# National Update and Issues

5. Nuclear Energy: Projections and Economics
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# Nuclear Energy: Projections and Economics

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Presentation for Prayas Workshop, March 22-23, 2007



## Why Discuss Nuclear Energy?

- Back in Vogue
  - In India due to US-India Nuclear Deal
  - Elsewhere due to Global Warming Concerns

## Joint Statement, 18 July 2005

- The US:
  - will work to achieve full civil nuclear energy cooperation with India
  - would seek agreement from Congress to adjust U.S. laws and policies
  - will work to adjust international regimes to enable full civil nuclear energy cooperation and trade with India
- Against its historical non-proliferation policy, largely resulting from 1974 Indian nuclear test



## Indian Commitments

  - Identifying and separating civilian and military nuclear facilities and programs in a phased manner and filing a declaration regarding its civilians facilities with the International Atomic Energy Agency (IAEA);
  - Placing voluntarily its civilian nuclear facilities under IAEA safeguards;
  - Signing and adhering to an Additional Protocol with respect to civilian nuclear facilities.
- Historically opposed to safeguards

# DAE's Motivation for Deal

- Failures of Department of Atomic Energy
  - Uranium Crunch
  - Mismatch between plans and reality

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# Uranium Shortages

- Estimated annual uranium production ~ 300 tons
- Estimated annual uranium consumption ~ 450 tons
- Living off stockpile (consumption earlier was lower)
- "The truth is we were desperate. We have nuclear fuel to last only till the end of 2006. If this agreement had not come through we might have as well closed down our nuclear reactors and by extension our nuclear programme" -- *Indian official to BBC*
- Reduction in reactor capacity factors (NPCIL Figs.)

| Year | 2003-04 | 2004-05 | 2005-06 | 2006-07 |
|---|---|---|---|---|
| C.F. | 74.2% | 70.8% | 60.4% | 46.4% |

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## DAE: Projections and Achievements

- DAE has not fulfilled any stated goals

| Year | AEC (1954 ) | Bhabha & Dayal (1962) | Energy Survey Committee (1965) | Vikram Sarabhai (1969 ?) | Raja Ramanna (1985) | Actual |
|---|---|---|---|---|---|---|
| 1971 | 600 | | 600 | | | 320 |
| 1975 | 3000 | | 2000 | | | 540 |
| 1980 | 8000 | | 5000 | | | 540 |
| 1987 | | 20 – 25,000 | | | | 1200 |
| 2000 | | | | 43,500 | 10,000 | 2720 |

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## Current Capacity

- Installed Nuclear Capacity = 3900 MW (primarily PHWRs except for two 160 MW BWRs built by General Electric & Bechtel)
- Approximately 3% of total electricity generation capacity
- Under construction = 3380 MW (4X220 MW PHWR + 2X1000 MW VVER + 500 MW FBR)

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# Current Projections

- 20,000 MW by 2020
- Will only be 8-10% of projected total electrical generation capacity
- 275,000 MW by 2052
- Only 20% of projected capacity (1344 GW)
- For comparison, coal = 615,000 MW; hydrocarbons = 205,000 MW
- Clearly global warming doesn't seem to be a major constraint

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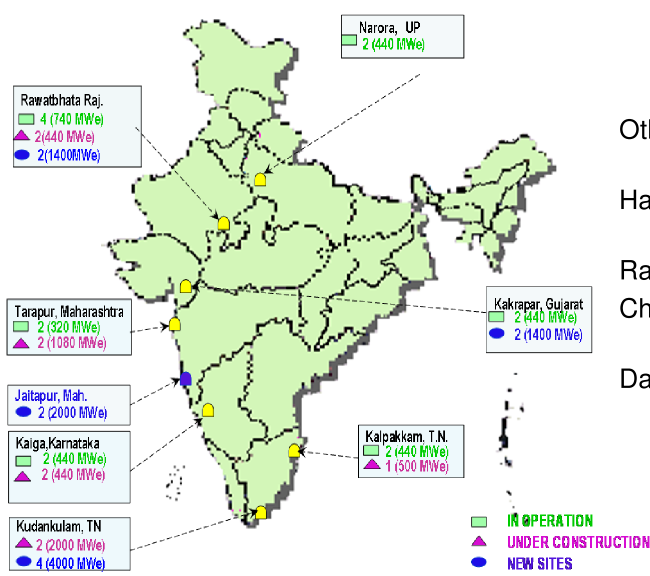


Other Possibilities:

Haripur (West Bengal)

Rajauli (Bihar)

Chutka (Madhya Pradesh),

Darauli (Punjab)

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## Breeders in Current DAE Predictions

- Of the 20 GW by 2020, 2.5 GW is from MOX fueled fast breeder reactors
- 275 GW by 2052, of which 262.5 GW is from fast breeder reactors (2.5 GW based on MOX fuel, 260 GW based on metallic fuel)
- "Thorium based thermal and/or fast breeder technology as well as Accelerator Driven Subcriticals…to provide required fissile material beyond 2052"



## What difference does the US Deal Make?

- Imported Light Water Reactors = 8000 MW
- Breeder Reactors based on plutonium obtained from reprocessing LWR spent fuel = 61000 MW
- Total = 69 GW out of 275 GW in 2052

## PFBR – Cost Estimates

- Construction Cost = Rs 3492 Crores*
- Unit cost = $1293.6/kWe (2004 $)
- OECD's Nuclear Energy Agency estimate for MOX fueled fast reactors = $1850-2600/kWe
- Cost of Kaiga III&IV (2X 220 MW) PHWRs under construction = Rs. 2727 Crores ($1174.3/kWe)
- PFBR cost may well be higher



