Towards improving service delivery and sector health through multi-disciplinary skills in electricity sector: A Training workshop for civil society and electricity sector professionals

11th and 12th February, 2019

Pune

Prayas (Energy Group)

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Towards improving service delivery and sector health through multi-disciplinary skills in electricity sector

Training workshop for civil society and electricity sector professionals

Organised by Prayas (Energy Group), Pune
Venue: YASHADA, Pune
Date: February 11-12, 2019

Agenda

Time		Session	Session Coordinator
11th February			
10:00-10:30		*Registration and Tea*	
10:30-11:30	S1	Introduction to the workshop and participant's introductions	Shantanu Dixit
11:30-11:45		*Tea break*	
11:45-13:30	S2	Legal and institutional overview of the sector	Ashwini Chitnis
13:30-14:30		*Lunch*	
14:30-15:30	S3	Technical concepts relevant for understanding sector operation, policy and regulation	Sreekumar N
15:30-16:00		*Tea break*	
16:00-17:00	S4	Related sectors - Coal	Ashok Sreenivas
17:00-18:00	S5	Related sectors - Agriculture	Sreekumar N and Ashwini Dabadge
19:30-21:00		*Dinner*	
12th February			
10:00-11:15	S6	Tariff and Regulatory concepts -1	Ann Josey and Manabika Mandal
11:15-11:30		*Tea break*	
11:30-12:30	S6	Tariff and Regulatory concepts -2	Ann Josey and Manabika Mandal
12:30-13:30	S7	Power sector planning - why, what and how	Sreekumar N
13:30-14:30		*Lunch*	
14:30-15:15	S8	Emerging trends: challenges and opportunities	Ashwin Gambhir
15:15-16:00	S9	Importance of tools and modelling based approaches for sector engagement	Srihari Dukkipati
16:00-16:30		*Tea break*	
16:30-17:30	S10	Conclusion and way forward	Ashwini Chitnis, Sreekumar N and Shantanu Dixit

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Training workshop for civil society and electricity sector professionals

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List of Participants

(In alphabetical order)

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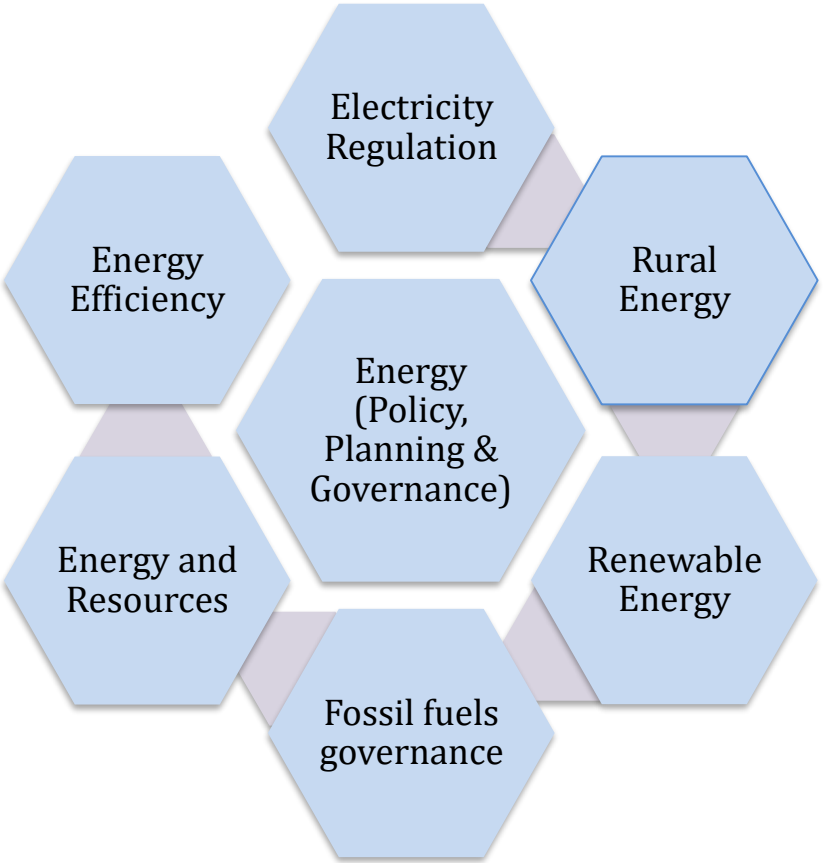
Introduction

Training Workshop
Pune, February 11-12, 2019

Shantanu Dixit

Prayas (Energy Group)

- Not-for-profit orgn. founded in 1994
- **Analysis based policy advocacy for promoting public interest**
- **Focus on governance aspects & policy innovation**
- Extensive engagement with civil society groups, peoples' movements, consumers groups and media.



- Part of several high-level Govt. Committees & regulatory processes
  - Regulatory commissions: Consumer Representative and Advisory Committees
  - NITI Aayog**:** 175 GW Expert Committee, Low Carbon Inclusive Growth, India Energy Security Scenarios, New Integrated Energy Policy; Indo-US energy dialogue.
  - MoEFCC – BASIC Group (till 2012)
  - MNRE: RE Law, 12th Plan ; MOP: 12th Plan, tariff rationalisation committee

Objectives, scope and coverage

- Financially healthy, technically efficient, and environmentally friendly electricity sector key to development
  - Analysis based regulatory and policy engagement can make a difference
- Workshop aims at providing a comprehensive overview of the Indian electricity sector and to introduce the upcoming challenges in its operation and planning
- Varied audience – utility engineers, regulatory staff, academic and civil society - all interested to improve the sector, using professional skills
- Scope: Concepts crucial for developing a sound understanding of the overall functioning and planning of the electricity sector.
  - No claim to be exhaustive, limited critique, no specific action items.
  - Some areas such as transmission, energy efficiency, critique of the sector reforms, complaints handling, consumer awareness etc. not part of the scope.
  - Similarly, amongst various interlinked sectors, such as fuels, land, water, environments, etc. the workshop only briefly covers coal and agriculture.
  - Present the concepts from a “practitioner’s perspective”

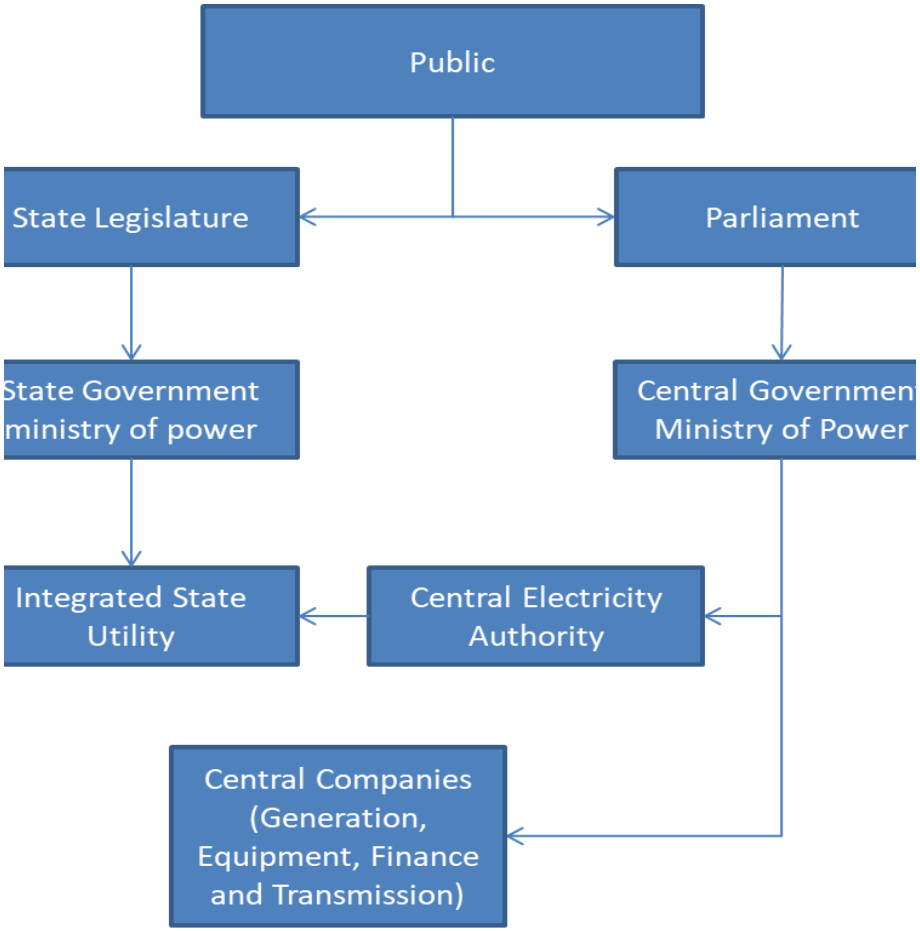
Legal and institutional overview

Training Workshop

Pune, February 11-12, 2019

Ashwini Chitnis

Institutional structure of the Indian power sector before reforms of 1990s



- Electricity (Supply) Act 1948 mandated formation of vertically integrated State Electricity Boards (SEBs)
- Central Electricity Authority (CEA) set up by the central government in 1951
- Through 1970s, many corporations were set up: River Valley Corporations (DVC, BBMB), NLC (lignite based power), DAE (nuclear power), REC (to give thrust to rural electrification), central generating companies (NTPC, NHPC, NEEPCO), and the central transmission company (POWERGRID)
- 70s and 80s witnessed significant growth in generation capacity and, in some states, also in rural and household electrification
- Decline in SEB performance and finances from 1980s onwards

First phase of the market oriented reforms: 1990 to 2003

- Thrust on “un-bundling” and privatisation
- Financial issues were seen as the only major problem and reforms were designed with a narrow focus of improving finances
- Reforms financed and encouraged by international funding agencies

- Major developments / policies of this period
  - 1992 Independent Power Producer’s policy (IPPs)
  - 1996 Odisha ERC act and subsequent privatisation
  - 1998 Electricity Regulatory Commission’s Act and establishment of CERC
  - Many state electricity acts as well as setting up of several SERCs
  - 2001 Delhi distribution sector privatisation
  - Enactment of the Electricity Act 2003

Major features of Electricity Act 2003

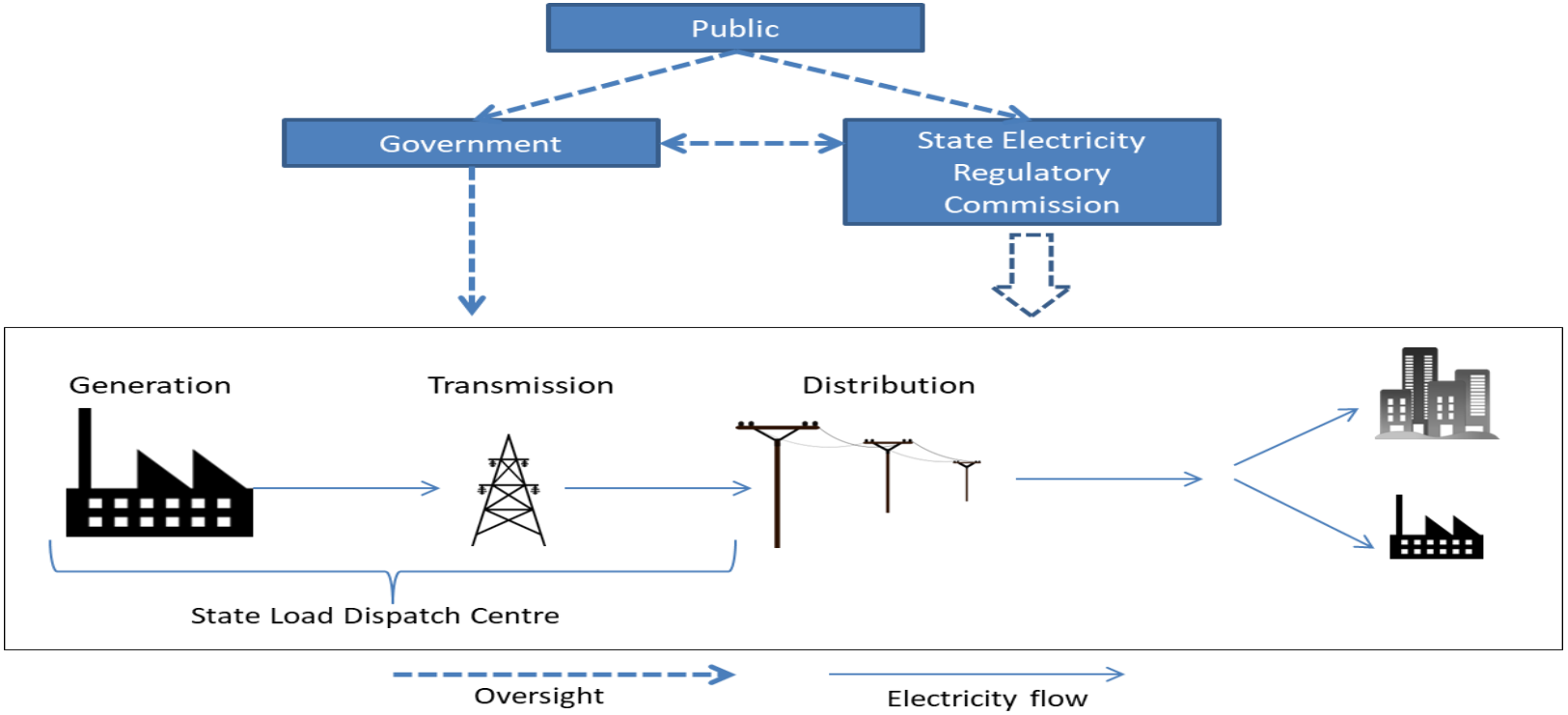
- Thrust on competition and markets
  - Un-bundling of SEBs and de-licensing generation
  - Non-discriminatory access to distribution and transmission wires (open access)
  - Creation of independent and autonomous load despatch centres
  - Recognition of electricity trading as a separate activity

- Protection of consumer interest
  - Three tier mechanism for grievance redressal
  - Standards of performance and compensation
  - Supply obligation, emphasis on metering, facilitating rural electrification, etc.

- Enhanced and empowered regulatory institution with improved provisions for transparency and public participation

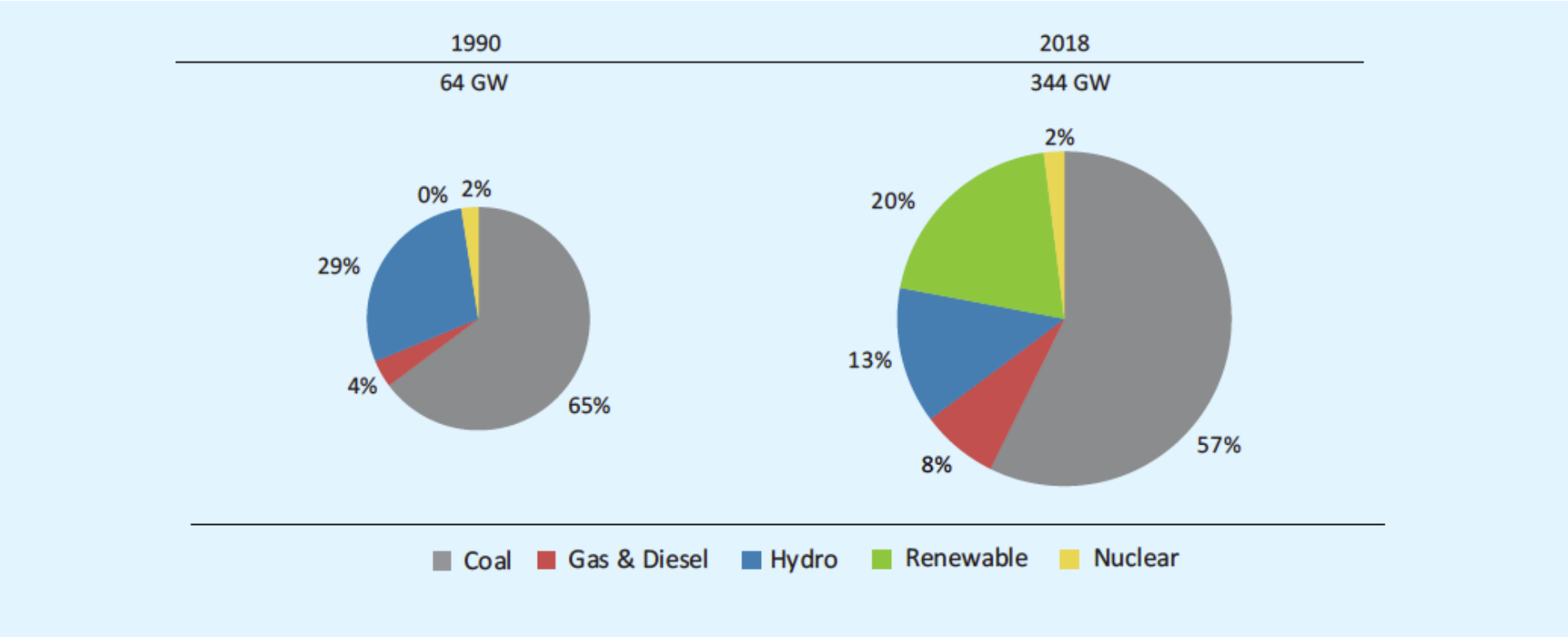
- Separate specialized appellate authority for expeditiously dealing with sector issues and disputes

