxiliary heating
Capacity of SWHS (Collector area)
SWHS capacity
Technical Potential
Constraint: roof area availability
Base load for heating
Electricity/ fuel savings
Price of electricity
Investment for SWHS
Economic viability
SECTOR (i)
Classification based on factors* (j)
Sub-class (i, j)
Single end use point
POTENTIAL
No. of end use points
Technical Potential
Economic Potential
Market Potential
Economic Constraint
Constraint: market acceptance
Potential for end use sector (i = 1)
* Factors affecting the adoption/sizing of solar water heating systems

Potential of Solar Water Heating Systems for Pune

- Technical Potential=0.35 million m^2 of collector area
  - Electricity Savings = 225 GWh
- Market Potential = 0.05 million m^2 of collector area
  - Electricity Savings = 43 GWh

Load Curve Representing Energy Requirement for Water Heating for Pune



Total Electricity Consumption of Pune

Electricity Consumption for water heating of Pune

Potential of SWHS for a state: Maharashtra

	Selected district/State	Population (million)	% urban population	Estimated potential	
				Electricity savings (GWh)	Collector Area (million sq. m.)
1	Maharashtra	96.9	42.4	1620	7.6
2	Mumbai	1.20	100	477	2.5
3	Pune	7.22	58.07	242	1.0
4.	Nagpur	4.05	64.36	129	0.6

Potential for Sample States

	State	Potential of SWHS	
		Electricity savings (GWh)	Collector area (million m^2)
1	Tamil Nadu	920	4.7
2	Karnataka	780	3.6
3	Rajasthan	450	2.1
4	Haryana	300	1.3
5	Assam	30	0.1
6	Maharashtra	1620	7.6
	India	12200	57.0

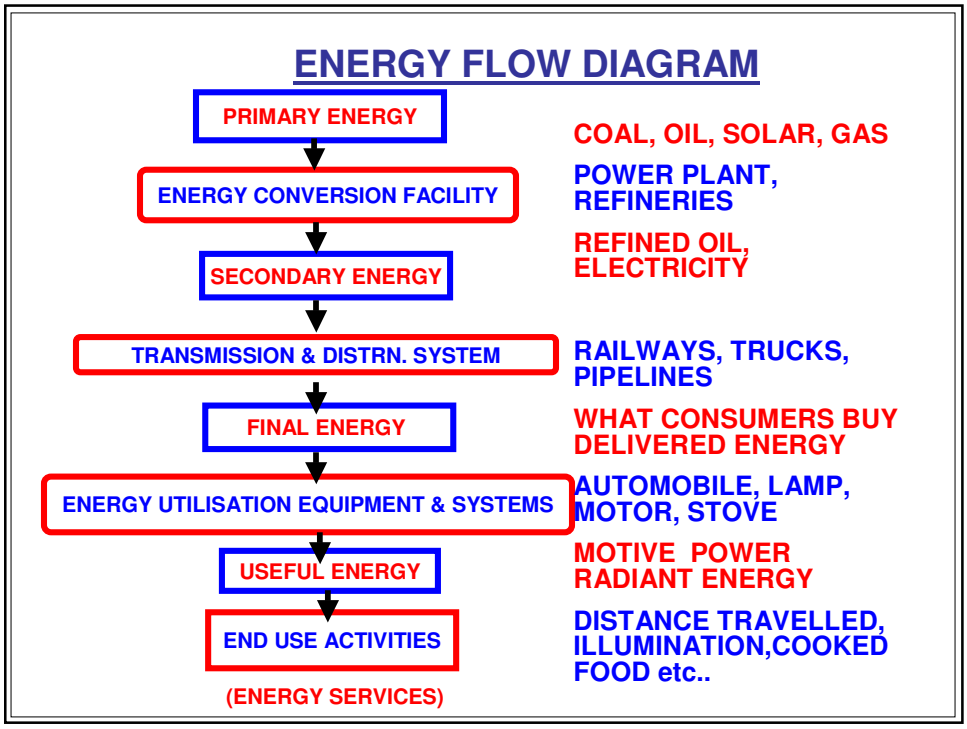
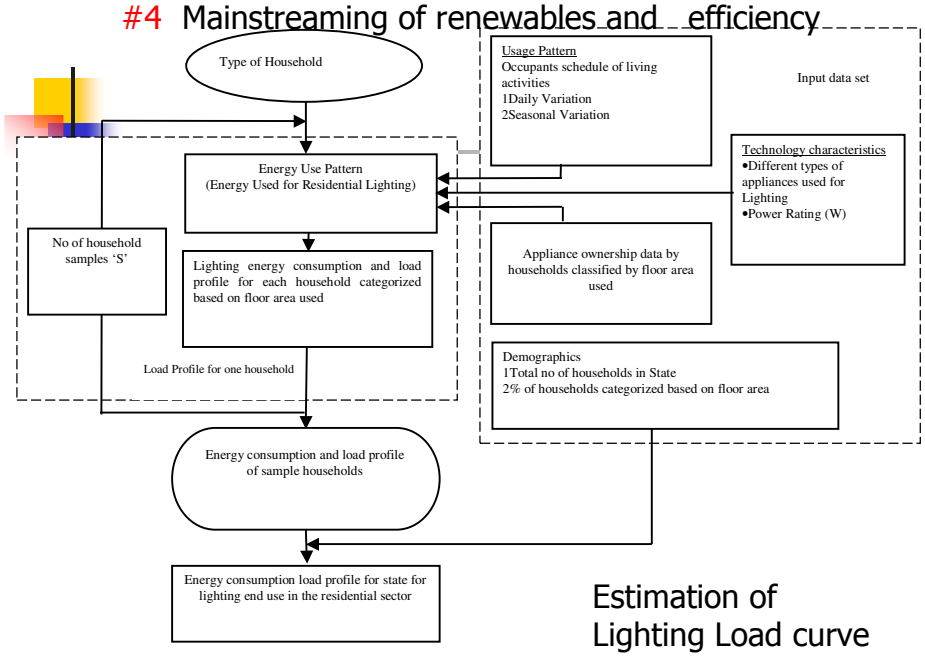