## Plutonium: Taxpayer Subsidy?

- Fallacious argument: because the PFBR is a breeder reactor that will produce more plutonium than it will consume, the cost of the plutonium can be ignored
- Breeding ratio = 1.05 => consumes roughly as much fissile plutonium as it produces
- Plutonium can be recovered only at the end of 40 years (lifetime of reactor)
- Worth only about 15% of present value*

*at 5% real discount rate

## Plutonium Cost

- From Kalpakkam Reprocessing Plant
- No official estimate of cost of reprocessing or producing plutonium
- Estimated using data from various official documents
- Levelised Cost = Rs. 26000/kgSF (5% discount rate) => Rs. 6700/gram of Pu*
- Reprocessing PFBR spent fuel will be more expensive

*Ramana and Suchitra, Forthcoming, International Journal of Global Energy Issues



## PFBR – PHWR Levelised Cost Difference (Preliminary)*

| Reprocessing Cost ($/kg) | Capacity Factor of PFBR (%) | Cost difference (PFBR-PHWR) Rs/kWh |
|---|---|---|
| 886 | 80 | 0.19 |
| 2500 | 80 | 0.44 |
| 4050 | 80 | 1.36 |
| 2500 | 62.8 | 0.95 |

*Suchitra and Ramana, Forthcoming

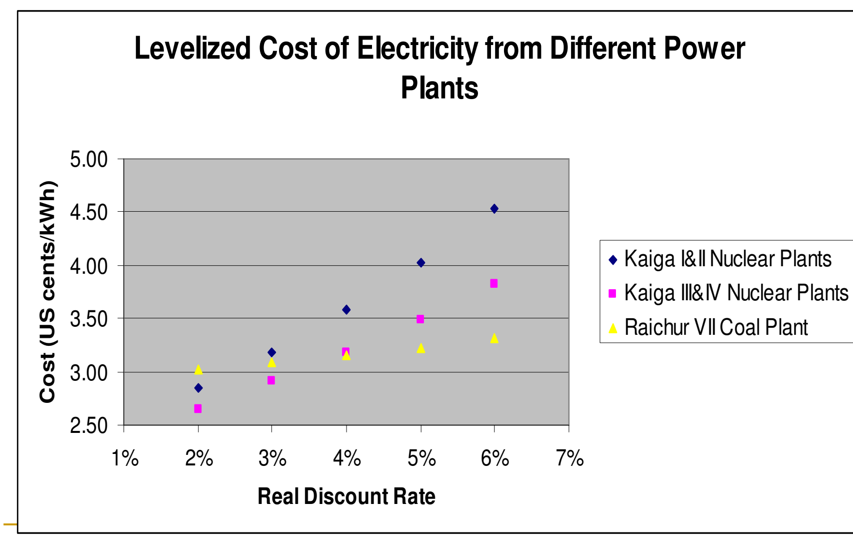
## Crossover between PFBR and PHWR as a function of Uranium Price (Preliminary)

| Reprocessing Cost ($/kg) | Capacity Factor of PFBR (%) | Uranium Price ($/kg) |
|---|---|---|
| 886 | 80 | 336 |
| 2500 | 80 | 576 |
| 4050 | 80 | 806 |
| 2500 | 62.8 | 1085 |

- Official price of uranium from existing mines (0.067% grade) = $150/kg
- Rough estimates of uranium from new proposed mines (0.04% grade) = $225/kg



## PHWRs vs Coal Plants



## Levelised Costs

- Lifetime of 30 years for coal plant, 40 years for nuclear reactor, capacity factor 80%

| Discount Rate | Kaiga I/II | Kaiga III/IV | RTPS VII |
|---|---|---|---|
| 2% | 1.28 | 1.19 | 1.36 |
| 3% | 1.43 | 1.30 | 1.39 |
| 4% | 1.61 | 1.43 | 1.42 |
| 5% | 1.81 | 1.57 | 1.45 |
| 6% | 2.04 | 1.72 | 1.49 |



## Imported LWRs?

- Indian construction costs are lower
- Yet, nuclear power is not economical
- M. R. Srinivasan (2003):
  - Recent cost projections show that if an LWR were to be imported from France, the cost of electricity would be too high for the Indian consumer. This is because of the high capital cost of French supplied equipment.
  - [The United States] is not building at present the type of reactors we are interested in; the ones it is considering in the revival of nuclear power are the types we have no immediate interest in.

## Nuclear Power: the International Scene

- Total nuclear capacity ~ 370 GW
- Under construction ~ 24 GW (many since 1980s)
  - 17 GW of PWR
  - 2.6 GW of BWR
  - 2.1 GW of PHWR
  - 1.2 GW of FBR



## Reactors Under Construction

- Only one in Western Europe/USA: Olkiluoto-3, 1600 MW(e), Finland
- France has recently announced decision to build a 3.3-billion euro (4.3-billion dollar) 1600 MW European Pressurized Water Reactor at Flamanville

## Reaction in France

- http://www.ttc.org/200703171648.l2hgm5d19598.htm
- **THOUSANDS DEMONSTRATE IN FRANCE AGAINST NEW NUCLEAR REACTOR**
  **Received Saturday, 17 March 2007 16:48:00 GMT**
- **R**ENNES, France, March 17, 2007 (AFP) - Tens of thousands of people demonstrated in five French cities on Saturday against plans to build a so-called "third-generation" nuclear reactor in Normandy.
  Some 40,000 people demonstrated in Rennes in Britanny, 2,000 in Lille in the north, 2,000 in the eastern city of Strasbourg, 2,000 in Lyon in the centre and thousands more in Toulouse in the south west, police and organisers said.