A typical state electricity sector post 2003



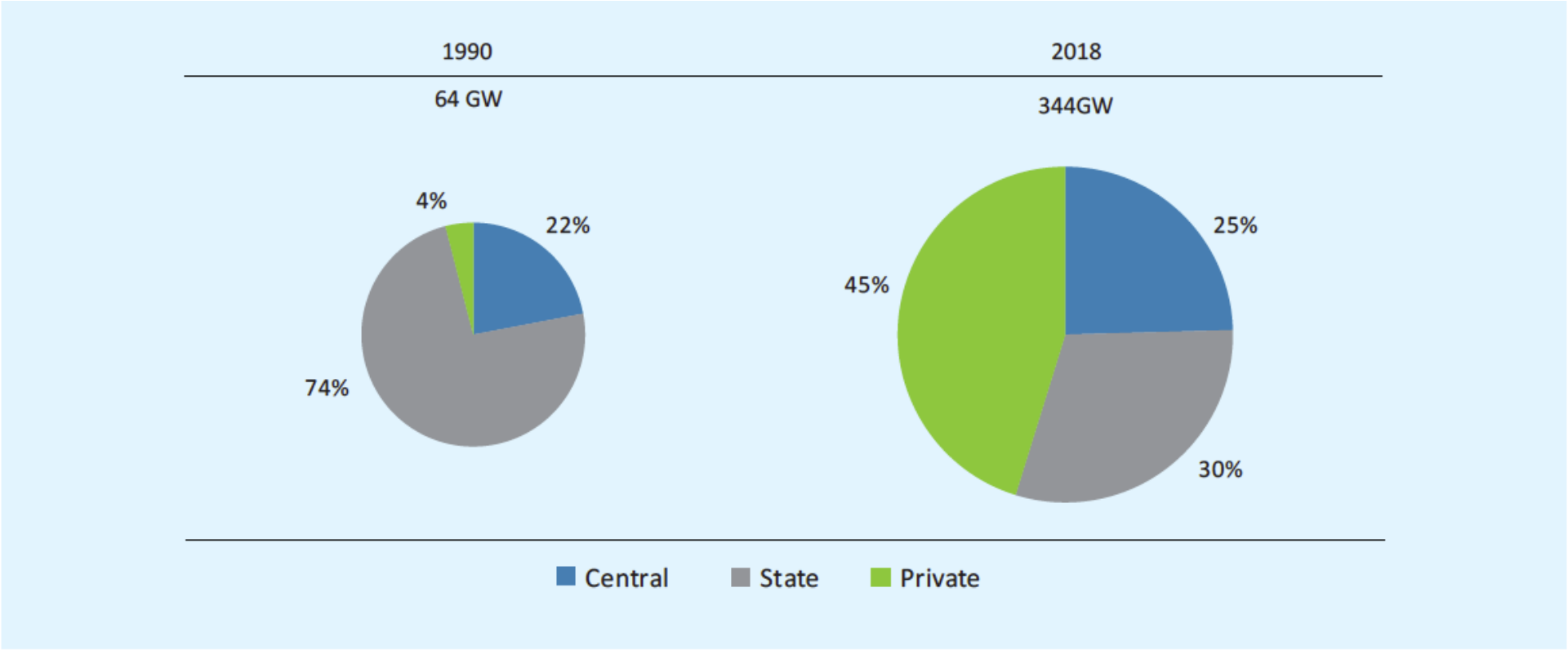
- Generation and transmission companies can be owned by the state government, the central government or by private companies.
- Distribution companies are mostly owned by the state government and, in some cases, by private companies.
- Load Dispatch Centres are independent bodies

Generation capacity-fuel mix 1990 and 2018



Source: CEA monthly report on installed capacity for March 2018

Generation capacity-ownership mix in 1990 and 2018



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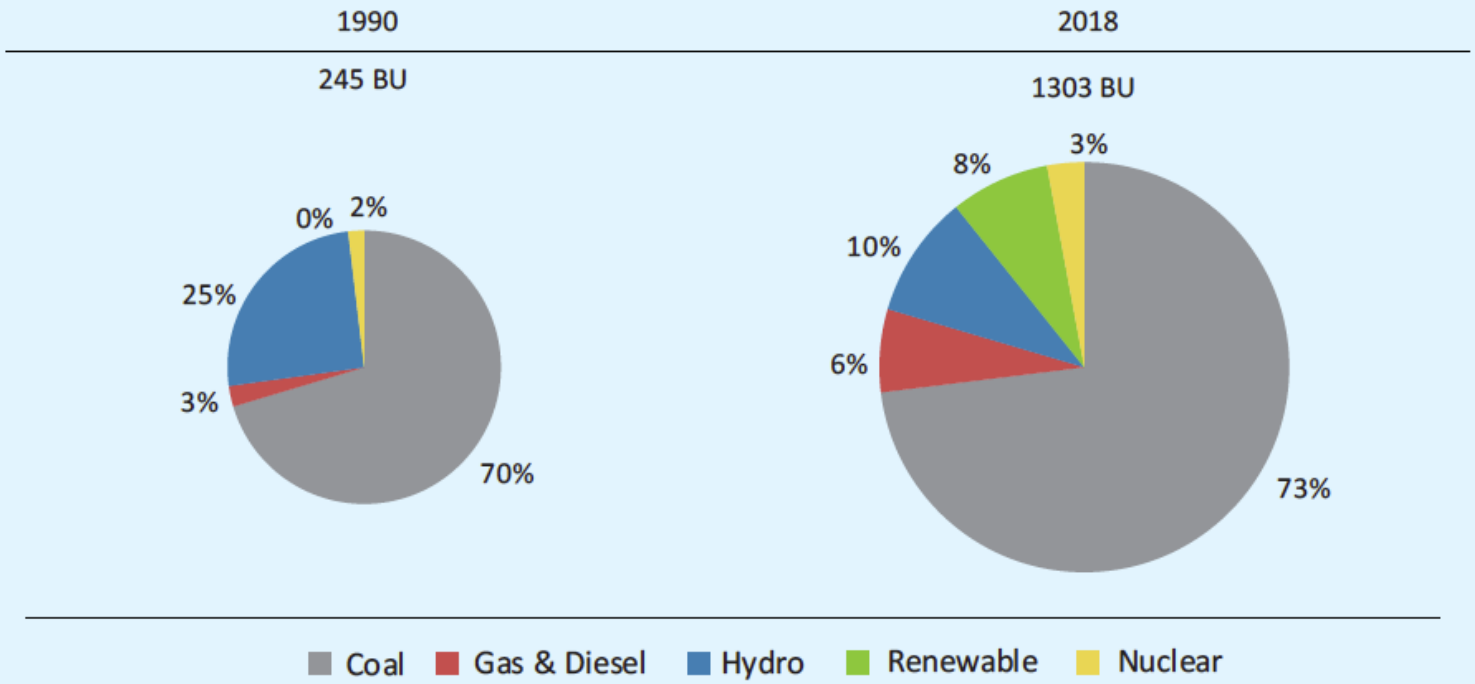
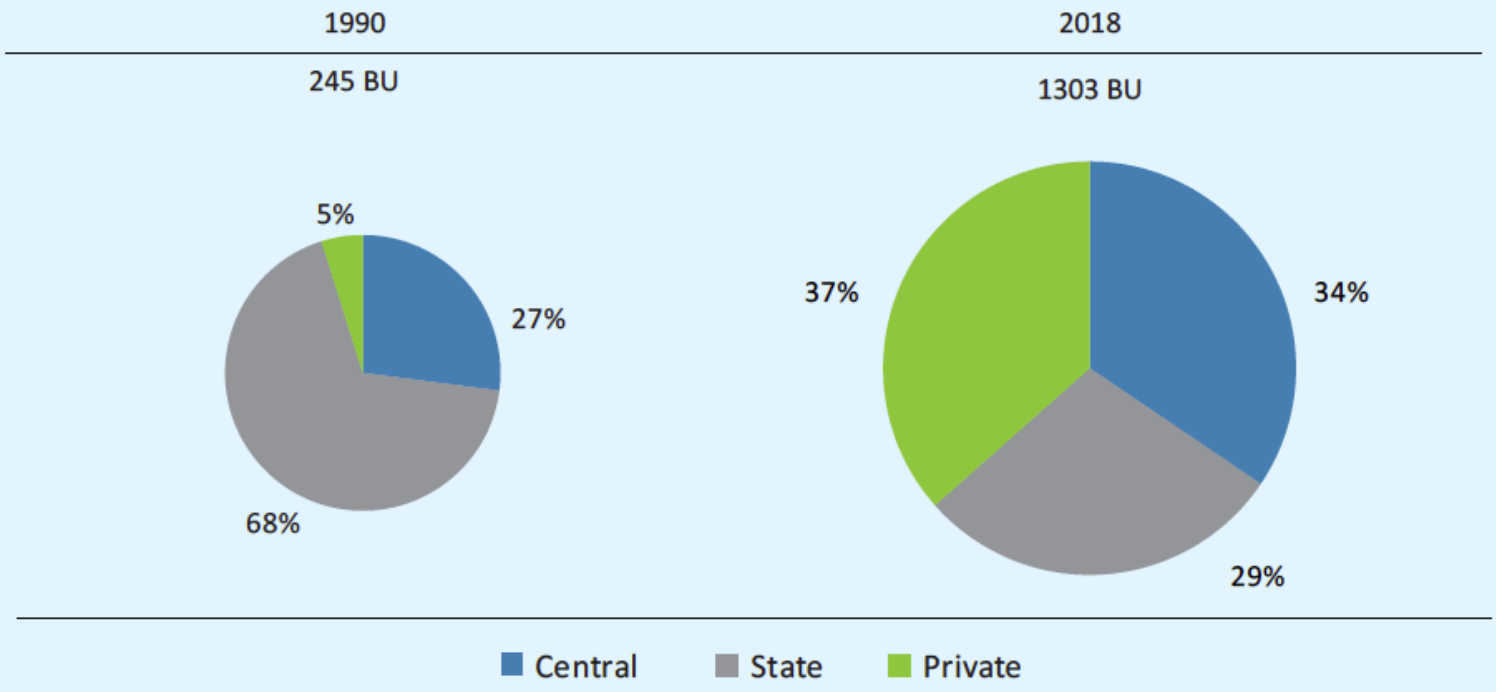
Generation-fuel mix 1990 and 2018



Source: CEA executive Summary for the month of March 2018 and CEA annual report for 2017-18

Generation-ownership mix 1990 and 2018



Source: CEA executive Summary for the month of March 2018 and CEA annual report for 2017-18

Thermal power – reform milestones

Competitive bidding (post Electricity Act)

- Major step forward
  - Guidelines for transparent process
  - Standard bidding document
  - Flexibility in terms of quoting escalable and non-escalable bid parameters
  - more than 42 GW of capacity added through this route

- Ultra mega power projects > 4000 MW super-critical multi-state projects
  - Government assistance in land acquisition, fuel allocation, environment an
  - 4 out of 10 identified sites awarded, 3 won by one company, 2 operational, 2 abandoned

- Challenges and issues
  - Tariff discovered through bidding seemed economical, but the gains mired by post bidding tariff revisions
  - Fuel production, availability, allocation and pricing related issues
  - Regulated projects: in-ability to control costs
  - Sharp increase in fixed costs of new units
    - Mostly on account of IDC, hard costs have not increased much

Fuel related issues

- Imported coal
  - Change in Indonesian regulation that increased price of imported coal

- Domestic coal
  - availability and quality issues leading to disputes and/or coal imports and hence increase in cost
  - Allocation issues
    - Ad-hoc and ambiguous allocation policy, both for linkages and captive blocks
    - Absence of institutional structure to ensure proper contract enforcement and delivery of coal of agreed quality and quantity
  - Uncertainty in pricing

- Gas
  - Lack of availability biggest challenges, imports too costly to be be viable
  - Capacity stranded for want of fuel

Inter-linkages and impacts

- Demand assessment and planning
  - Continues to be neglected in spite of failures since the IPP era
  - Dwindling consumer base with increasing open access and competitiveness of renewables, changing industry structure

- Most of non-performing assets are on account of fuel related issues

- Role of lenders and financial institutions
  - Failure in due-diligence

- Huge Environmental and socio-economic impacts

→ Failure to factor in the inter-linkages in planning has resulted in significant thermal capacity that is stranded

Large Hydropower – Reform issues

- Non transparent MoUs and negotiated tariffs
  - Maheshwar project: Rise in cost (6800 Cr for 400 MW), poor R&R, private to pubic, incomplete
- Himalayan projects based on high upfront payments
- Improper environmental & livelihood impact assessment, no cumulative and basin wide (2013 Uttarakhand floods)
- No proper policy and law for R&R of affected people
- No clear assessment of contribution to peak power
- Fundamental problems with privatising hydro, as determining "fair" cost is difficult (so cost-plus regime problematic) and bidding also difficult
- Project financing largely from public institutions

Large Hydropower – Status & Challenges

- Hydro power as a percent of capacity has been reducing from 1966 and is now lower than RE
- Private ownership increasing very slowly, low at 7.3% and investment is mostly public finance
- Most new projects in Himalayan, North East states
- Growing opposition to projects due to displacement, environment impacts and downstream impacts

Renewable – reform milestones

- 2003: Electricity Act, Renewable purchase obligations (RPOs)
- National Electricity Policy (2005) & National tariff Policy (2006): progressively increase RPOs, appropriate differential w.r.t conventional power, preferential tariffs
  - SERCs set yearly technology and state specific feed-in-tariffs
- 2009: National Solar Mission, competitive pricing.
- 2010: Renewable Energy Certificate (REC) Mechanism, CERC
- 2011: Amendment in tariff policy for solar RPOs (3% by 22)
- 2012: Cess on coal for National Clean Environment Fund (NCEF)
- 2015: 175 GW by 2022

Renewable – Status & Challenges

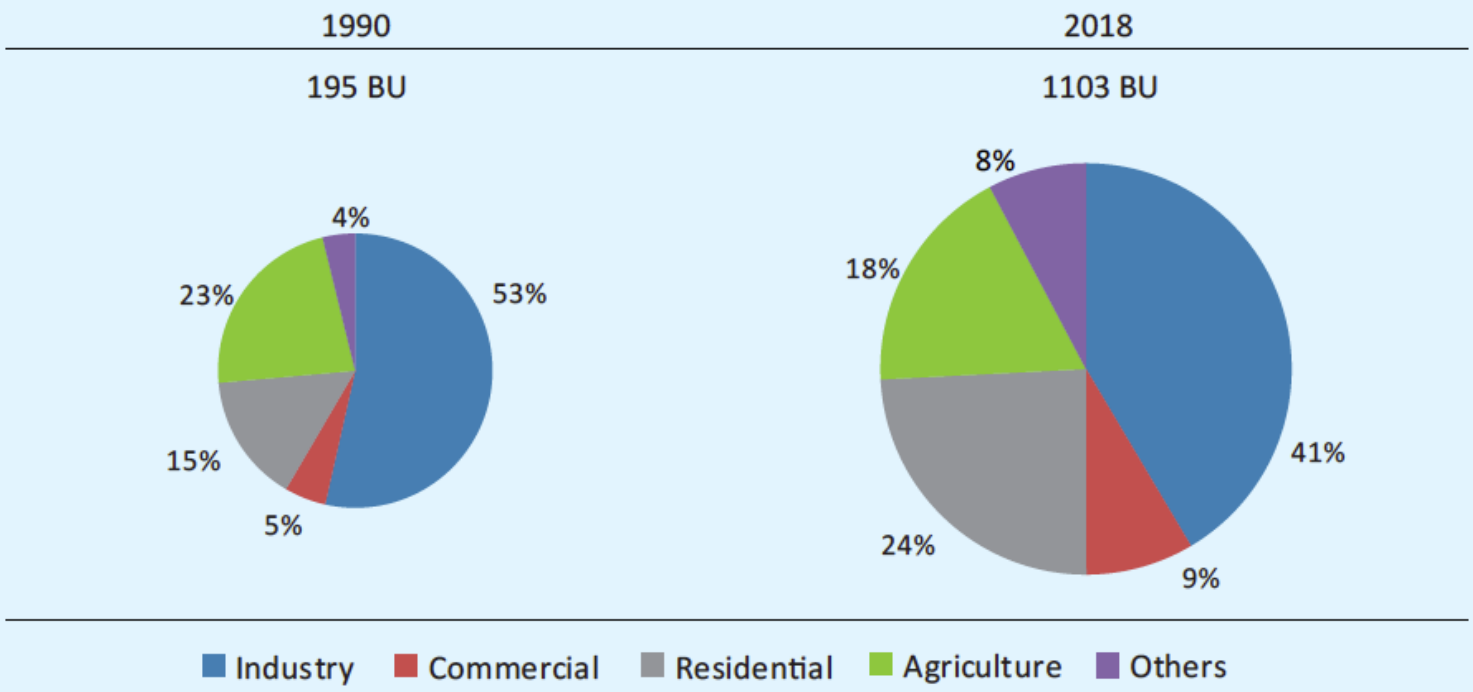
- With 42 GW capacity, era of treating renewables as marginal resource over; sector increasingly mainstreamed;
  - *RE has to confront issues faced by electricity sector in India and wider macro-economic aspects.*

- Being a variable source of energy, potentially entails higher system-integration costs.
  - Estimating and attributing any renewable-energy-specific integration costs is not an easy exercise

- In terms of energy cost, capacity addition in the future is likely to be less expensive than the long-term capacity currently contracted by the DISCOMs
  - APPC: ~ 3.5-4/kWh; new coal: Rs 4-5/kWh; new solar/wind: Rs 2.5-3/kWh (fixed over 25 yrs)

- Open questions
  - Long term national targets and its distribution across states
  - Will state DISCOMs with poor financial health buy RE power
  - How much RE can be reliably integrated into the central grid
  - Land issues

Electricity consumption mix 1990 and 2017-18 (estimated)



Source: CEA report "Growth of Electricity Sector in India from 1947 - 2018"

Distribution sector – status and challenges -1

- SEB unbundling and corporatisation
  - Transfer scheme not complete
  - State Corporations not behaving like companies

- Distribution privatisation
  - Odisha failure: Public to private to public to private?
  - Better model in Delhi, but issues of high regulatory asset and regulatory challenges
  - Franchisees: Failure in rural model, mixed result in urban
  - Special case of Mumbai

- Power purchase
  - Serious issues in demand estimation and power purchase planning – periodic shortage and surplus
    - Maharashtra, Gujarat, Punjab, MP, AP, TS – 20% or more surplus
  - Weak implementation of energy efficiency