Table 1 Comparison of Initial cost and Annualised Life Cycle Cost (ALCC)

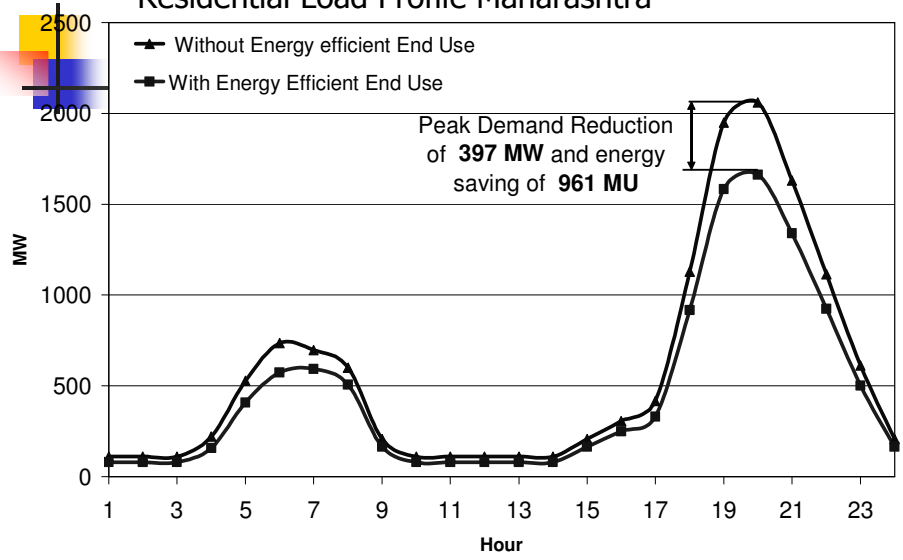
S. No.	Equipment	Rating	Initial cost (Rs)	Annual Electricity Cost (Rs)	ALCC (Rs)	Cost of electricity as % of ALCC
1.	**Motor**	20 hp	45,000	600,000	605,720	99.0
2.	**EE Motor**	20 hp	60,000	502,600	512,700	98.0
3.	**Incandescent Lamp**	100 W	10	1168	1198	97.5
4.	*CFL*	11 W	350	128	240	53.6

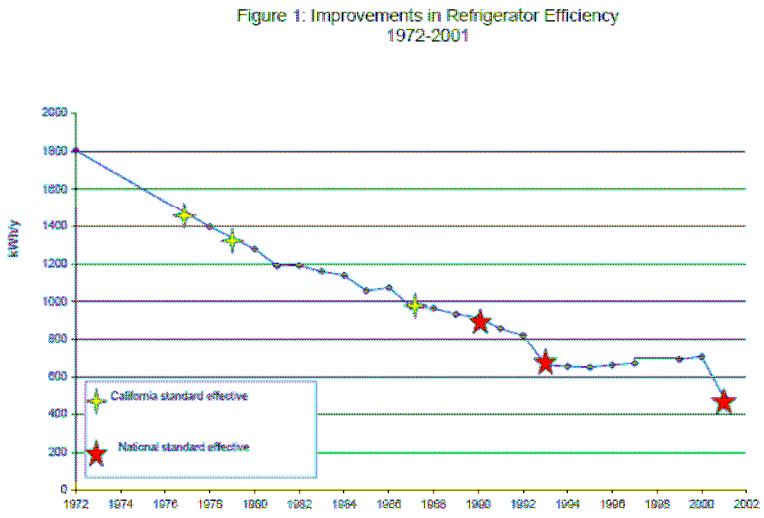
#4 Mainstreaming of renewables and efficiency