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## Recent Capital (Overnight) Costs

- Japan:
  - Genkai-3 ($2818/kW)
  - Genkai-4 ($2288/kW)
  - Onagawa ($2409/kW)
  - KK6 ($2020/kW)
  - KK7 ($1790/kW)
- South Korea
  - Yonggwang 5 and 6 ($1800/kW)
- Finland
  - Olkiluoto-3 ($2500-3000/kW)
- Compare with Indian PHWRs (~$1200/kW) + approx. 50% more for initial heavy water loading

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# Nuclear Revival Hopes

- Based on:
  - Rapid construction, no delays
  - Easy financing
  - No escalation during construction
  - Cheap uranium
  - Vendor estimates with no owner's costs
  - No transmission interconnection costs
  - Easy importation of Asian learning (crews and contractors)
  - "Learning curves"



# Learning and Escalation: USA

Historical US Construction Costs (pre-TMI-2 plants operating in 1986; $2002)

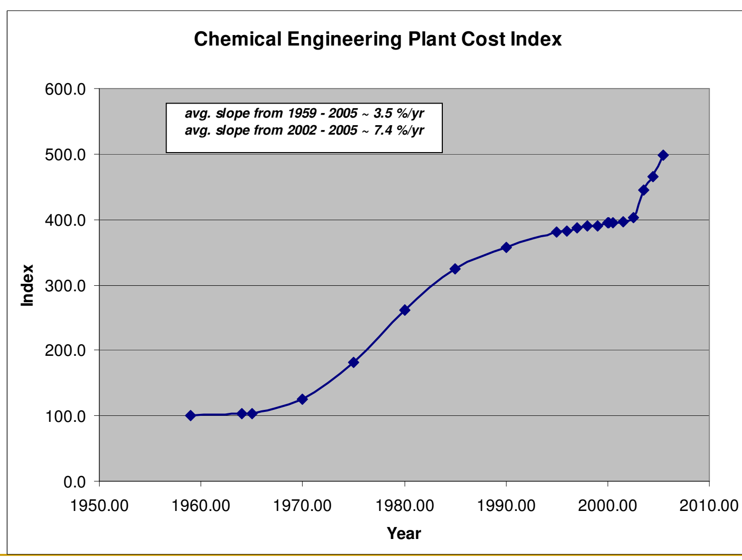
| Construction start | Estimated Overnight | Actual Overnight | % Over |
|---|---|---|---|
| 1966-1967 | $560/kW | $1170/kW | 209% |
| 1968-1969 | $679/kW | $2000/kW | 294% |
| 1970-1971 | $760/kW | $2650/kW | 348% |
| 1972-1973 | $1117/kW | $3555/kW | 318% |
| 1974-1975 | $1156/kW | $4410/kW | 381% |
| 1976-1977 | $1493/kW | $4008/kW | 269% |

# Nuclear Reactor Construction Costs

| Station | Original Cost (crore Rs) | Revised Cost (crore Rs) |
|---|---|---|
| TAPS I & II | 48.5 | 92.99 |
| RAPS I | 33.95 | 73.27 |
| RAPS II | 58.16 | 102.54 |
| MAPS I | 61.78 | 118.83 |
| MAPS II | 70.63 | 127.04 |
| NAPS I & II | 209.89 | 745 |
| Kakrapar I & II | 382.5 | 1,335 |
| Kaiga I & II | 730.72 | 2,896 |
| RAPS III & IV | 711.57 | 2,511 |



# What about Now?



## Safety Issues – Possibilities

- Nuclear technology has accident possibilities, some catastrophic
- Chernobyl, Three Mile Island,…
- Many more instances of smaller accidents (also called incidents)

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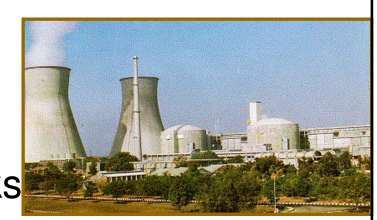
## Safety Issues – Accidents in India

- Most nuclear reactors in India have had small or large accidents
- 2004: Kakrapar power surge
- 2003: KARP waste tank
- 1999: Kaiga dome fire
- 1994: Kaiga dome collapse
- Numerous heavy water leaks



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## Narora Fire of 1993

- Accident that came closest to large radioactive release
- Two blades in the turbine generator of NAPS-I snapped under accumulated stress
- Sliced through other blades and set off fire
- Cables of back-up power systems were burnt
- (Unknown) Operators used torches to climb and release boron solution to shut down the reactor

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## More on the Narora Accident

- 1989: General Electric Company warned BHEL of the possibility of turbine blade failure – ignored
- Power cables of back-up systems were laid in the same duct without any fire-resistant material – the lesson from the well-known 1975 Browns Ferry accident
- Similar fire at Kakrapar reactor in 1991

## Normal Accidents

- Sociologists/Organization Theorists: Complex technological systems *inevitably* lead to serious accidents
- Charles Perrow: “Normal Accidents” –to explain how serious accidents appear to be an inevitable consequence of such technologies, regardless of the intent or skill of their designers or operators



## Characteristics of Normal Accident Prone Systems

- “interactive complexity”: those of unfamiliar sequences, or unplanned and unexpected consequences, and either not visible or not immediately comprehensible
- “Tight coupling”: there is no slack or buffer or give between two items; what happens in one directly affects what happens in the other

## Implications

- Hard to foresee all possible accident modes
- Operator errors comprehensible only after the fact
- Small beginnings cause big failures
- Possibilities for common mode failures
- Renders estimates of probabilities of accidents somewhat meaningless
- Redundancy can also cause problems



## Breeder Reactors & Explosive Accidents

- Large Breeders: Positive Sodium Void Coefficient
- If for some reason the sodium were to heat up and vapourise, then it would increase the reactivity of the core of the reactor.
- If the operating system fails to insert control rods fast enough, the increased reactivity would, in turn, heat up the sodium further; this chain could ultimately cause a fuel meltdown into a supercritical configuration and a small nuclear explosion.