- Electricity markets
  - Slow progress with open access, markets

Distribution sector – status and challenges -2

- One nation one grid – lot of progress

- T&D Loss reduction
  - 23% in 1990, 21% in 2016-17 – Figures questionable
  - Many central programs from 2000 (IPDS now), progress in some DISCOMs, especially in urban areas

- Weak financial health
  - Growing financial losses of DISCOMs
  - Reasons: No tariff increase, T&D loss, non payment of subsidy, power purchase planning issues and heavy borrowing
  - Three financial bail outs - 2001 (0.42 lakh cr), 2012 (1.19 lakh cr), 2015 UDAY (~ 2 lakh cr)

Distribution sector – status and challenges -3

- Rural and household electrification
  - Not a focus in initial years of reform
  - Claims of almost 100% household electrification, but still a long way to go for 24 X 7 power for all
    - Reliablity, affordability, and safety remain key challeges

- Agriculture supply and consumption estimation issues continue to be a major challenge

- Emerging issues
  - Sales migration, large scale addition of renewable energy sources, burden of past losses and stranded assets
  - Changing consumer mix and loss of cross-subsidy will require fundamental re-thinking of existing distribution business model

Regulatory Commissions and Appellate tribunal

- Introduced transparency and created space for public participation
- Many challenges regarding capacity, appointments, autonomy, and indpendence
- Focus has been limited to tariff and issues concerning financial viability
  - Few proactive steps for furthering access, improving supply and service quality or monitoring of large scale public programmes
- Increasingly becoming more legalistic
- Many access barriers: location, fees, procedures, etc.
  - Not accessible for common consumers

Major changes in the electricity and related sectors since 1990

Area	Pre-reform, before 1990	Current status (2018)
Utility structure	Integrated SEB, with the functions of generation, transmission and distribution	Most SEBs unbundled into generation, transmission and distribution companies
Ownership pattern	Mostly with the government - central or state	Large presence of private players in generation, moderate presence in distribution, growing presence in transmission
Policy	Policy making largely by state and central governments. Electricity considered a major development input	In policy making, influence of international funding agencies during the beginning of reforms, increasing role of central government and private players in subsequent years. Electricity transitioning towards a market commodity
Electricity regulation	Directly by the central and state governments	By regulatory commissions appointed by the central and state governments
Electricity markets	Not present	Increasing role of markets facilitated by open access, trading, merchant power plants and power exchanges. Competitive bidding, a market feature has been introduced in areas like franchisees, coal allocation, and capacity addition in generation and transmission.
Renewable energy	Very less, only small hydro, small pilots—not connected to grid	Significant rise in capacity and generation. Capacity added mostly through bidding and by private sector. Ambitious plans going forward.
Coal sector	Supply by government owned companies	Growth in production, but shortages and imports persist. Some attempts at privatisation, linkage auctions, commercial mining, and regulation. Ambitious targets for increasing domestic production and reducing imports
Gas sector	Few government companies, moderate imports	High imports, few private companies also, regulation for downstream.

Lessons for way forward

- No blue print or silver bullet
  - No black & white answers to public Vs private, monopoly Vs competition, coal Vs renewable, centralised grid Vs distributed
- Clear prioritisation of objectives
  - Electricity as a commodity or an input for development?
- Agile & comprehensive planning
  - Future of the conventional utility model?
- Transparent, accountable, capable institutions
- Participative policy making and regulation
- Enhancing competition

- **State has a key role – as an active participant and a non-partisan referee**

Technical Concepts

Training Workshop

Pune, February 11-12, 2019

Sreekumar N

Technical Concepts

- Not a session on Electrical Engineering
- A quick overview of technical concepts for understanding
  - Policy and Planning
  - Regulation
  - Operation
- Because
  - Tariff, supply & service quality depend on policy, planning, regulation and operation

Functional components of the sector

- Technical
  - Generation
  - Transmission – bulk transport (grid, 132 kV and above)
  - Distribution – retail transport (radial, 33 kV and below)
  - End-use
  - System Operation
- Two models
  1. **Many large generating stations, grid spread over states or countries**
  2. Small generators, stand alone, micro grid or grid interactive – same concepts apply
- Commercial – supply, billing and collection
  - Whole sale – trading, exchanges
  - Retail – to small consumers
- Management
  - Law, Policy, Planning
  - Regulation

Electricity is the most versatile form of energy

- Easy to transport
- Easy to convert to other forms
- Non polluting at the point of use/transport

Electricity is the most versatile form of energy

So what?

- Cost effective for
  - Motive power (industry, transport, weather conditioning … 3-phase)
  - Lighting
- Essential for
  - Electrolysis, welding
  - Electronic appliances, Communication, Medical appliances …
- Use is not very sensitive to price
- Percent share in the energy use is 15% and growing
- Not cost effective for
  - Resistance Heating, but OK for induction heating

Electricity travels nearly at the speed of light

So what?

- Fast coordinated actions needed
- Some without human intervention (protection, speed governor, capacitor switching ..)
- Some by the operator (plant control, load dispatch, hierarchy ..)

Electricity takes the path of least resistance

All electrons are equal. They obey of the laws of Physics, not contract

So what?

- Possible overloads (congestion) of lines/transformers, which need to be managed
- Extensive on-line measurements and complex calculations needed to guide the system operator
- Need special provisions to control flow as per contract terms
- Need to protect from lightening and ground faults
- Essential to provide and maintain proper earthing, especially for appliances to reduce shock hazards

Demand for Electricity keeps changing with time and place

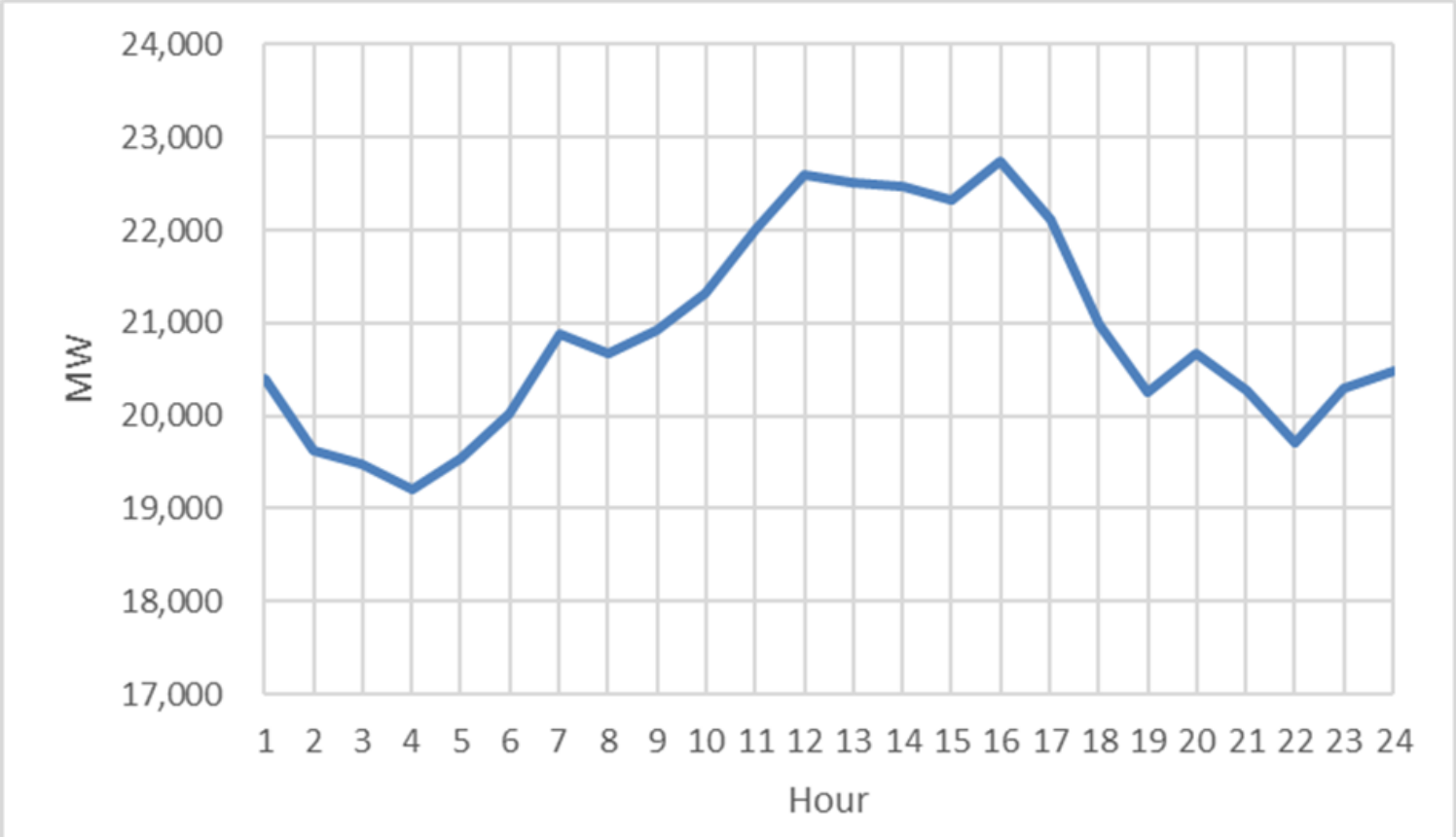
Second to second, day to day, season to season, year to year, place to place …

So what?

- Generation or Demand has to change to maintain the balance
  - Supply & Demand side mechanisms
- Integrated grid offers better optimisation (State, Region, Country, Continent)
- Need to have Reserve Margins

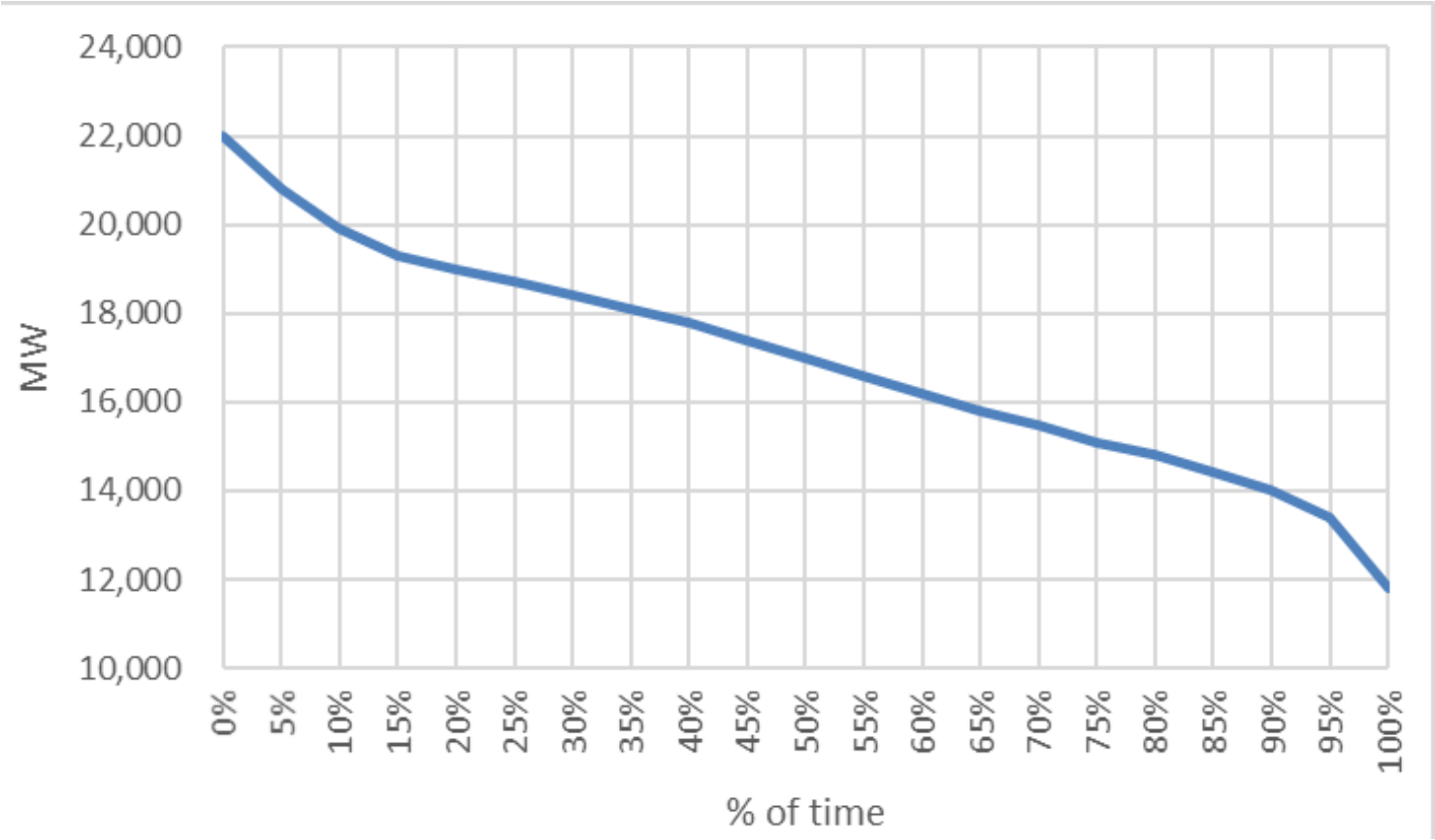
Load curve - daily

- Peak, off peak, base load
- Tariff implications (Two part, ToD)
- Demand Side Management
- MW, MU, Load Factor, Diversity Factor, PLF



Load duration curve - yearly

- Base load (Nuclear, Coal), Peaking (Hydro, Gas, Battery), Variable (Wind, solar)
- Seasonal variation: Scheduling
- Generation expansion planning



Electricity cannot be stored in large quantities yet …

Water or Chemical storage is limited, costly as of now

So what?

- Generation to match consumption at every instant
- System reliability is a common interest, but individual players may act in contrary fashion
- Mechanisms needed to handle small mismatch
- Large, persistent mismatch leads to system breakdown

Operating the grid

- Generating stations: 600
- Grid substations: 750
- Transmission companies: 30
- Distribution companies: 70
- Transmission lines: 4 lakh ckm
  - 10 times earth's circumference
- Managing the grid
  - Protection systems
  - Scheduling generation, maintenance
  - Handling variations by managing two key parameters
    - Frequency - Active Power
    - Voltage – Reactive Power
  - Grid code, Deviation and Settlement Mechanism

Indian Electricity Grid Code, Demand and Settlement Mechanism

- **IEGC**
  - Prepared by CERC in 2000, periodically revised
  - Rules/guidelines for generators, bulk consumers and transmission companies to connect to the grid, as well as for Load Dispatch Centres etc
  - State Grid Code along similar lines
  - Voltages and Frequency levels to be maintained and penalties for violation

- **Unscheduled Interchange (UI) and DSM –** financial carrot & stick to enforce grid discipline

  UI part of Availability Based Tariff (ABT) 2000

  Capacity charge – based on schedule

  Energy charge- based on schedule

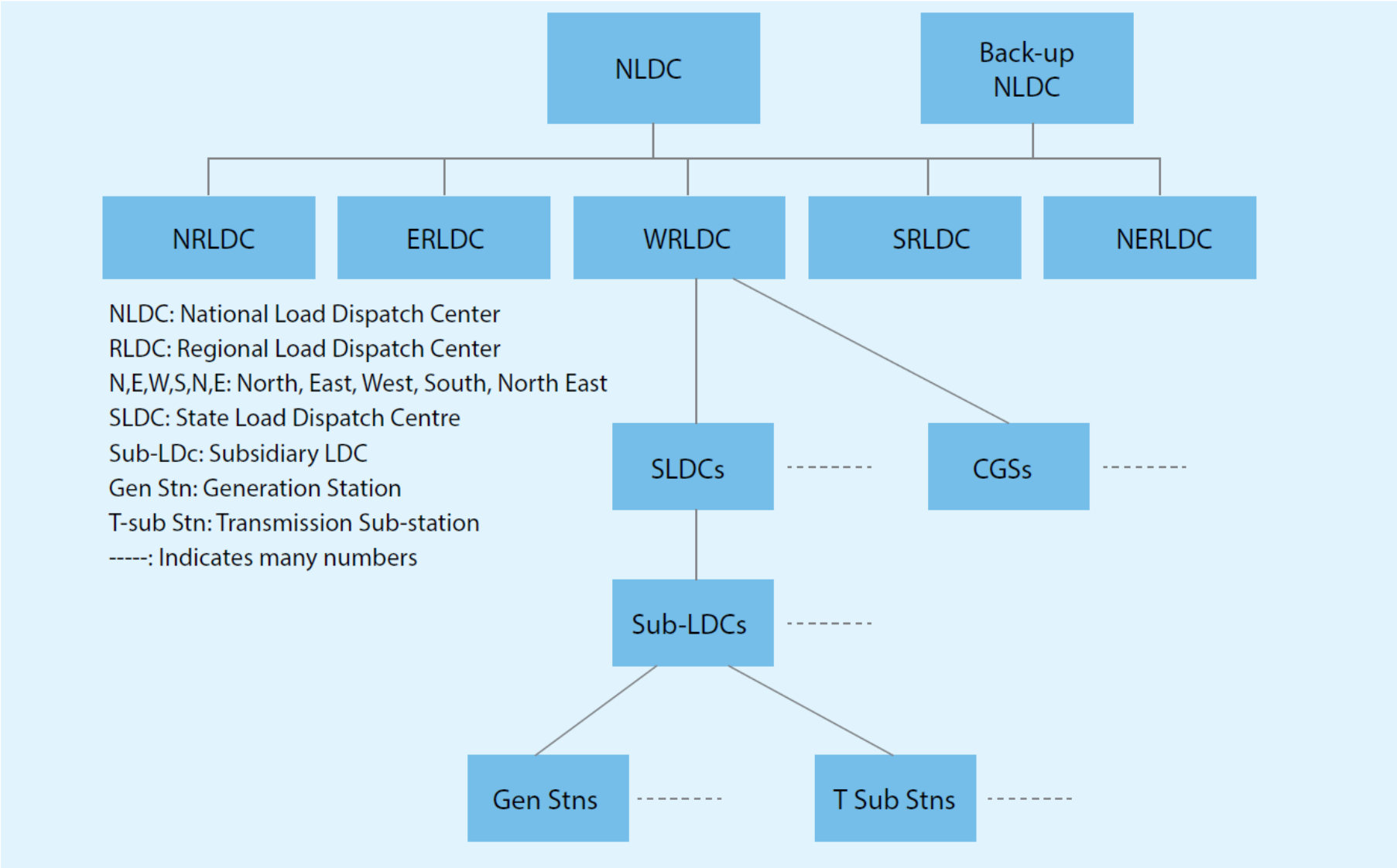
  UI charge – based on deviations from schedule and depending on frequency