Estimation of Lighting Load curve

Residential Load Profile Maharashtra





#4 Mainstreaming of renewables and efficiency

- Market distortions, Quantification of Environmental Costs – "Externalities"
- Life Cycle Costing
- Getting Incentives Right
- Tracking of Performance (generation based)
- Analytical Support
- Institutional Mechanisms

#5 Technology Development/ Cost Reduction

Performance of coal based plants (2005-2006)

	Average	**Min**	**Max**
Rating	175 MW	30 MW	500 MW
Net Heat Rate (Efficiency)	3218 kcal/kWh 26.8%	2489 kcal/kWh 34.6%	6341 kcal/kWh 13.6%
Auxiliary Consumption	9.5%	5.6%	16.2%
CO2 kg/kWh	1.04	0.784	1.61

#5 Technology Development/ Cost Reduction

Clean Coal and advanced coal options

Sub-critical Pulverised Fuel	**36 – 38%**	$900-1000/kW (Rs 4 crores/MW)
Super critical pulverised	Net efficiency 40-46%	Capital cost 950-1600$/kW (20% higher)
AFBC/CFBC 250 MW Atmospheric Fluidised Bed Combustion	Similar to Sub-critical	Fuel flexible 1000-1600$/kW
Pressurised Fluidised Bed Combustion (PFBC)		$1300-$1400/kW
Integrated Gasification and Combined Cycle (IGCC)	43-45% 100-320MW (38 - 43% - actual plants)	$1600-$2400 Not Commercial Technology

#5 Technology Development/ Cost Reduction

- Learning Curve effect (e.g. PV/ Wind)
- Renewables – High Initial Capital Cost
- Need for technology/systems development
- Some areas – Low size Inverters, Controllers for Hybrid systems, Small Wind Turbines..
- Consortium Approach – Industry-R&D-Govt

Distributed Generation options

	Type	Status	Capacity factor	Cost of Generated Electricity (d=0.1)	Comments
Diesel	NR	C, I	N	LF0.5 Rs.5.10/kWh LF 0.8 Rs. 4.85/kWh	Existing base > 10,000 MW as backup.
Gas Engine	NR	C	N	LF 0.5 Rs. 2.62/kWh LF 0.8 Rs. 2.29/kWh	Relative price of Natural gas low.
Micro Turbine + Natural Gas	NR	D	N	LF 0.5 Rs. 3.24/kWh LF 0.8 Rs. 2.82/kWh	Technology not proven in India
Fuel Cell + Natural Gas	NR	D	N	LF 0.5 Rs.6.64/kWh LF 0.8 Rs.4.68/kWh	Demonstration required
Wind Turbines	R	C, I	13% Avg < 30%	LF 0.2 Rs. 8.71/kWh LF 0.3 Rs. 5.84/kWh	2000 MW already installed
Photovoltaic	R	C, I	<25%	LF 0.25 Rs. 17/kWh	Niche applications
Biomass Gasifier Gas – Engine	R	C	N	LF0.5 Rs. 3.16/kWh LF0.8 Rs. 2.59/kWh	
Biomass Cogen.	R	C, I	>50%	LF 0.5 2.40/kWh LF 0.6 2.27/kWh	About 300MW installed

Comparison

	Net energy ratio	Cost (Rs/kWh)	GHG (kg CO_2-eq /kWh)	Resource constraint
Coal based	0.35-0.4	1.2-2.2	0.85-0.9	Fossil fuel
Solar PV	1.6-4.2	8.5-52	0.05-0.13	Higher cost
WECS	8-26	1.8-13	0.012-0.04	Grid penetration
Biomass	8.5-12.5	2.8-4.2	0.06-0.08	Land

Technology/Research Challenges

- Demand Estimation Methodology - administered prices, energy scarcity
- Clean Coal Technology Development
- Cost Effective Remote Metering
- Distributed Generation – Grid Interconnection
- DSM & LM options for Peak Power Planning

Policy Interventions

- Independent Tracking of performance/ costs.
- Renewable energy targets based on generation
- Assess impacts of policies
- Preferential Feed-in tariffs
- Innovative cost recovery/ policy experiments for Isolated Systems
- Changes in Building Bye Laws –SWH, Passive
- Institutional Building – e.g National Bio Power Corporation
- Centres of Excellence
- India as a global renewable energy hub

End-Note

The use of solar energy has not been opened up because the oil industry does not own the sun

Ralph Nader US Consumer activist

Thank you

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