## Greater Impact of Accidents

- Breeder Reactors use MOX (mixed oxide fuel) containing plutonium
- Plutonium – about 30,000 times more radioactive than uranium-235
- More severe health effects coming from exposure (especially through inhalation) to this fuel.
- Also greater buildup of fission products
- Public Health impacts of a full-scale (Beyond Design Basis) accident much more severe than in a Light Water or Heavy Water Reactor.



## Public Health

- Only reactor around which there has been a scientific study of consequences on health of local population is RAPS
- 1991 Survey – 5 villages (population 2860) within 10 km of plant and 4 villages (population 2544) more than 50 km away
- Not refuted by DAE

## RAPS Survey Results

- Increased rate of congenital deformities;
- Significantly higher rate of spontaneous abortions, still births, and one-day babies
- Significant increase in chronic diseases especially amongst the young, but no differences in acute infections
- Significantly higher rate of solid tumours
- More cancer patients and cancer deaths
- Significantly fewer electrified household and pumping set connections near the plant

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## Uranium Mining in Jaduguda

- Similar survey performed
- Statistically significant increase in congenital deformities near plant
- Number of people, including workers, suffer from various lung diseases – routinely classified as tuberculosis

## Conclusions

- Nuclear power programme – more promise than delivery
- Expensive
- Several obstacles to large scale expansion – both in India and worldwide
- Important safety concerns
- Damage to public health and environment

# Lessons from International Experience in Power Sector Reforms

**Daljit Singh**
Prayas Energy Group
Pune

Presentation at:
Workshop on Power Sector Reforms and Regulation in India
Pune
March 23, 2007

## Why Review Experience in Other Countries?

- Worldwide, the electricity industry is being restructured due to changes in technology and due to a change in economic thinking
- Reforms in Indian power sector strongly influenced by these trends.
- Recent questioning of the theoretical models and realization that restructuring is more difficult than expected
- Important to factor in these experiences and debates in developments in the Indian power sector.

## EPW Special Issue

- Based on a collection of papers for a Special Issue of Economic and Political Weekly on Global Experience with Electricity Reform

  Navroz K. Dubash and Daljit Singh (Editors)

  December 10-16, 2005, Vol. XL No. 50
- Papers on experience in seven countries or regions: UK, USA, Norway, Latin America, Sub-Saharan Africa, South Africa, and ASEAN countries
- Wrote introduction to papers and overview of international experience

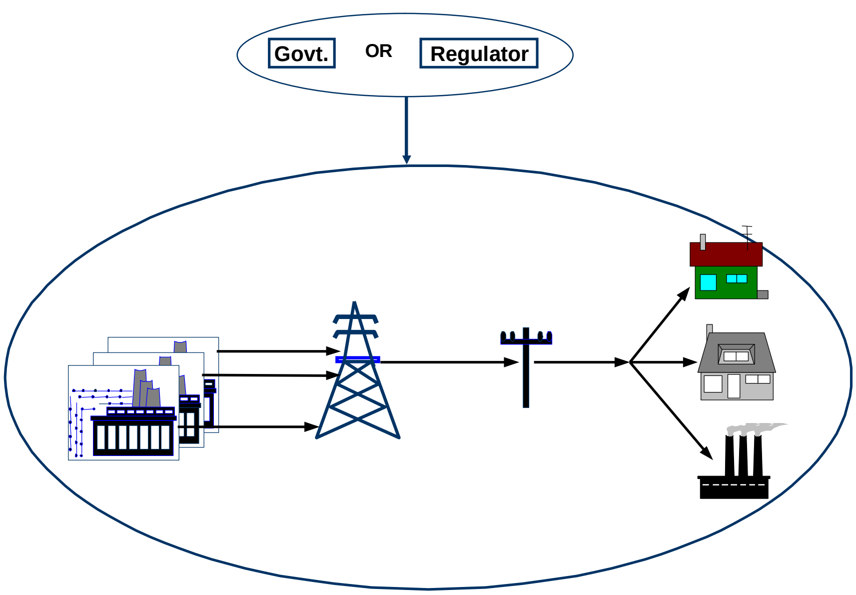
## Overview

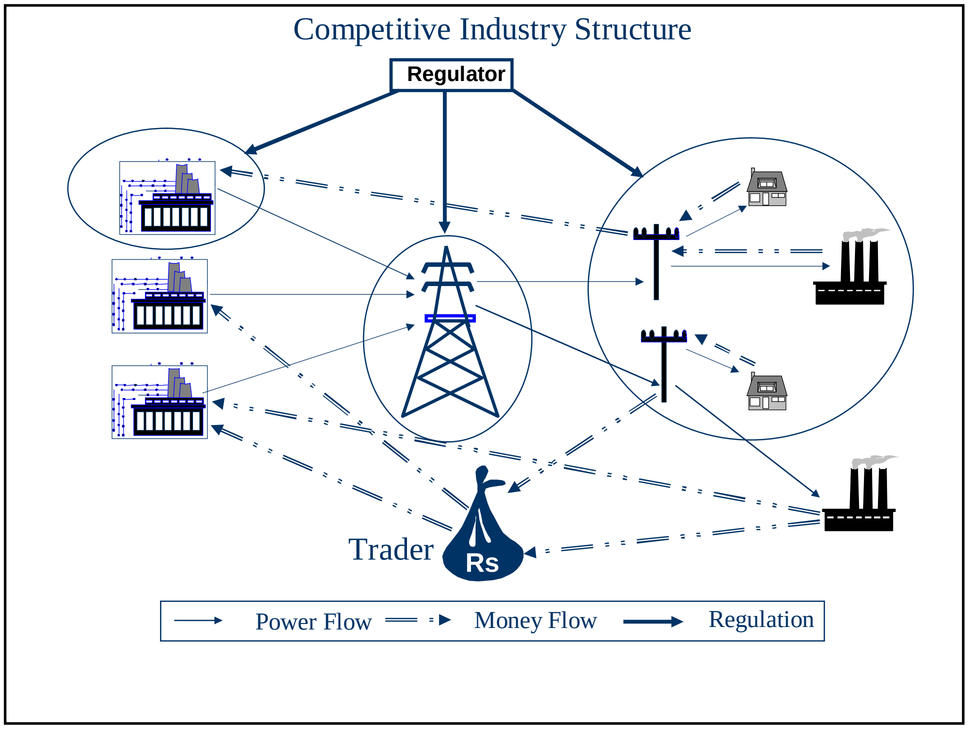
- Part I -- Historical Background on Reforms and Restructuring of Electric Utilities
- Part II – Lessons from the Experience of Developed Countries
- Part III – Lessons from the Experience of Developing Countries
- Part IV - Way Forward for India