  DSM replaced UI in 2014

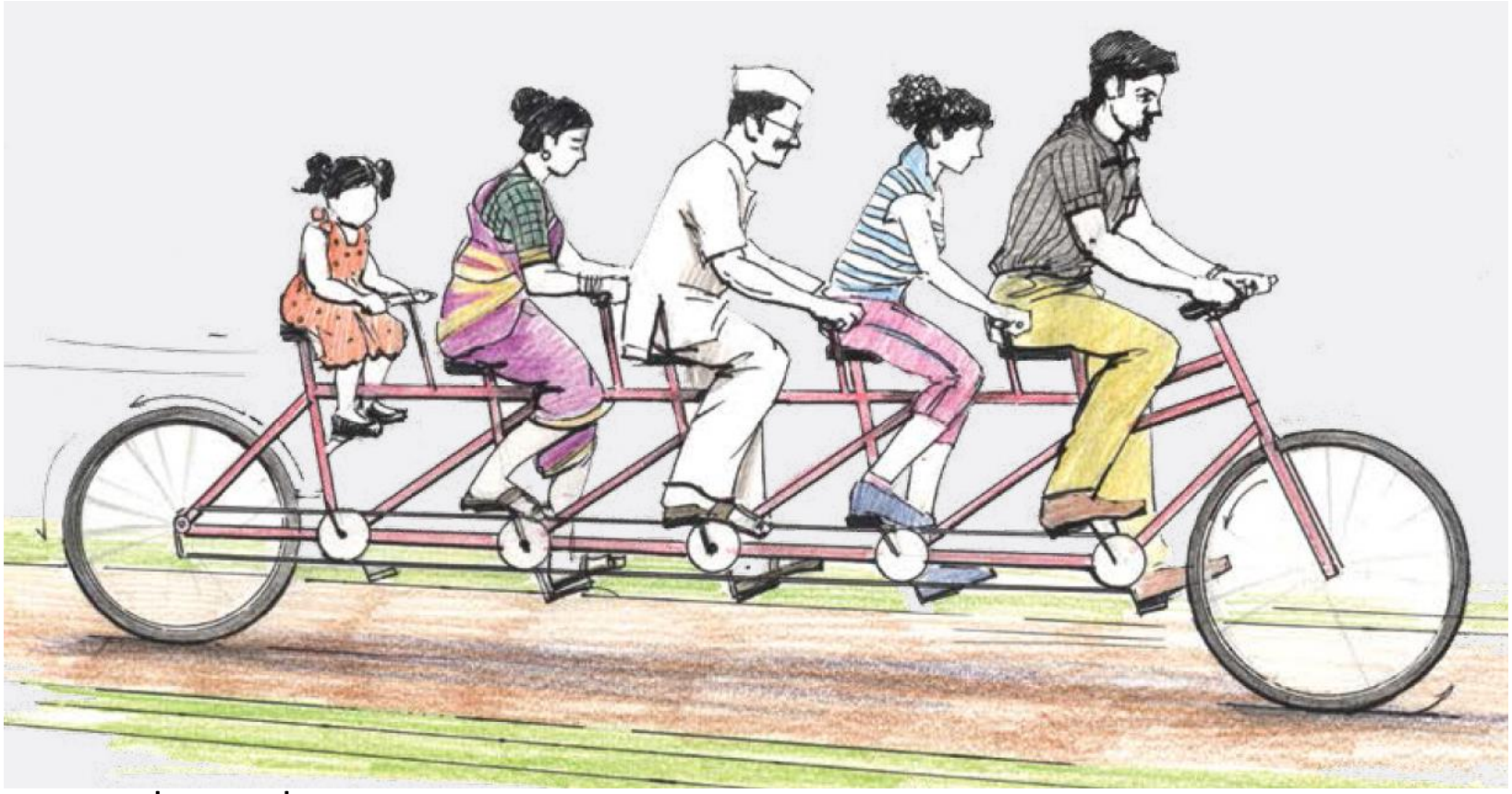
  Tighter frequency band - 50.05 – 49.85

  Limits on volume of unscheduled interchange

Load dispatch hierarchy



Riding a cycle to understand grid operation



Cycle balance and speed

- Generators
- Loads
- Right side and left side riders
- Shifting seats
- Line and Neutral

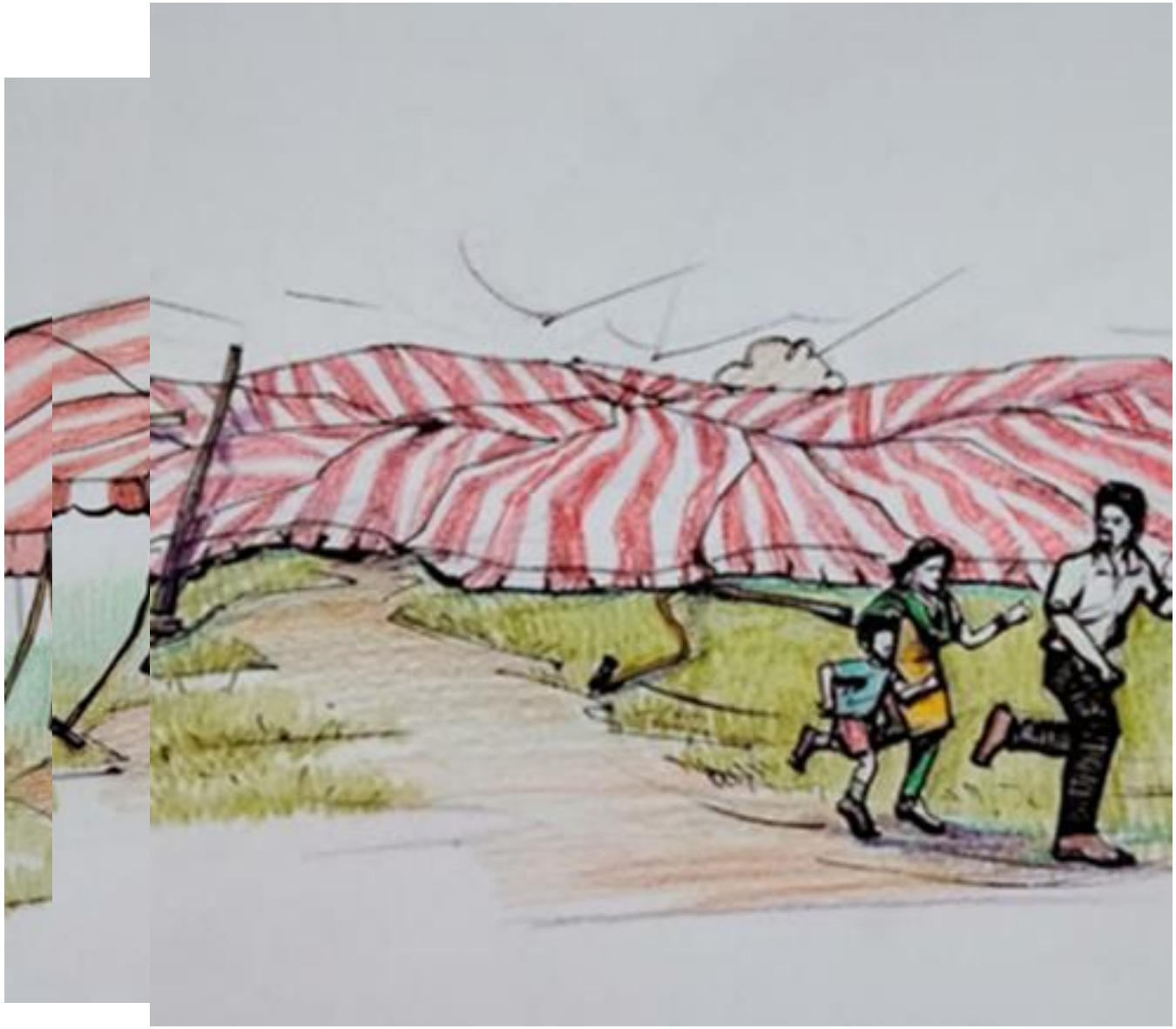
Mismanagement can lead to grid collapse

Pole= Generator

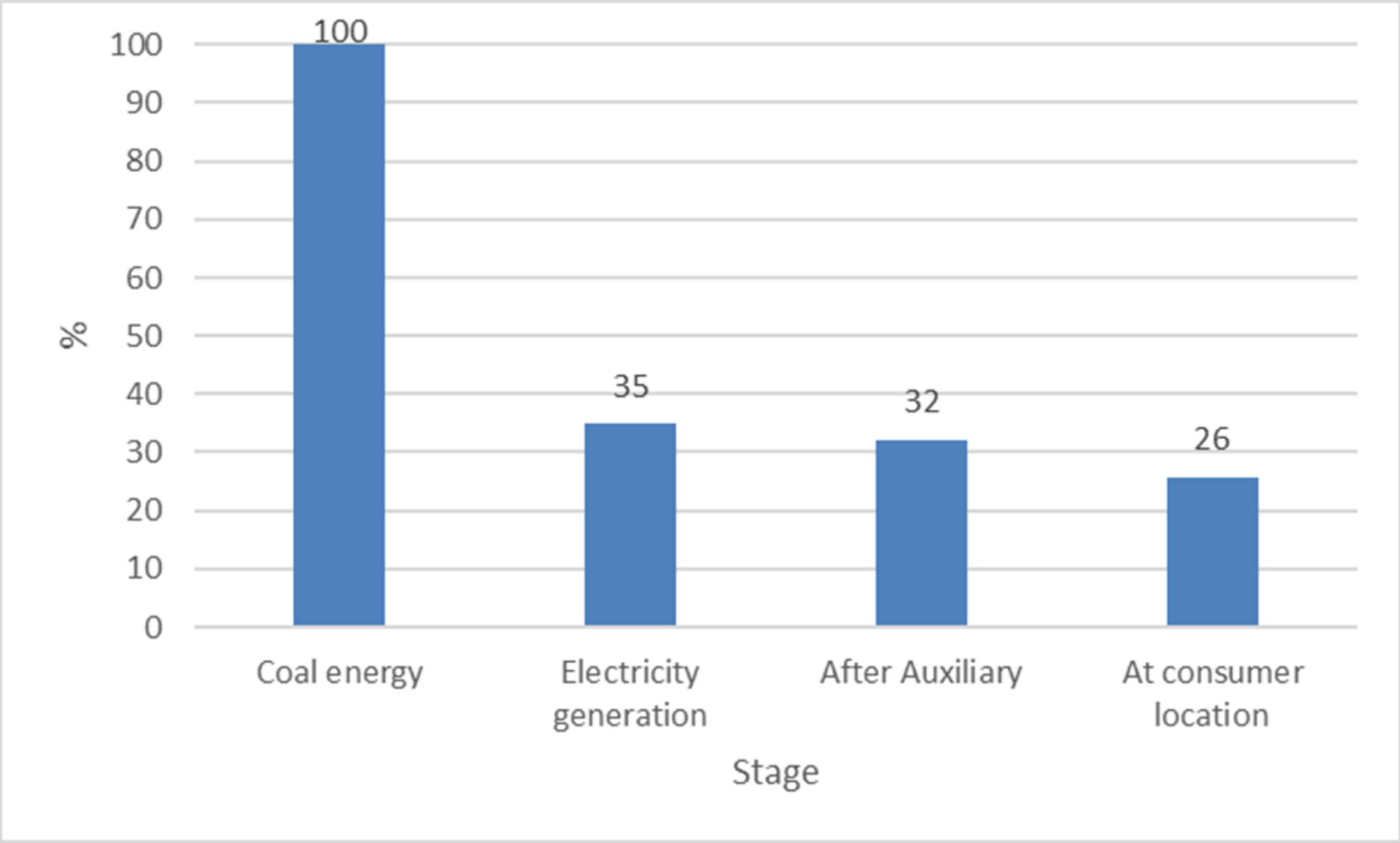
Tent weight = Load

Tent rope = Grid

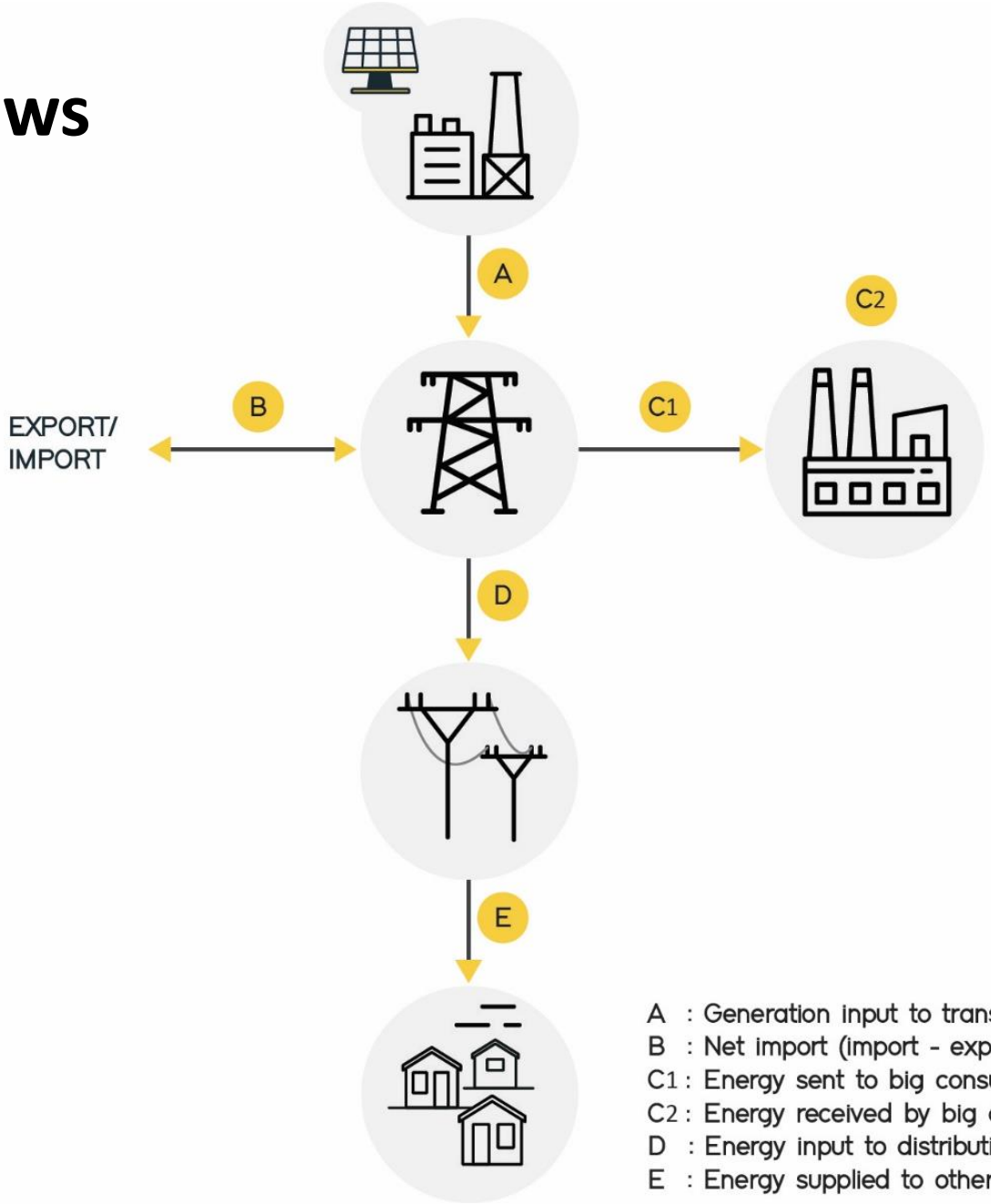
Priority order
Reliability/Resilience
Quality
Economy



There are losses at each stage



Energy flows



A : Generation input to transmission
B : Net import (import - export)
C1 : Energy sent to big consumers
C2 : Energy received by big consumers
D : Energy input to distribution
E : Energy supplied to other consumers

Aggregate Technical & Commercial Loss

Input Energy = 100 units

Distribution Network

Technical Loss = 10%

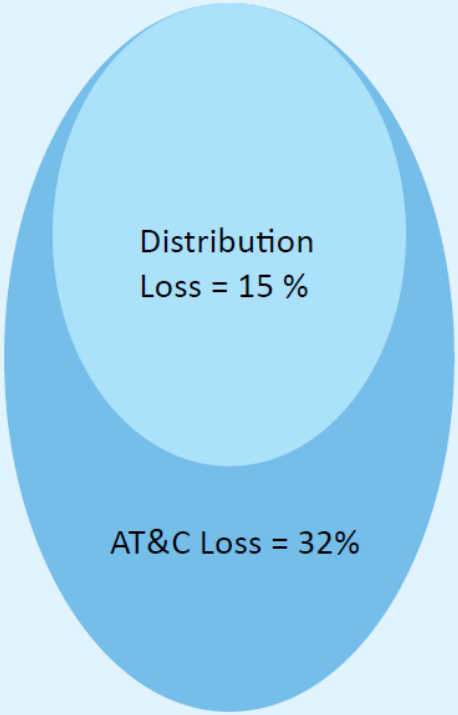
Non-technical Loss = 5%

Billed Energy = 85 units = 340 Rs (@ 4 Rs/unit)

Consumer Billing & Collection System

Collection Loss = 20 %

Collected Amount = 272 Rs = 68 units (@ 4 Rs/ Unit)



Distribution Loss = (100-85)/100 = 15 %

Billing Efficiency = (85)/100 = 85%

Collection Efficiency = 272/340 = 80%

AT&C Loss = (100-68)/100 = 32%

Supply and service quality

- Cost implications (to utility and consumer)
- Is related to investment and management
- Different consumers have different demands
- Technical Indicators
  - Frequency variation
  - Voltage variation
  - Phase Imbalance, Harmonics, Power factor
  - Supply reliability
- Service related indicators
  - Power outage, repair time
  - Bill and Meter complaints
  - Shock accidents
  - Requests about connections, category change, net metering etc

Overview of the Indian coal sector

Ashok Sreenivas, Prayas (Energy Group), Pune

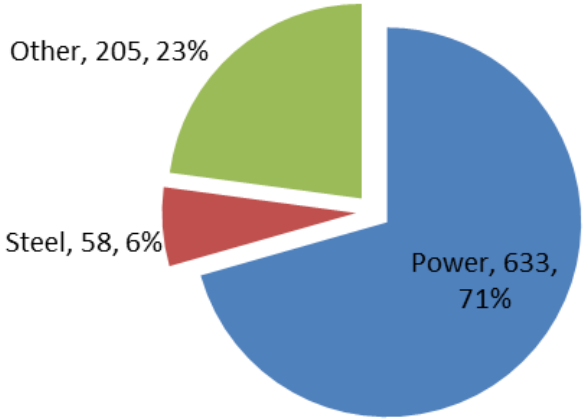
Towards improving service delivery and sector health through multi-disciplinary skills in electricity sector

February 2019

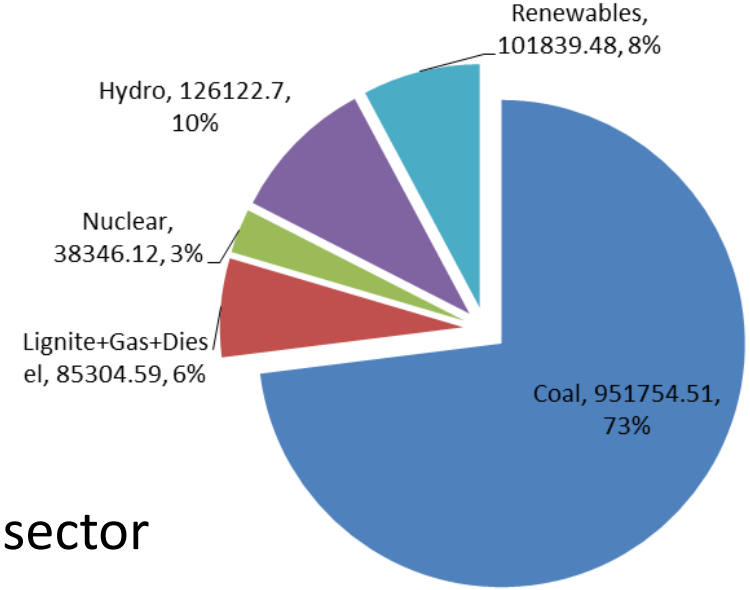
COAL SECTOR IN NUMBERS

Coal and power: the Siamese twins (as of now)

Sectoral distribution of coal consumption 2017-18

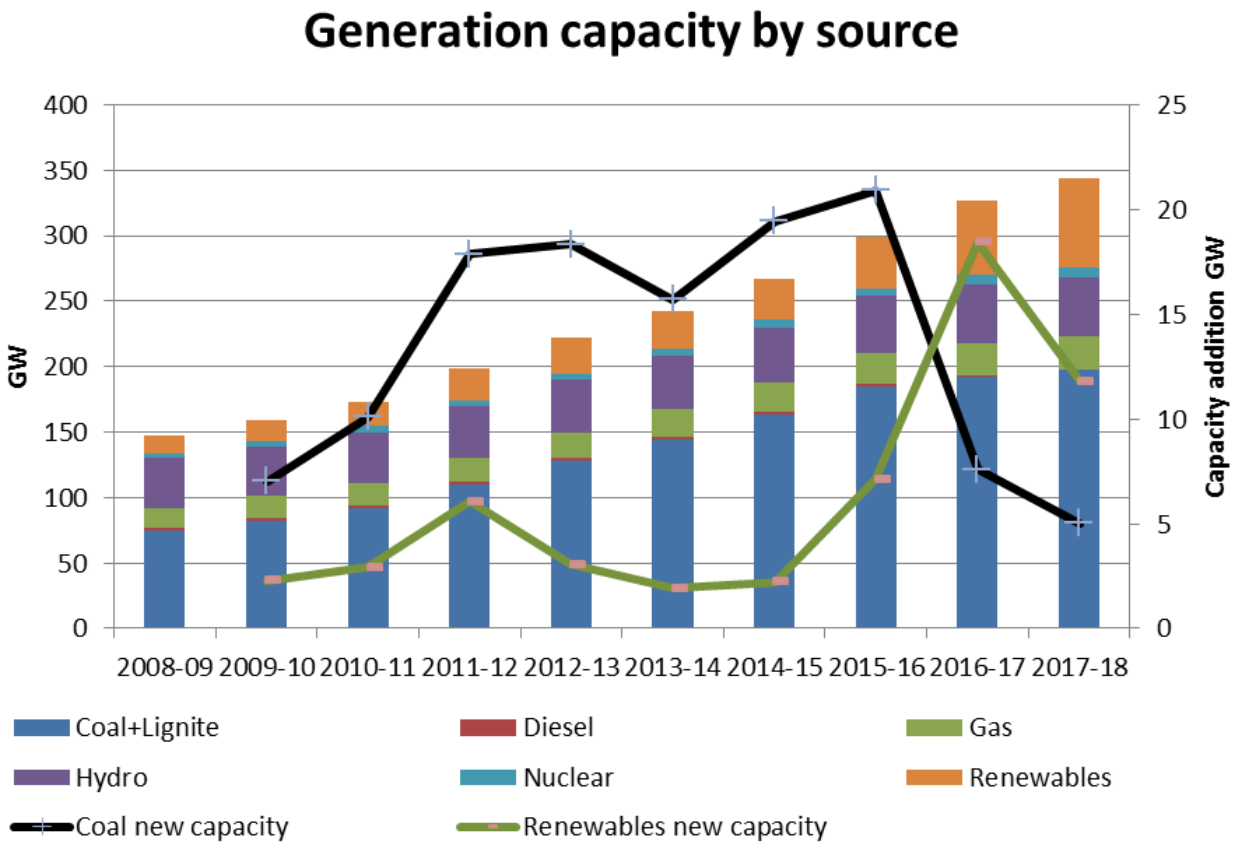


Electricity generation by source 2017-18



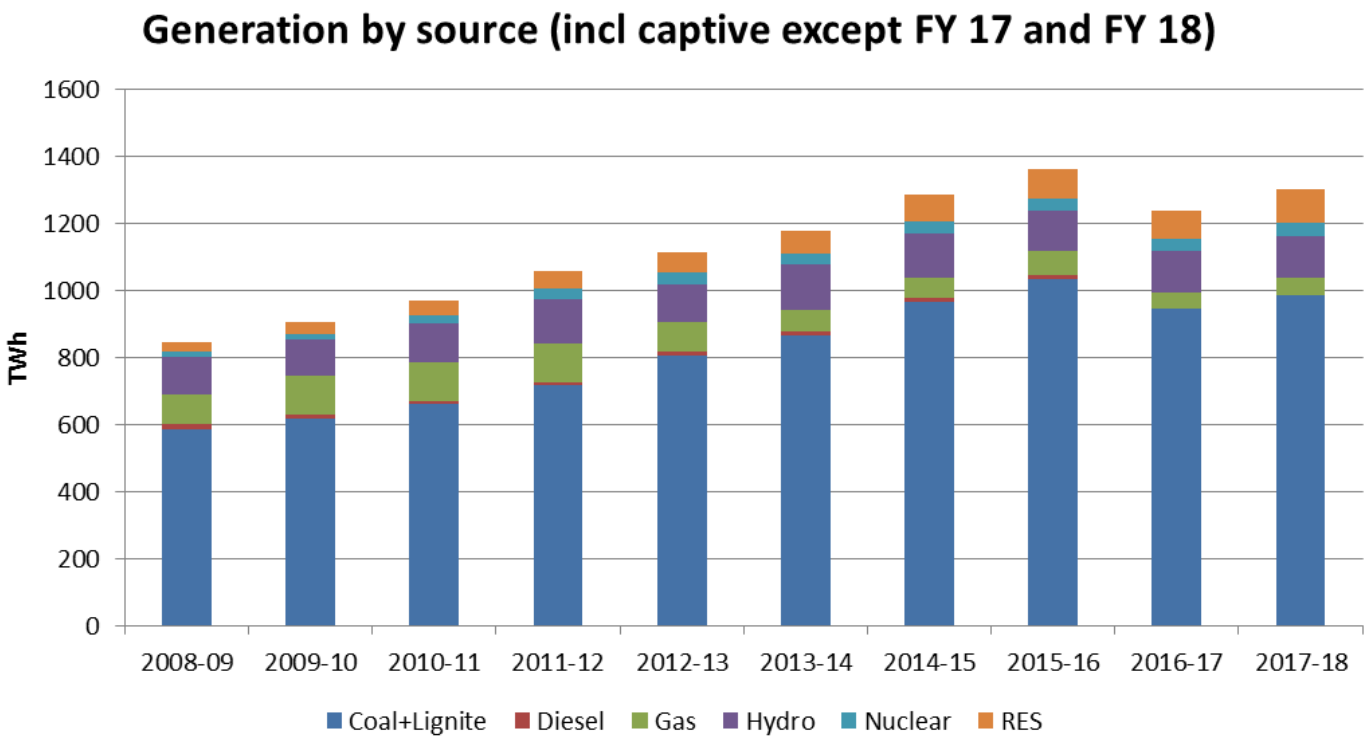
- ~70% of coal gets used in power sector
- ~75% of power comes from coal
  - Gradually reducing but will be big for some time
- Hence coal sector functioning, policies important for power sector

Electricity capacity by source



- Share of coal still very high
- But, dramatic change in new capacity addition recently

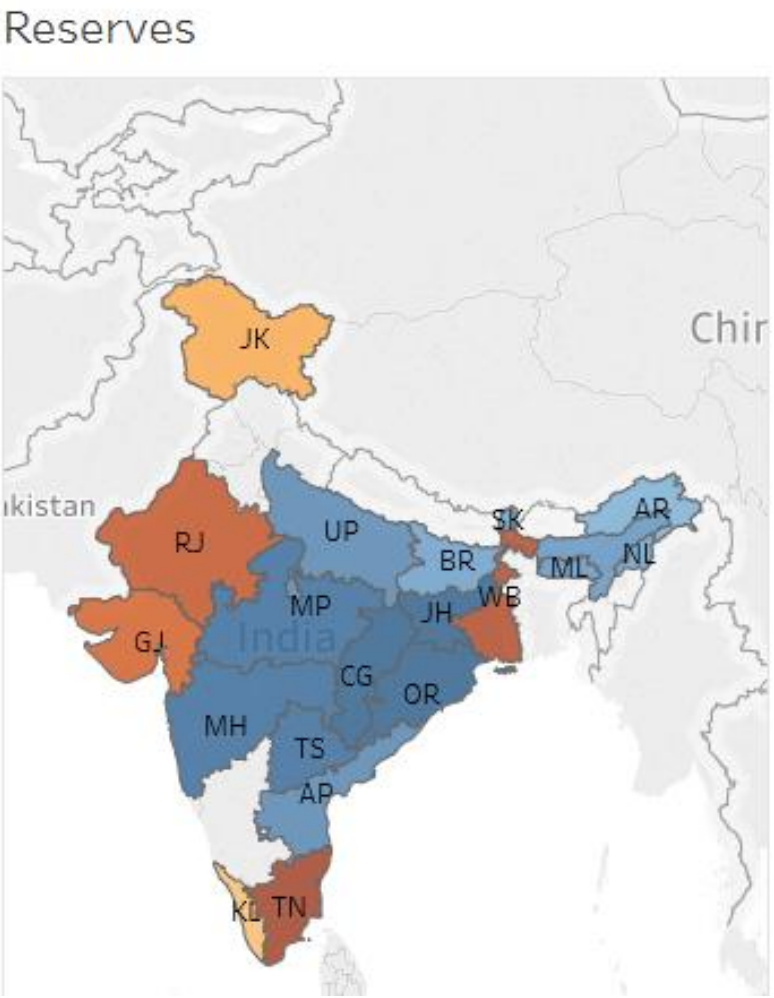
Electricity generation by source



- Role of coal even more prominent in generation
- But renewables share gradually picking up

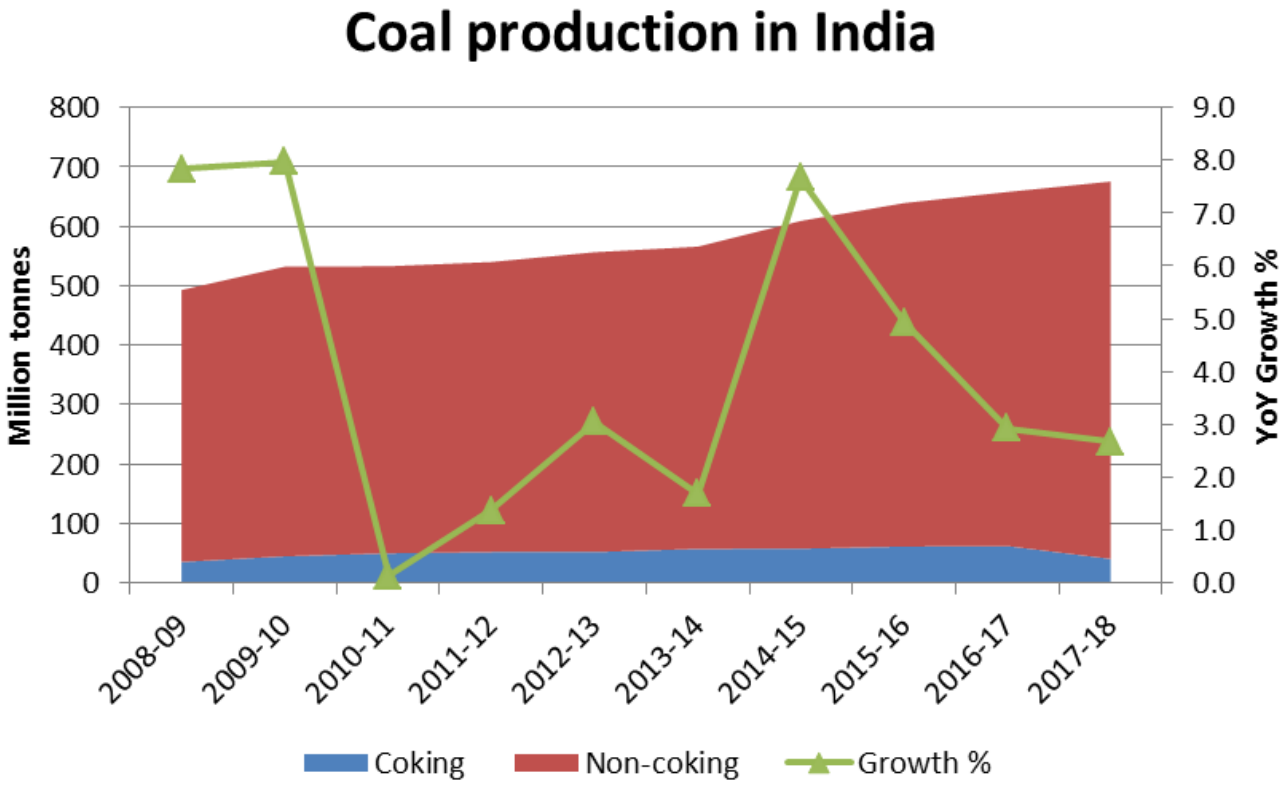
Coal reserves in India

- Concentrated along East of country
- Proved resources > 130 bn tonnes
- Economically extractable reserves much lesser (~60 bn tonnes?)
- Enough for ~80 years at current rates of production
- Typically poor quality
  - High ash
  - Low calorific value