# Short History of Electric Industry Restructuring

- Earlier vertically integrated industry structure with public ownership because of huge capital outlays required.
- New idealized structure for industry envisions:
  - Generation competitive with many buyers and sellers of electricity
  - Investment risk borne by investors and not consumers
  - T&D are natural monopolies so need to be regulated but open access must be provided to T&D networks.

## Vertically Integrated Utility Structure






## Drivers of Restructuring

- Availability of combustion turbines which were small, cheap and modular undermined economies of scale
- A shift in economic thinking away from state-based solutions and towards market-based approaches
- In developing countries, poor performance of state-owned enterprises (SOEs) resulting in lack of public capital and shortages of power.
- World Bank policy encouraged private investment

## Steps in Move to Standard Model

- Corporatizing of State-Owned Entities (SOEs) to bring commercial outlook in decision making
- Vertical Unbundling to separate generation, transmission and distribution
- Usually privatization of generation and distribution.
- Usually free entry to create multiple players to enable competition. May also need horizontal unbundling.
- Creation of Independent System Operator (ISO)

## Some Setbacks Leading to Reassessment

- California Crisis – 2000-01
- No new state restructuring since 2003 in the US
- Widespread blackout in the North-East US in August 2003
- Enron collapse
- UK power pool replaced by NETA
- High, volatile energy prices
- Brazil crisis
- Stalling of reforms in several countries such as South Africa, Indonesia

## Reform of the Indian Power Sector

- Starting with Orissa in 1996, unbundling and corporatization of SEBs;
- Setting up regulatory commissions
- Distribution privatization: Orissa – 1999, and Delhi – 2002
- Comprehensive Electricity Act – 2003
  - Enables competition but does not mandate it
  - States to unbundle SEBs
  - Generation delicensed
  - Consumers can avail of open access and seek alternative supplier (in a phased manner according to size with largest consumers allowed first)

## Experience of Developed Countries - Major Issues Reviewed

- How have prices behaved post-restructuring?
  - Economic efficiency with consequent price reductions was main selling point of restructuring in developed countries
- How well have the markets worked?

## Experience of Developed Countries - Price Record

- While there may be efficiency gains due to markets, it is difficult to separate the effects of changes in prices of inputs or macro-economic changes.
- Price volatility increases in price-bid markets
- Small consumers do not do as well as large consumers.

## Creating Competitive Markets is Challenging

- Physical characteristics of electricity
- Market concentration and market power are problems.
- Difficult to create adequate incentives for capacity additions
- Greater stress on transmission infrastructure
- Not many takers for retail competition

## Experience of Developing Countries – Unfavorable Starting Conditions

- In developed countries, restructuring was done on systems that were generally well-functioning. In contrast, developing countries start with unfavorable conditions:
  - Weak institutions and systems
  - Fragile financial condition
  - Political interference

## Lessons from Experience of Developing Countries

- Several examples where privatization increased efficiency but there are also examples of non-performance.
- Regulatory Inadequacy is widespread and is a significant barrier for successful reform efforts.
- Increasing access to electricity is possible with explicit policy goals, regulatory instruments, dedicated implementing institutions and funding.
- Govt playing multiple roles can lead to conflict of interest and erode confidence of private players.

## Organized Electricity Markets in the Indian Context – Take Cautious Approach

- No country has introduced electricity markets during periods of shortages. In fact, in most countries, elec markets in trouble when surplus exhausted.
- Potential buyers – SEBs are financially fragile
- Inadequate transmission capacity for effective inter-regional trading
- Regulatory capacity inadequate
- Competition in generation will provide gains of 5-10% while gains from loss reduction and subsidy reform much greater.

## Way Forward for India

- Creating competitive electricity markets is a challenge under the best of circumstances
- Establish specific national priorities keeping local needs and capabilities in mind
- Rather than focus on full restructuring as the single long run vision for the sector, adopt a "no-regrets" strategy and carry out improvements that would be required anyway such as loss reduction, improvements in T&D networks, strengthening regulatory capacity.

## Way Forward for India (Contd)

- Move focus away from organized electricity markets and think about alternative ways to bring greater competition, example competitive bidding.
- Have more explicit discussion about political problems such as tariffs and service for agricultural consumers
- Most important, remember there is no silver bullet that will remove all the sector's woes.