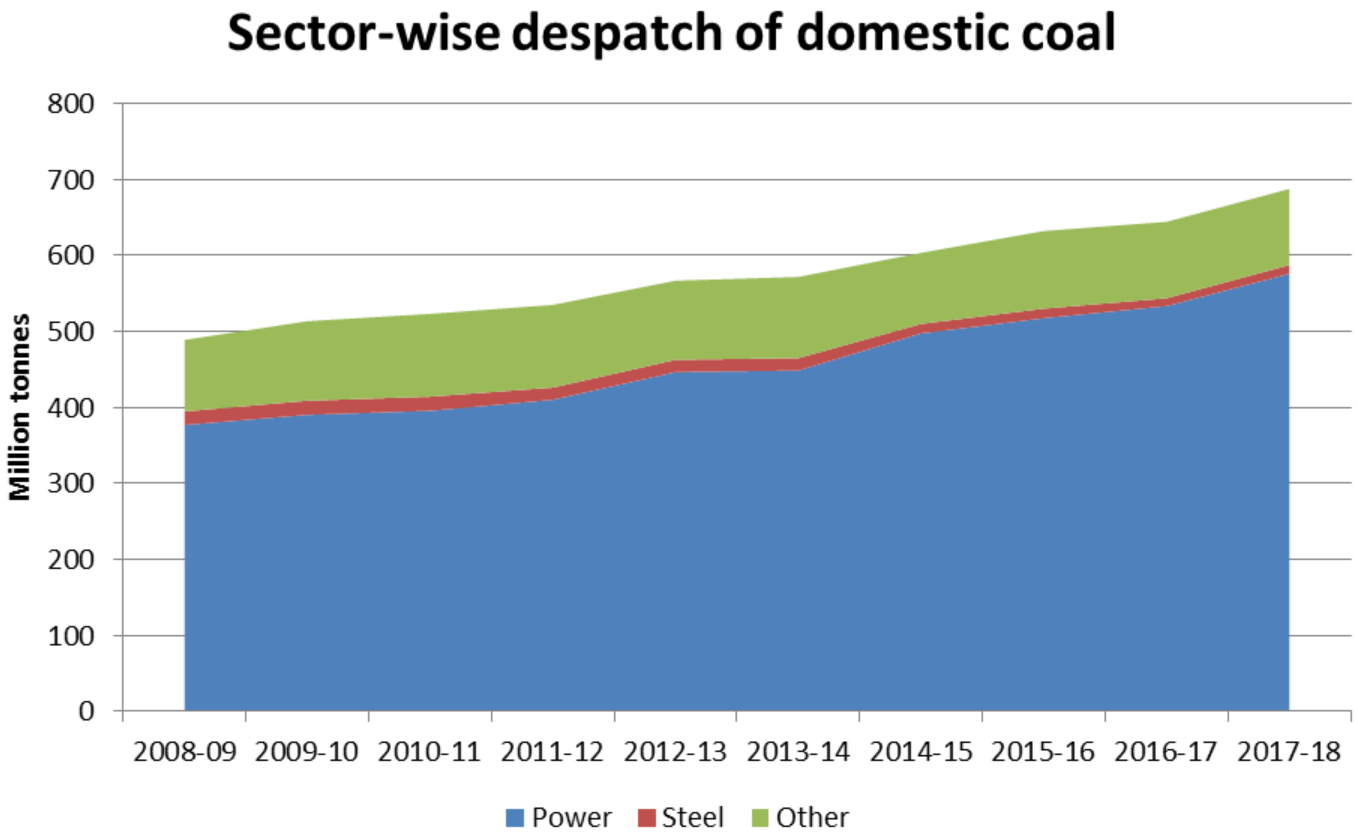


Coal production

- ~675 MT of coal produced in FY18
- Bulk of production is non-coking coal
  - Used in power generation
- Steadily increasing
  - But erratic spurts and dips in YoY growth

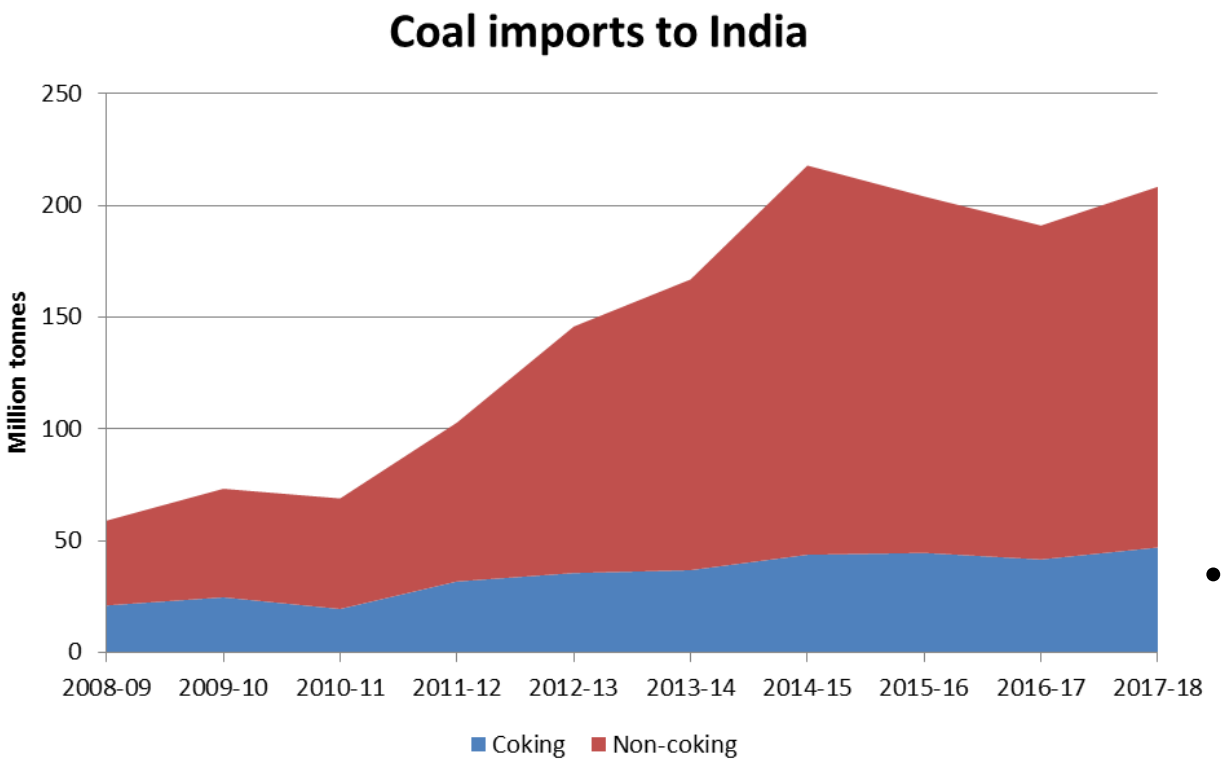


Domestic coal dispatch by sector



- Power the only growing sector
  - ↑ by 53% in 9 years
- In contrast
  - Dispatch to steel sector ↓ by 35%
  - "Other" ↑ by 6%

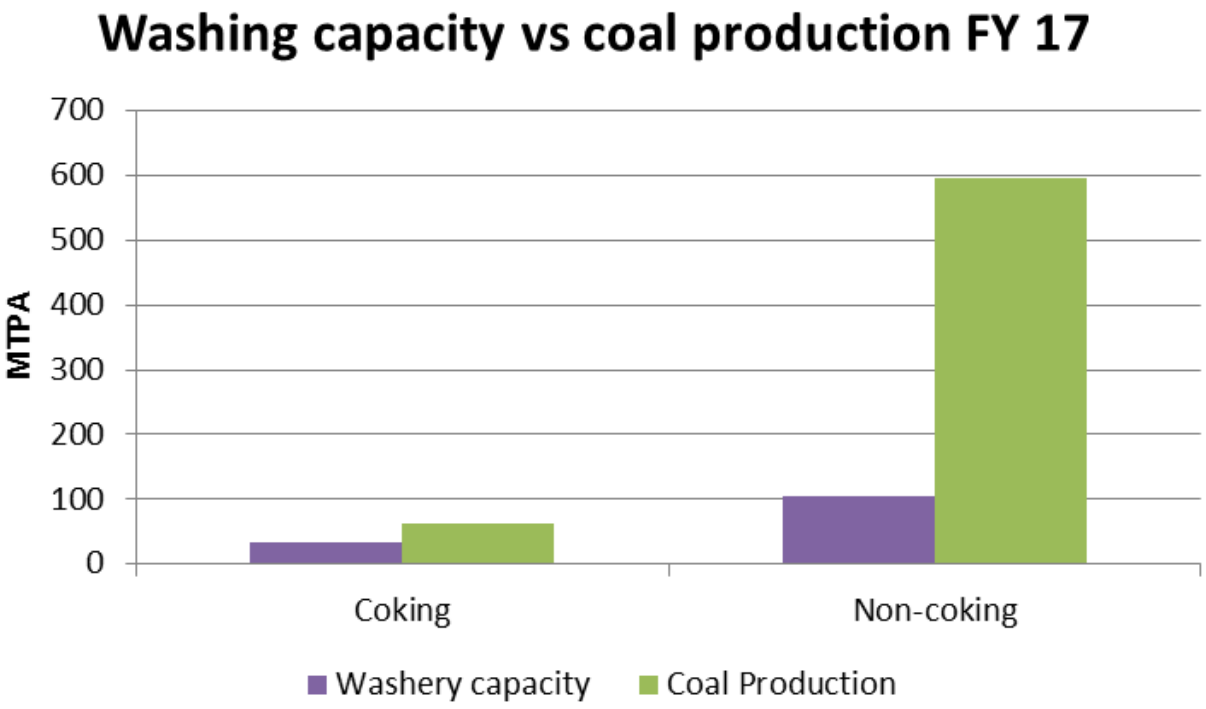
Coal imports



- Massive spike in import of non-coking coal post 2010
  - Spike in thermal generation capacity + irrational coal allocation
  - Inability, unaccountability of CIL to produce and supply
- Slight fall in last few years but still significant imports

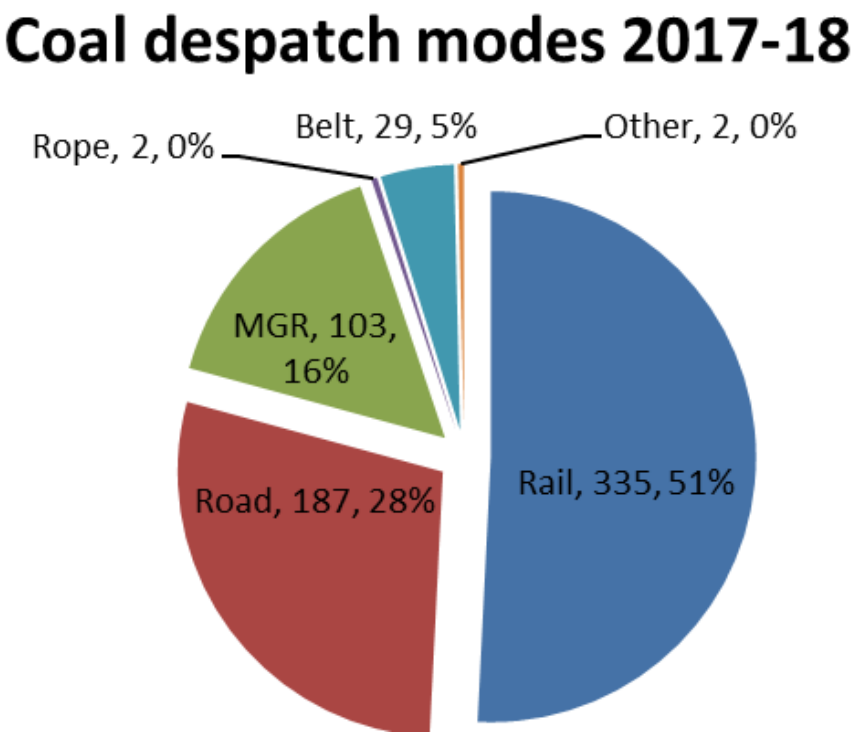
Coal beneficiation

- India one of the only countries with little or no beneficiation
  - Even sizing of coal before supply only a recent phenomenon
- Insufficient non-coking coal washing capacity
  - Ash transported long distances



Coal transport

- Rail is predominant mode of transport
  - Slightly reducing share recently with road, MGR etc. gaining
- Significant amount of ‘pit-head’ capacity and usage
  - Decreasing average distance transported by rail



INSTITUTIONAL STRUCTURE OF COAL

Brief history of the coal sector

- Coal mining began in 1860s in Raniganj, Bengal
- Initially primarily for the steel sector

- Private sector dominated
  - Poor mining and labour practices
  - Unable to meet growing demand

- Sector nationalized in 1973
- Formation of Coal India Ltd. (CIL)
  - World’s largest coal producer today

Brief history of the coal sector …

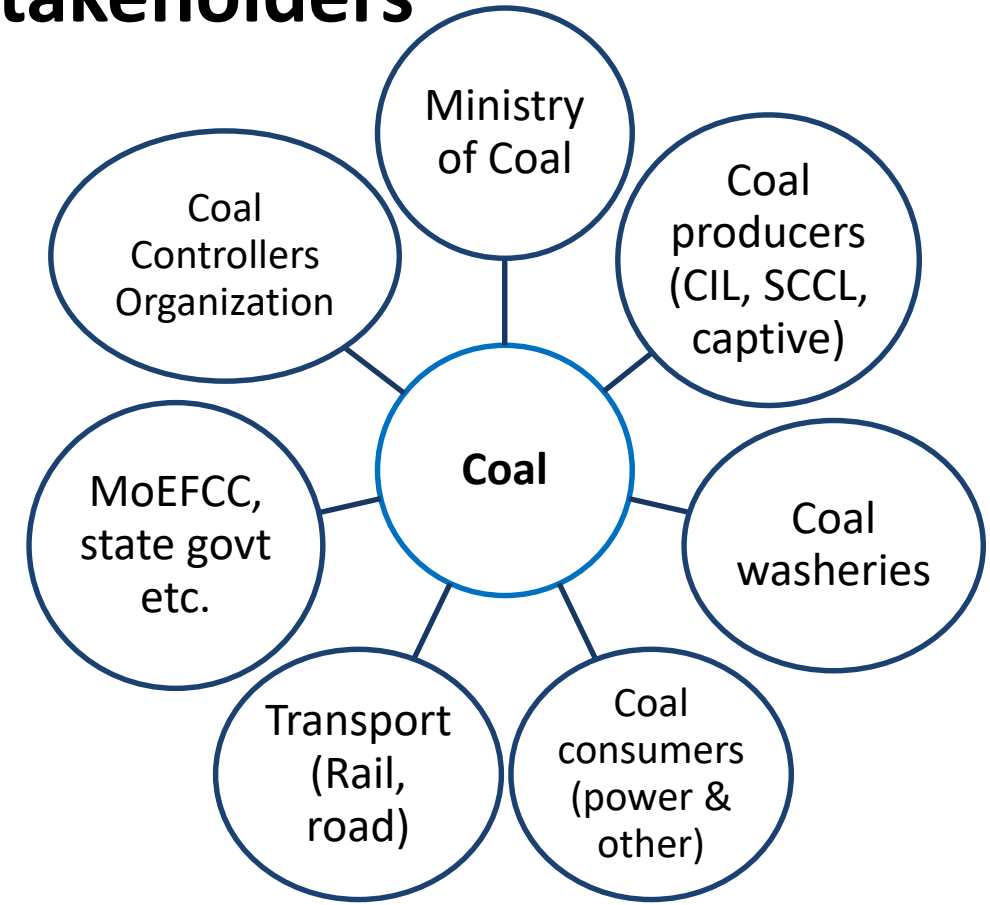
- ‘Captive mining’ permitted
  - Mine given to ‘end user’ – not for sale but own consumption
  - For steel sector in 1970s itself
  - Extended to power in early 1990s
  - Then cement, coal washing etc. in mid 1990s

- 200+ blocks allotted for captive mining by 2010
  - Most of them cancelled by Supreme Court in 2014

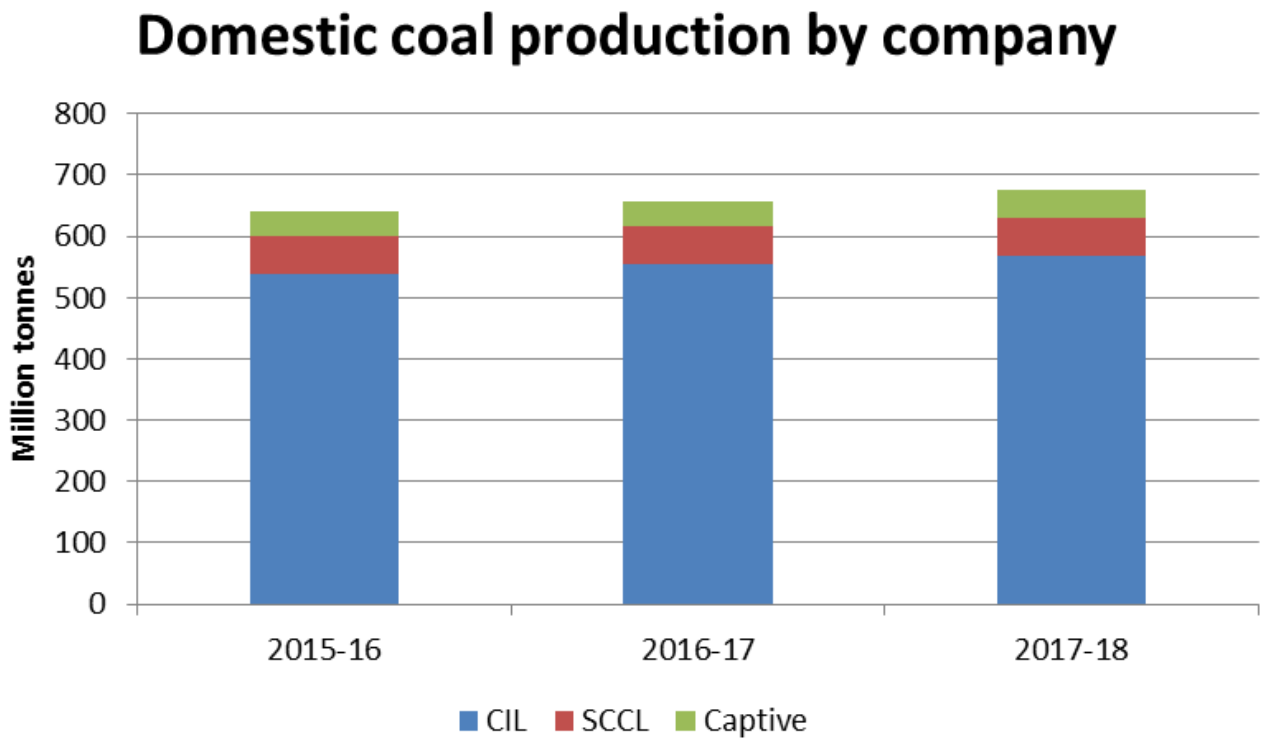
- Major changes in 2015 including de-nationalization – on paper

Coal sector structure/stakeholders

- Governed by Ministry of Coal
  - CCO subsidiary agency
- Most coal producers also government cos
- MoEFCC (and PCBs) for environmental issues
- No independent regulator



Market structure



- CIL dominates
  - ~84% of domestic production in the last three years
  - Largest coal producer in the world (~570 MT in FY 18)
- SCCL is the other major producer (~60 MT in FY18)

Market structure …

- CIL's predominance
  - Accountability – quantity and quality of coal supplied
  - Pricing – 'free pricing' in spite of monopolistic market structure
  - Productivity

- Recent developments
  - Mines downgraded
  - Third party sampling introduced

- Captive coal mining
  - Never took off – contributes just 6-7% now

PREVAILING POLICY REGIME

Policy categories

- Coal mine allocation
  - Deciding who gets to mine which mine
  - Terms and conditions

- Coal allocation
  - Deciding who gets to use the produced coal
  - Methodology, pricing etc.