## Thank You for Your Attention!

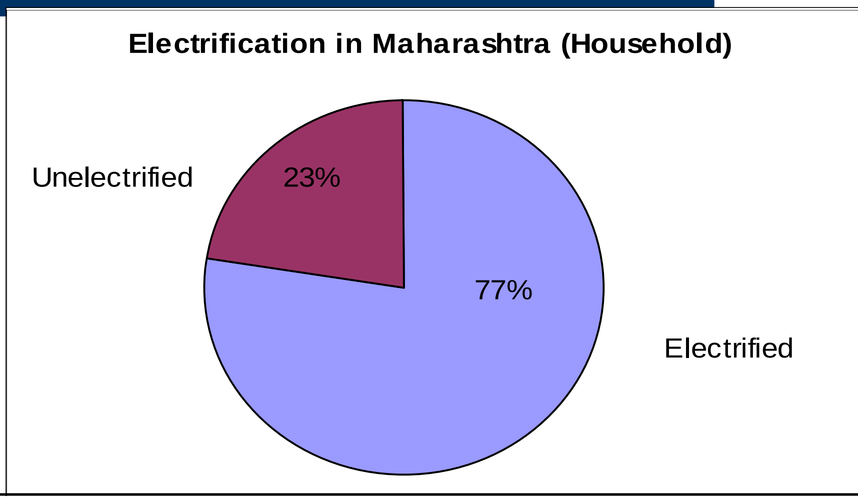
# Small Consumers in the Power Sector

Prayas Energy Group

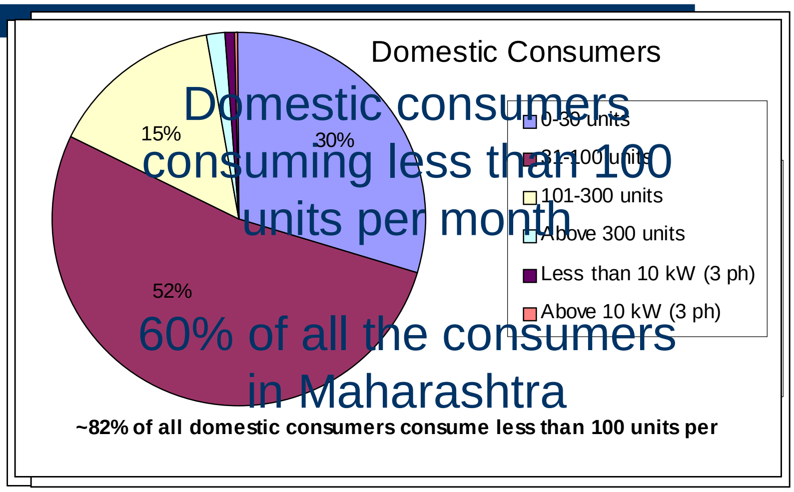
## National goals – E Act 2003 and NEP

- Power for all
  - 100% Village electrification by 2007
  - 100% household electrification by 2012
- No one should be supplied electricity without metering by 2005
- Utility to give connection on request and abide by performance standards

## Elecrtification (Census 2001)




## Who are the small consumers?




Domestic consumers consuming less than 100 units per month

60% of all the consumers in Maharashtra

## What are their problems?

- Access to electricity
- Procedural issues
- Quality of supply
- Affordability

## Access to electricity

- Network reach
- High initial costs
  - Meter costs ~ Rs. 700
  - Service connection costs ~Rs. 500
  - 0.38 crore X Rs.1200 = Rs. 456 crore
- Problems of local utility
  - Unavailability of material / manpower
  - Occurrences of petty corruption

## Procedural problems

- **Meter reading and billing**
  - Irregular or no meter reading (Often the first bill itself is late)
  - Average billing
  - **Any departure from monthly expenditure plan a problem for poor consumers**
  - **Poor households find it easier to pay small amounts more often than large amounts after long intervals**

è **Meter reading and billing are major issues for poor consumers**

## Power supply- its quality and reliability

- Quality of supply problems
  - Voltage problems
  - DT failure
  - Feeder problems
- Reliability problems
  - Long hours of unscheduled outage
  - High load shedding

## Affordability of power - MERC tariff

| Consumption (Units /month) | Tariff (Rs. /unit) | Energy Charge (Rs. /month) | Fixed Charge + FAC (Rs.0.41/unit + ASC (Rs./month) | Total Bill Rs/ month |
|---|---|---|---|---|
| 25 (BPL) | 0.40 | 10 | 3+10.25+0 | 25 |
| 25 | 1.90 | 47.5 | 40+10.25 | 105 |
| 35 | 1.90 | 66.5 | 40+14.35 | 125 |
| 45 | 1.90 | 85.5 | 40+18.45 | 150 |

**BPL consumer: Consistent consumption of 30 units or less per month for the previous 12 months**

## Consumer awareness and participation

- Inability to read the electricity bill
- Low awareness about consumer rights
- Low awareness about consumer grievance forums
- Procedural barrier
- Low capacity to actively participate in regulatory proceedings

## Possible Solutions

- Subsidy for initial costs (RGGVY etc.)
- Franchisee systems
- Group metering
- Pre-paid meters
- Limited load connections
  - Load is limited (60 W or 100 W)

## Advantages

- Fixed cost per month eliminates the uncertainty associated with meter reading and billing
- Cost of Rs.10-12 per bill is eliminated for the utility
- Encouragement for Energy Efficient Equipment

## Conclusion

- Small consumers face many problems
- Of these only few are currently being addressed
- Access, quality ad reliability and procedural problems need to be accessed simultaneously
- Innovative and participatory solutions needed to facilitate electricity access and use for small consumers

# Issues of Concern for Agricultural Consumers

Prayas Workshop
Pune
March 22-23, 2007

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## Issues of Concern for Agricultural Consumers

- Needed
  - Quality inputs at reasonable price
    - **Water (not electricity)**
    - Seeds
    - Fertiliser
    - Pesticide
    - **Credit**
  - (Weakly) Regulated prices for Produce

Placing Issues on the Table

## Macro picture

- Water sources
  - Canal (31%-India, 37% – AP)
  - **Well (59% -India, 43% - AP) Growing**
  - Others (10% - India, 20% - AP)
- Key states
  - Number of wells (>10 L) :Maharashtra, AP, Tamil Nadu, Karnataka
  - High consumption (>30%): AP, Karnataka, Gujarat,Rajasthan, MP
- Growing power consumption
  - 1970: 10%
  - 2005: 24%
- High number of Diesel pumpsets (30-40%?)