- Other aspects
  - Environment
  - Land acquisition and R&R
  - Safety and labour

Coal mine allocation

- Mines can be allocated for commercial or captive mining by GoI
- All miners have to pay a royalty (~14% of value) to state governments

- Commercial mining – public sector
  - Mainly CIL, SCCL
  - Recently also state government agencies

- Commercial mining – private sector
  - Based on auctions of revenue sharing with state governments
  - Floor price of auctions: Roughly CIL's profit in Rs / tonne
  - So, unless cost of mining can be greatly ↓, tough to compete with CIL
  - Not yet operationalized, but will there be interest anyway?
  - But very loose conditions on competition, pricing etc.

Coal mine allocation …

- Public sector
  - Allotments
  - Have to pay Rs. 100 / tonne in addition to royalty to state government

- Private sector – also has to pay Rs 100 / tonne in addition to royalty
  - Non-power sector: Auctions based on Rs / tonne to be shared with state government
  - Power sector: Reverse auctions based on Rs / tonne discount over CIL notified price to be considered for tariff
  - Claims made of ₹ 3 lakh crore revenue, ₹ 68,000 crore tariff reduction not realized
- Lack of interest in captive mining from private sector
  - Few auction rounds cancelled due to insufficient interest
  - Some with mines also want to return them

Coal allocations

- Convoluted and complicated story
- New Coal Distribution Policy (NCDP) 2007
  - Government committee SLC(LT) to allocate coal to consumers
  - Formal Fuel Supply Agreement (FSA) contracts
  - Effectively, all could get coal through CIL even if CIL needed to import
  - But FSA did not bind CIL to supply requisite coal
  - But allocations did not clarify how much of coal allocation to a consumer was domestic and how much imported

- Amended in 2013 to specify how much of contracted amount CIL was bound to supply

Coal allocations …

- Much confusion and damage by then
  - Many litigations regarding tariffs – still playing out at various forums
- Most coal allocations today bound by NCDP

- SHAKTI introduced in 2017 for fresh allocations to power sector
  - Public sector generators to still get coal through allotments
  - Private sector to get coal based on auctions
    - Premium on CIL price or tariff-based reverse bidding
  - Only applicable to allocations from CIL / SCCL
- Concerns re SHAKTI
  - Discretionary allocations to continue as most capacity in pipeline public sector owned
  - Insistence on long term PPAs
  - Market distortions due to differential treatment?

Other coal allocation policies

- Optimising coal usage within plants of a generator
  - Can swap coal around to reduce transport and processing costs, optimise fuel use during outages etc.

- ‘Case 4’ or ‘coal tolling’
  - State-owned generator with high cost of generation can allot the coal to another private generator based on bidding to lower tariff

Environmental policies / issues

- Ash related
  - Coal with ash content > 34% cannot be transported more than 500 km
  - Not observed in practice
  - Too few washeries
  - Either way, ~240 MT of ash produced per year
    - In contrast, estimated solid waste production in India ~70 MT per year
    - Disposal major challenge

- New norms for coal-based power plants
  - Notified in 2015, to be effective 2017 but being disputed – 2022 may be new effective date
  - Aims to address emissions and water consumption
  - Will increase cost of coal-fired power and make it more uncompetitive
  - Lack of clarity as of now re monitoring progress and compliance

Future of coal

- Coal-based power increasingly uncompetitive
  - Hence role will gradually reduce

- Given current role and sunk costs, change likely to be slow
  - Over a few decades
  - But low PLFs likely to be the norm
- However, given lock-ins and heavy investments
  - Decisions today need to be carefully taken
  - Particularly regarding new capacity, new mines etc.

- Coal sector structure – unlikely to change significantly with current set of policies

Mining process

- Mine allocation
- Prospecting license (if unexplored)
- Mining lease
- Mining plan
- Mine closure plan
- Environment clearance
- Forest clearance
- Land acquisition
- Mine preparation
- Mine operations
- Mine closure

Many of these can proceed in parallel up to mine preparation / operation

Electricity, Water and Agriculture Linkages

Training workshop

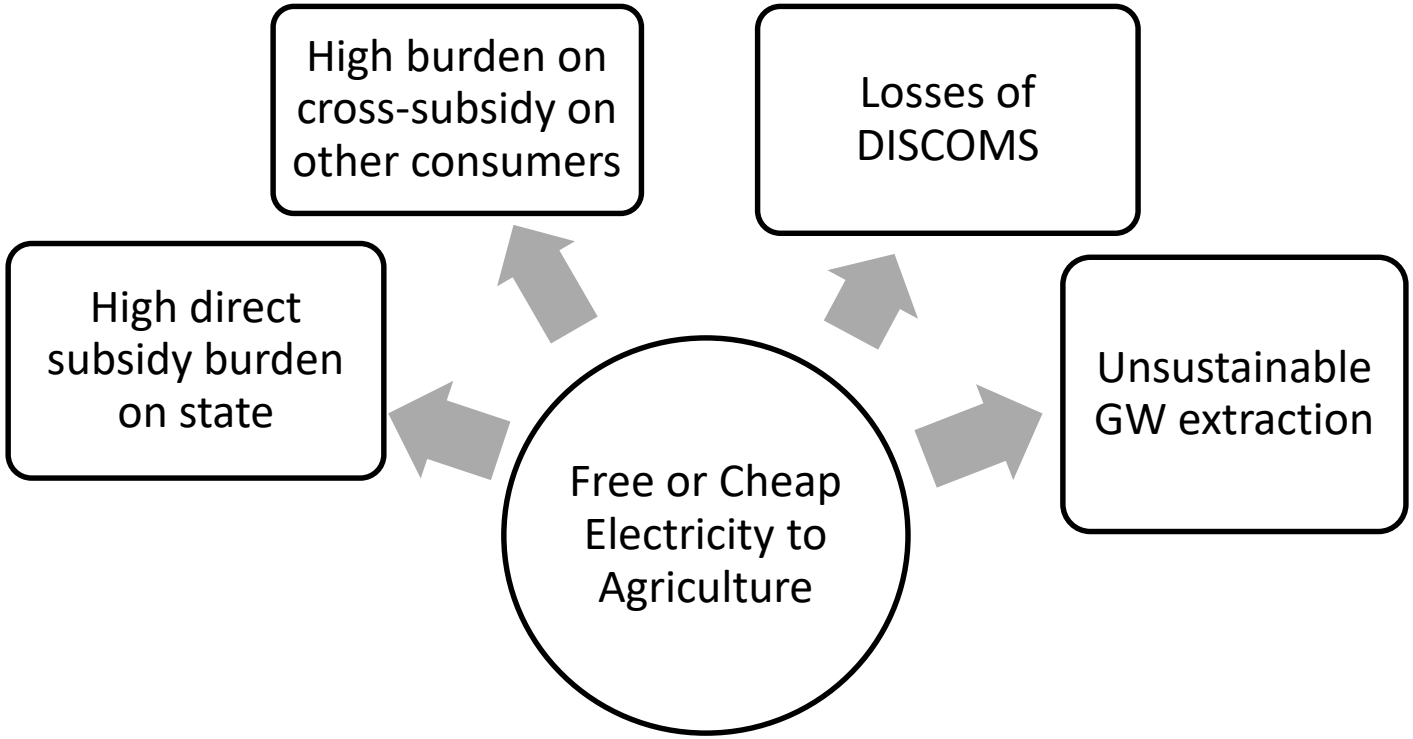
Pune, February 11-12, 2019

Ashwini Dabadge, Sreekumar N, Shripad Dharmadhikary

Prayas (Energy Group)

Agriculture supply: Common Understanding

- Total accumulated losses of DISCOMs in March 2015 were Rs 3.8 lakh crores —3.3% of the country's Gross Domestic Product (GDP) for that year (MOSPI, 2017).
- Agricultural supply singled out as the main cause



Agriculture supply: Common Understanding

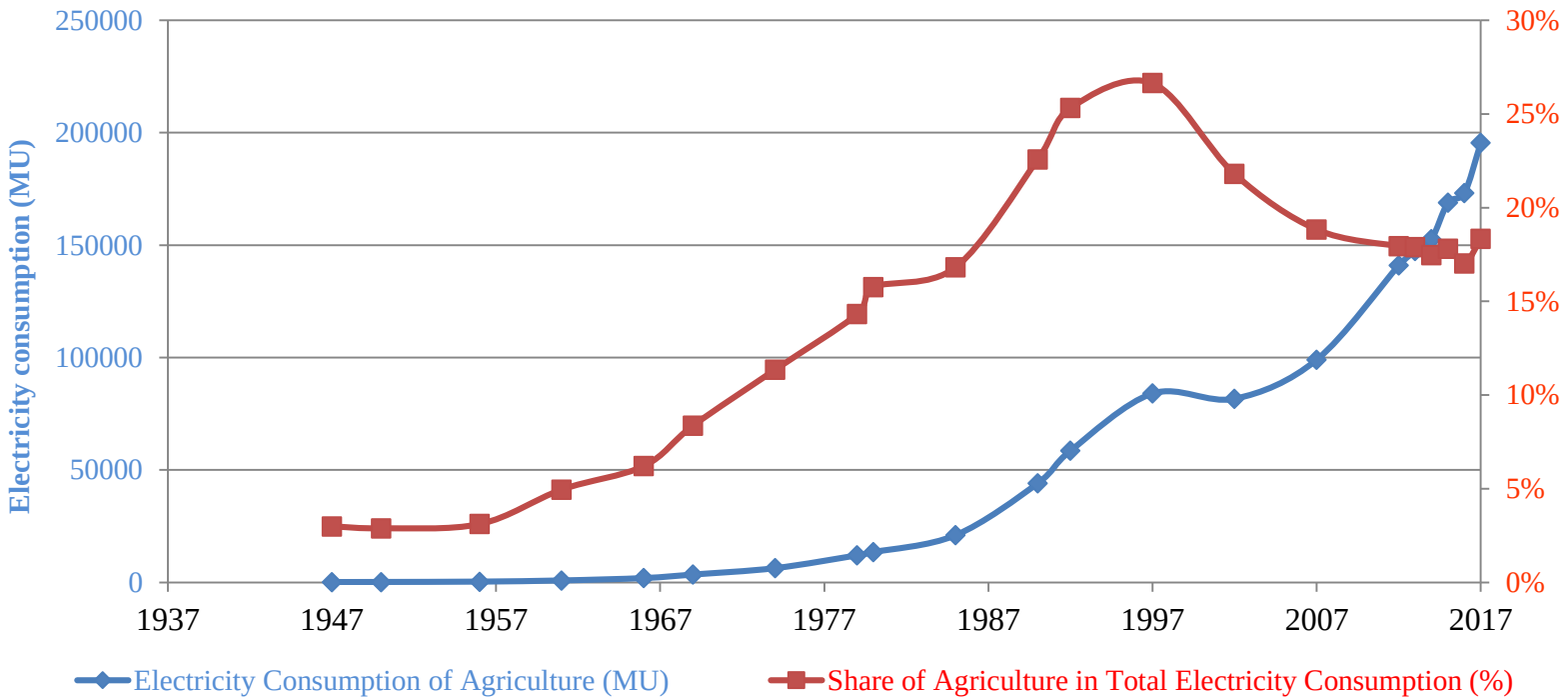
- A major push of power sector reforms
  - Rationalise subsidy – increase tariff (attempted)
  - Universal metering (not done)
  - Limit hours of supply to agriculture (done)
  - Limit number of connections (done)

Focus only on DISCOM finances - misses key aspects, ignores linkages

Why solutions have not worked?

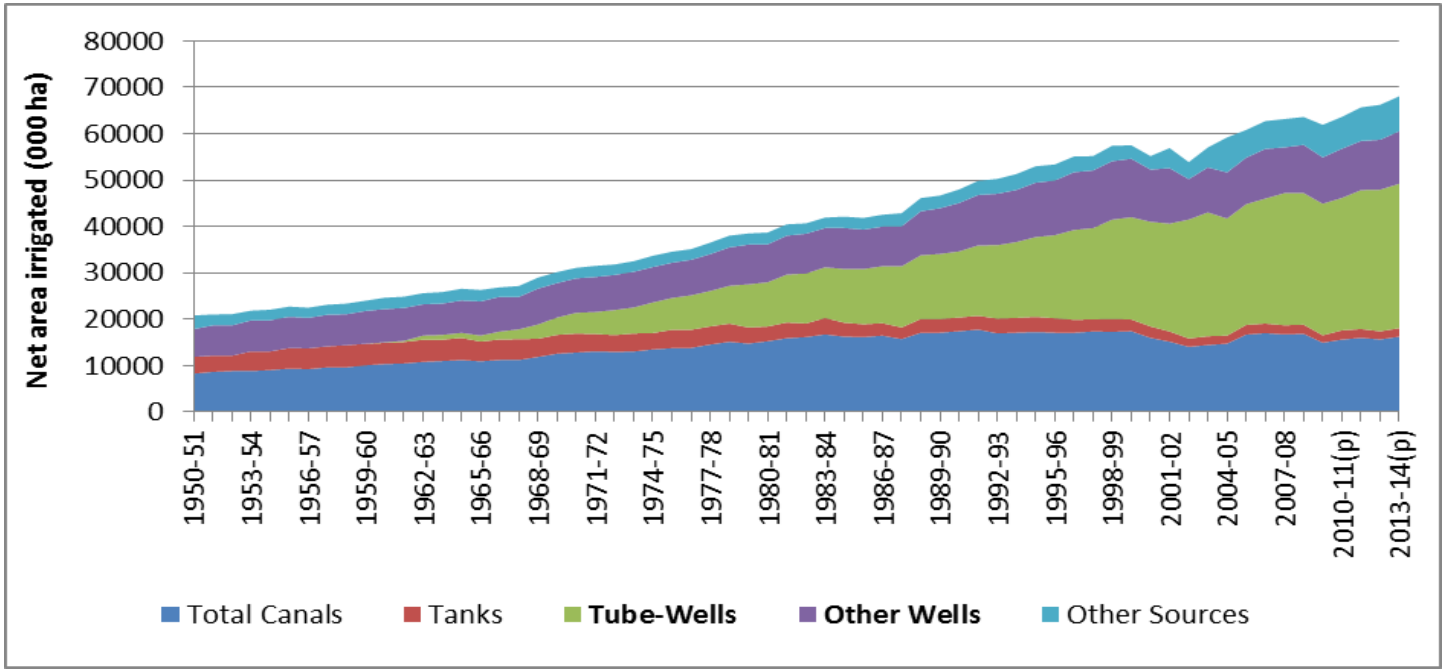
- Three financial bail-out packages for DISCOMs between 2001 and 2015
- Some efforts to address agriculture supply issues
- Yet, farmer, DISCOM and government unhappy with the situation
- Why? Because discussion and solutions have ignored:
  - Crucial role of agriculture in the country
  - Strong linkages between electricity, water and agriculture sectors

Linkages: Rising Electricity Use in Agriculture



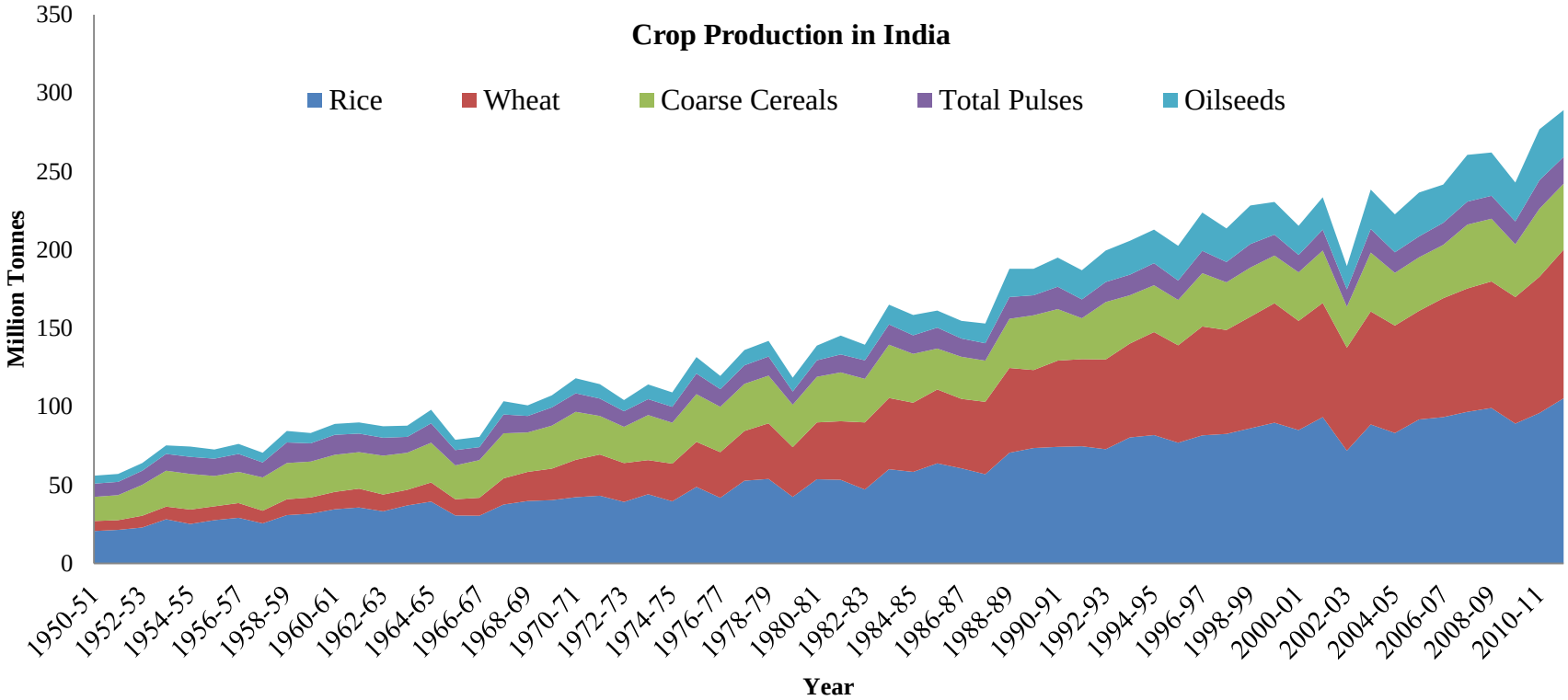
- 50 times growth in the electricity use in agriculture from 3,465 MU in 1969 (8% of total) to 173,185 MU in 2016 (17%)
- Virtually all electricity in agriculture used for pumping, mainly groundwater
- 85% of pumping energy from electricity
- Flat tariffs, mostly (~ 75%) unmetered
- Highly subsidized tariffs or free power