## Agricultural Consumers Issues -1

- Limited hours of supply, decided by utility (time, spell)
- Power consumption estimate are suspect
  - Inflated to hide theft and losses
  - Segregation of feeders, Census & Metering for accountability needed
- Annualised capital cost (Rs.30-40,000 – Bore well in AP) is the issue - not so much electricity tariff
  - Reasonable credit
- Efficiency improvement
  - Low at 20-30%
  - 7-10% improvement (TERI 2003) with
    - Foot valve (open wells), suction pipe, delivery pipe, motor efficiency, motor rating, capacitors (more for utility)
  - Participative DSM measures needed

## Agricultural Consumers Issues - 2

- Quality of Supply, Quality of Service
  - Low voltage, Interruptions
  - Very poor O&M – electrical accidents
  - Motor burn outs (1/season?), DT burnouts
  - Staff Shortage – delays in repair, accidents
- Metering
  - Ambitious, un realisable plans to meter all
  - Fear of harassment by utility staff
  - Metering for accountability (DT, load limiter etc) is a better approach



## Agricultural Consumers Issues - 3

- Tariff & subsidy
  - Tariff to be low for the majority marginal farmers
  - Willingness to pay linked to upfront improvement in quality of supply and assured tariff trajectory
  - Method of calculating Cost of supply of power to agriculture
  - Subsidy not targeted
  - Subsidy delivery mechanisms need to be strengthened

## Challenges – farm power subsidy

Inefficient electricity use

Little benefit to poor farmers

Lowering of water table à negative impact on poor

Overuse of ground water

Competitive well deepening

Improper crop selection

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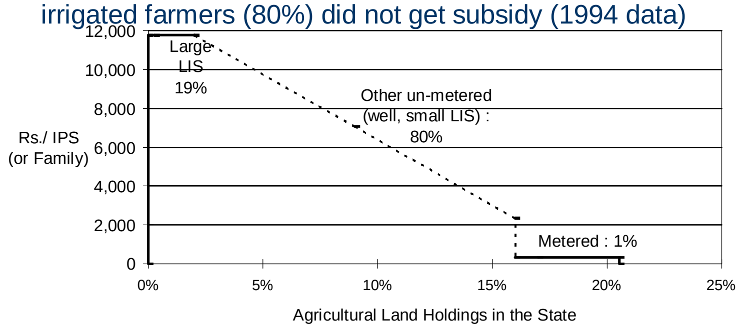
## Challenges – farm power subsidy

- Distribution of agricultural power subsidy in Maharashtra. Non-irrigated farmers (80%) did not get subsidy (1994 data)




- Karnataka – Only 10% subsidy reached poor farmers

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## Agricultural Consumers Issues -4

- Free power
  - Not so much of immediate economic impact on utility, **but**
  - A major political issue and
  - Has impact on Ground water
- Suggested solutions include:
  - Reserving low cost power for agriculture and poor (Sankar)
  - Separating agri feeders (controlling hours of use, and timing) and improve utility accountability
  - Efficiency improvement

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## Issues of Concern for Agricultural Consumers

- Need to comprehensively handle
  - Cropping pattern
  - Irrigation techniques
  - Ground water use
  - Power supply & service
  - Metering and Collection
- Need to increase participation
  - Build awareness and capability
  - Develop spaces for participation – DSM program in AP implemented in a top-down fashion
- Treat as consumers, not as a problem

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Prayas

WORKSHOP ON POWER SECTOR REFORMS AND REGULATION IN INDIA

# DEVELOPMENTS IN THE OIL & GAS SECTOR AND ITS IMPACT ON THE POWER SECTOR

March, 2007 Mumbai

ABPS Infrastructure Advisory

## Agenda

- Relevance of Oil & Gas Sector to Power Sector
- Recent Developments in Oil & Gas Sector
- Impact of developments on the Power Sector

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## Relevance Oil & Gas Sector to Power Sector

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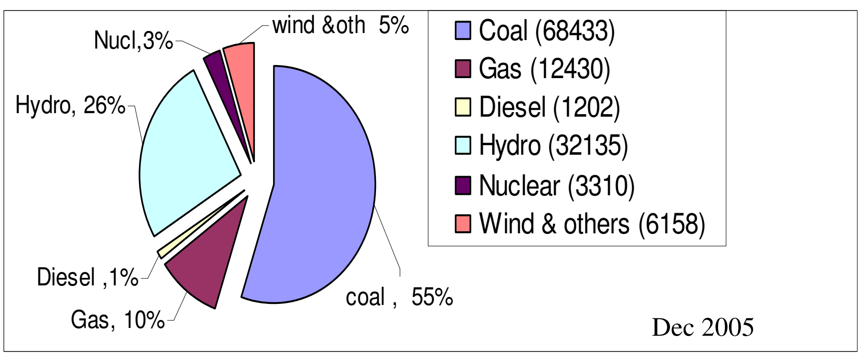
## PRESENT FUEL MIX IN THE COUNTRY




Source : MoP

Note: Diesel based captive power capacity is not included.

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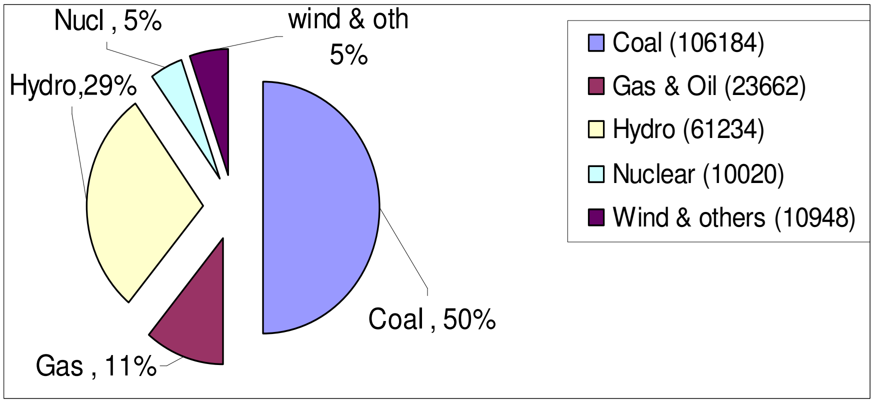
## EXPECTED FUEL MIX IN THE COUNTRY(2012)

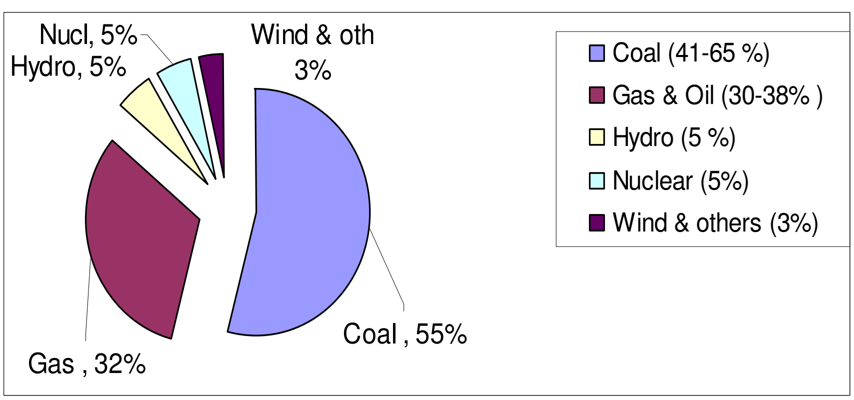



**(Installed Capacity 2,12,048 MW)**

Note: Diesel based captive power capacity is not included.



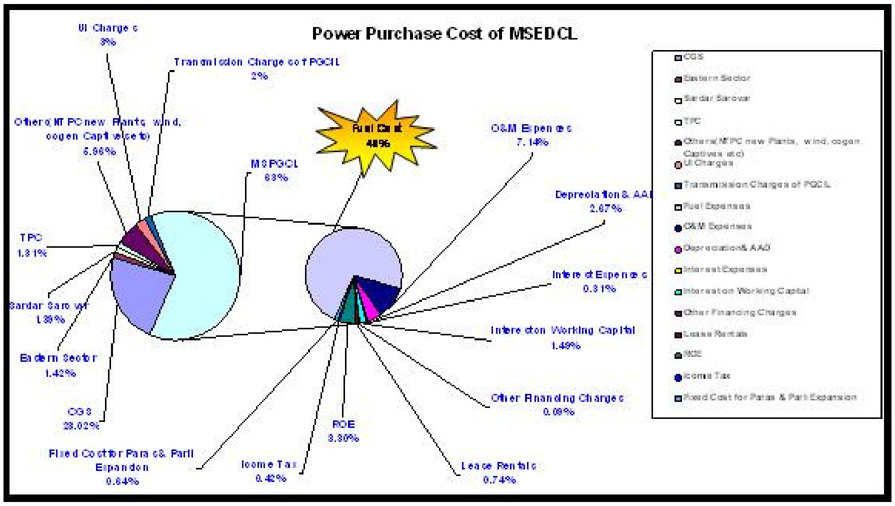
## EXPECTED FUEL MIX IN COUNTRY (2031-32)




**Source : Report on Integrated Energy Policy**

Note: Diesel based captive power capacity is not included.

## Cost of Fuel in the Cost of Power

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## Oil& Gas as Fuel for power Generation…

- Fuel Used in Power plant are:
  - Natural Gas
  - Naphtha
  - Liquid Fuel
- Gas is used either as a Gas based power plants or Combined Cycle Fuel Plants, Naphtha is used as substitute for natural gas
- GAIL the major marketing entity provides more than 40% of its allocated capacity to Power Sector
- Large difference between availability and demand, natural gas supply is allocated by the Government generally based upon the Imputed Economic Values (IEVs) of natural gas use
- Diesel if preferred fuel for Captive Power Plants specially to meet peak demand deficit

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## Gas as Fuel for power Generation…

- More than 8.5 MMSCMD of gas is being directly supplied by the JVs/private companies at market prices to various consumers. This gas is outside the purview of the Government allocations.
- NTPC has a gas based capacity of 3955 MW
- RGPPL the erstwhile Dabhol Power Plant is starting generation of 740 MW to meet Maharashtra power shortage
- Gas based Generating Plants have lower Commissioning time and hence lower Capital Cost like about 3.5 Crore per MW
- Currently Variable Cost for Gas based generation is costly due to high Gas Price and Price Volatility
- Fuel linkages for Gas base station are a major threat due to Gas Shortage



## Role of Oil & Gas in Power Sector

- Share of oil & gas based power plants is currently small
- Share of gas based capacity is expected to rise significantly
- Very few utilities are using liquid fuel power plants as base load
- No further capacity using liquid fuel is being planned
- Registered demand with Gas Authority of India Ltd. for natural gas in the country is around 260 MMSCMD.
- Domestic Production of Natural Gas has exceeded around 90 million standard cubic meters per day (MMSCMD)
- India has introduced schemes like NELP to explore the unexplored sedimentary reserves of India

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