Linkages: Growth in Groundwater Irrigation



- Groundwater irrigation dominates, accounts for ~66% Net Irrigated Area
- Net area irrigated by groundwater increased seven times from 1950-51 to 2013-14, from 5.98 m ha to 42.44 m ha
- In the same period, canal irrigated increased only two times, from 8.29 m ha to 16.28 m ha
- Trend likely to continue due to advantages of groundwater irrigation

Linkages: Growth in Food Production



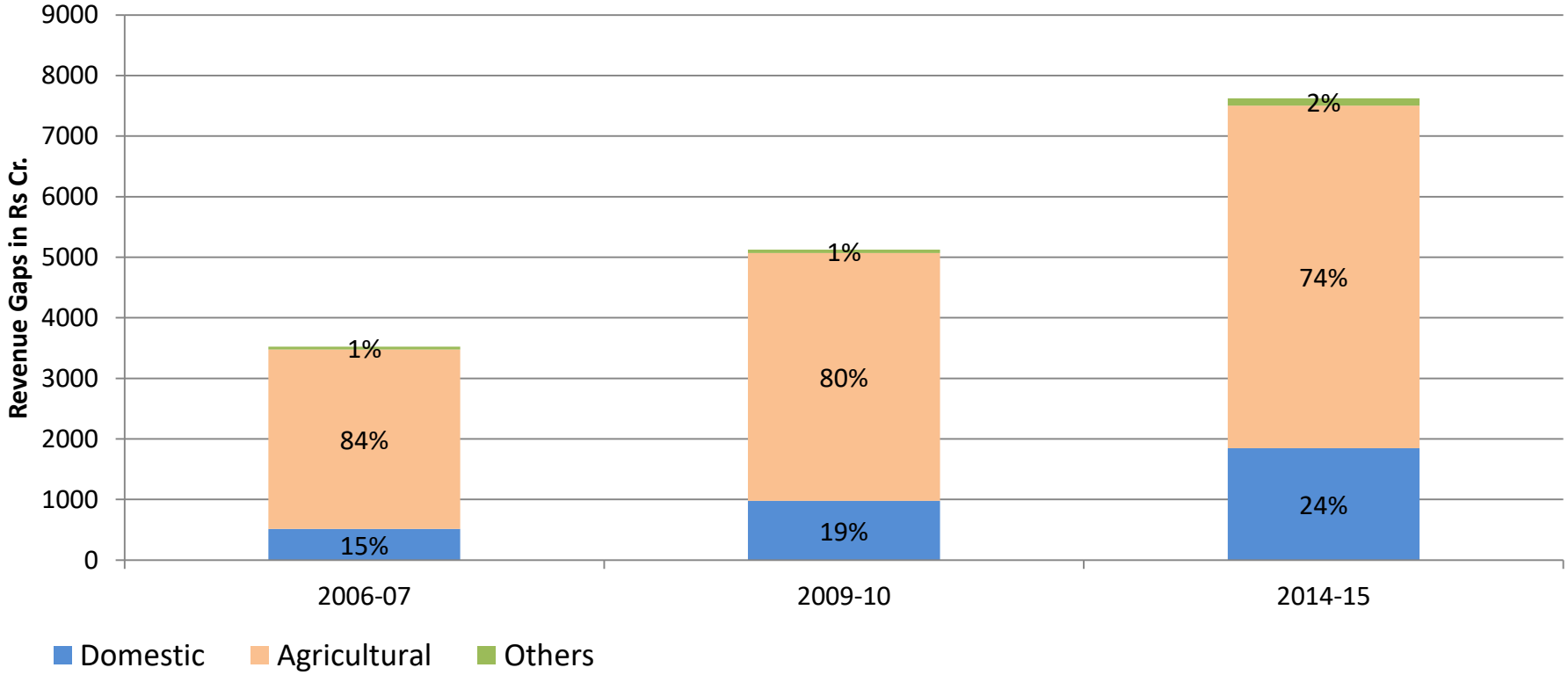
- High growth in food grain production since 1950, mainly in cereals
- Paddy and wheat account for 75% of total food grain production
- About 70% paddy and wheat production is from irrigated areas

Subsidy: Agricultural Subsidy is Overestimated

- Doubts on the Number, Connected load and Hours of operation of pumps
- Several re-statements of agricultural sales and distribution losses – e.g. thrice in Maharashtra so far, and twice in Punjab
- Agricultural sales re-stated in Maharashtra (10%), TN (16%), Punjab (5%) and Haryana (39%) in recent times
- Credibility of distribution/AT&C loss in question

Subsidy: To Other Categories Increasing

Revenue Gaps of Subsidised Consumer Categories in PSPCL (Punjab)



- Agriculture is the dominant subsidized category, but share of other categories increasing
- Small domestic dominate, but industry also being subsidized in some states

State government subsidy shortfalls

- State subsidy is about 75% of the total subsidy
- Outstanding subsidy or inadequate subsidy allocation by state government
  - Cumulative subsidy shortfall as % of total subsidy determined by ERC
  - Haryana (14%), Punjab (14%)
- Not all financial losses can be attributed to agriculture
  - Poor power procurement planning
  - Inefficiencies in operations
  - Loss of cross-subsiding consumers

Rationing of Electricity supply and Connections has Limited Impacts

- Decline in daily hours of supply to agriculture in many states due to rationing
  - by 1-5 hours on average between the period of (2005-10) and (2011-17)

- But significant increase in consumption and connected load in Maharashtra, Rajasthan, Punjab, U.P and Karnataka.
  - Decline in groundwater levels a factor, but not the only factor.
  - Example of Maharashtra in Table
    - hours of supply reduced from 16 hrs to 8 hrs from 2005 to 2013

- Irrigation need of crop is crucial driver for electricity consumption

Percentage Increase in select parameters over 2003-04 to 2012-13

State	Electricity			Ground water
	Connected Load (MW)	Consumption (MU)	Average Pumpset Size (kW)	Draft for Irrigation (BCM)
Maharashtra	102%	90%	28%	12%

Challenges in supply and service quality

- Limited hours of supply, based on DISCOM convenience
  - 7-10 hours of supply
- Night-time supply, frequent interruptions, voltage fluctuations
- Shock accidents, Long time to repair
- Irregular and faulty meter readings
- Trust deficit between DISCOM and farmers
- Higher tariff suggested as a solution, but it may not result in growth in revenue
- DISCOM to take first step to improve quality

Feeder separation, Metering

- Feeder separation
  - Helps to limit hours of supply and improve quality of supply
  - But may adversely affect water markets
  - Limited use of feeder metering for consumption estimation
- Low coverage and quality of DT metering
- Pump metering
  - Low coverage – overall 27%, many states 0%, poor quality
  - Farmer opposition is common narrative, but evidence of DISCOM reluctance also
  - West Bengal – impact on water markets
- Feeder and DT metering for estimation, Try pump metering in some areas

Groundwater Over-extraction: Subsidised Electricity is Enabler, not Driver

- Direct correlation between low electricity tariffs and over extraction of groundwater not uniformly applicable across states
  - Free power in Punjab, Haryana and AP, % of blocks under groundwater stress are high (75-80%) in first two and low in AP (20%)
  - Rajasthan has higher tariff: close to Rs 1/kWh tariff, yet high groundwater stress (81%)

Groundwater Over-extraction: Subsidised Electricity is Enabler, not Driver

- For individual farmer, low priced or free electricity offers an incentive for unchecked lifting of groundwater
- But at broader level, extraction is dependent on many factors
  - Quality of power and hours of supply
  - Hydrogeology of the region
  - Groundwater conservation efforts
  - Farmers' awareness
  - Cropping patterns

Groundwater Over-extraction: Cropping Pattern, the Major Driver

- Cropping pattern determines water requirement and hence irrigation withdrawals
- Cropping pattern is determined by price and market support, especially MSP and Procurement
- Support to water intensive crops not suitable to agro-climatic characteristics lead to excessive water withdrawals
- Extensive use of diesel powered wells in Punjab an example of pumping driven by cropping pattern and not cheap electricity

Impacts of Raising Tariffs

- Raising tariffs would have limited impacts on groundwater withdrawals
- Raising tariffs will significantly impact farmers' incomes
- Depending on crops and state, increase of Rs. 1 per unit of electricity can lead to increase of Rs. 1000-5000 Rs/Ha, being 5% to 89% of farmers net income
- Raising tariffs will not lead by itself to better quality of supply

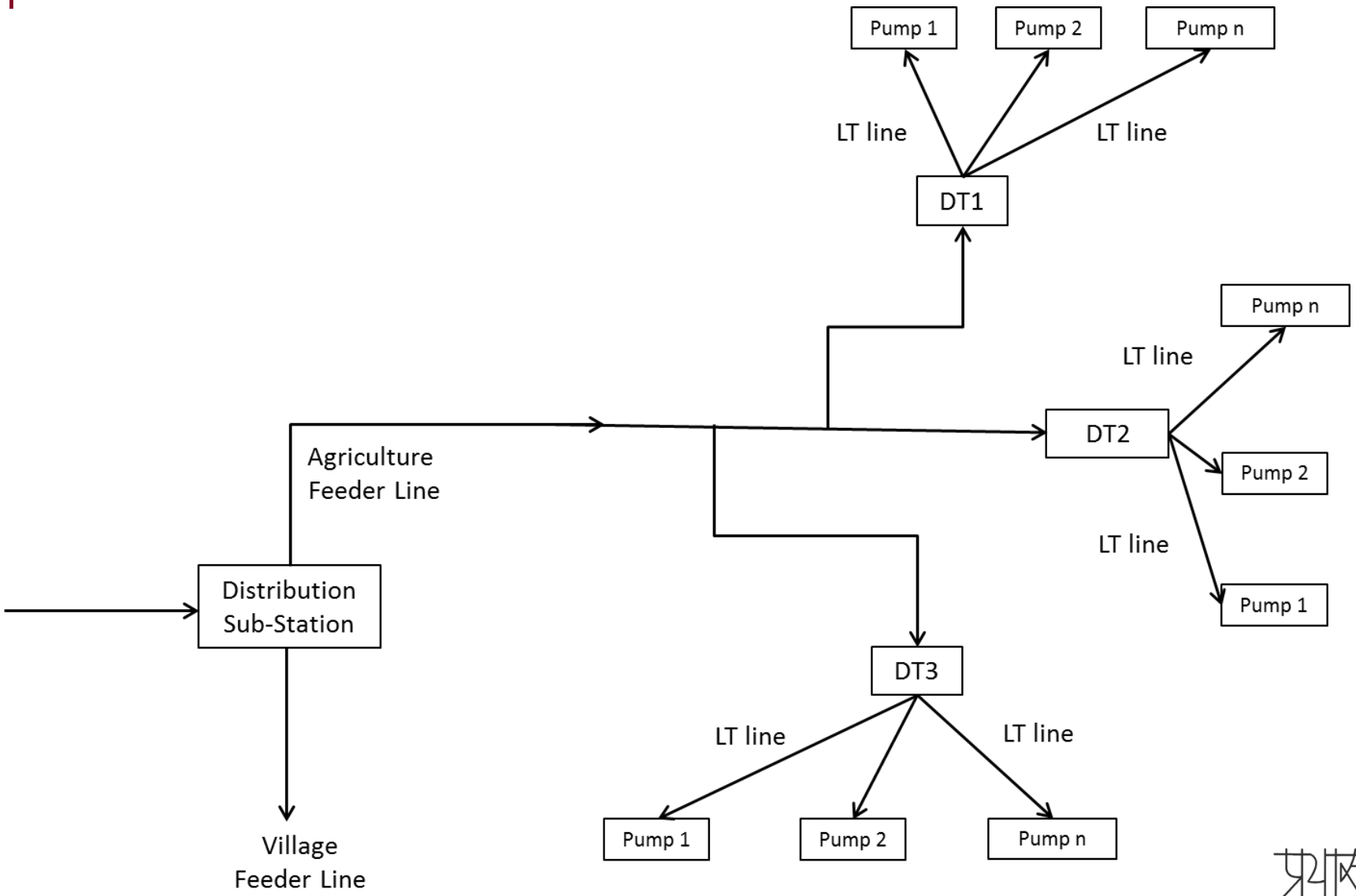
Need for a different approach

- Larger social perspective, not just DISCOM focussed
- Integrated across electricity, water and agriculture sectors: Including farmer's interests, goals of food security, agricultural growth
- Subsidy requirement based on a desired agricultural development plan
  - cropping pattern aligned to agro-climatic regions and groundwater situation
  - Gives better justification / rationale for subsidy

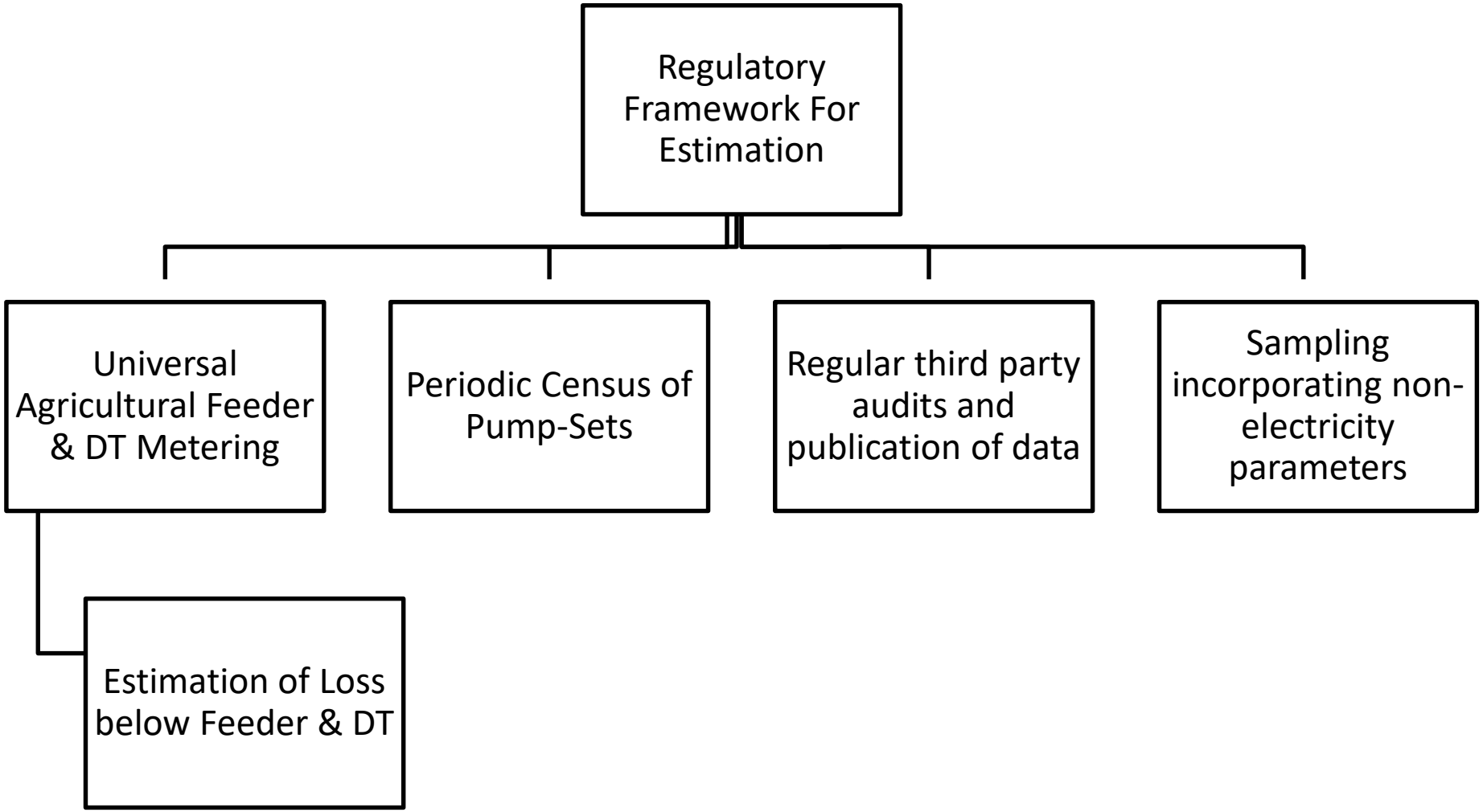
Need for a different approach

- DISCOMs to take first step to improve quality of supply
- Other measures like decentralised rainwater harvesting, drip-sprinkler irrigation, organic farming, community-driven regulation of groundwater extraction and recharge
- Improving availability and quality of data in all sectors
- Better estimation of agriculture consumption
- Pilot projects to test ideas

Schematic diagram of agricultural supply



Better estimation of agriculture consumption



Ideas for Pilot Projects

- Baseline studies for evaluation of impact

Solar Feeder

- 11 kV feeder level solar plants
- Grid connected
- Lower subsidy
- Day time good quality power supply for farmers

Block level tariff/hours of supply

- Cropping pattern and state of groundwater aquifers to be taken into consideration
- After consultation with farmers
- Crops suitable to agro climatic zone to be supported

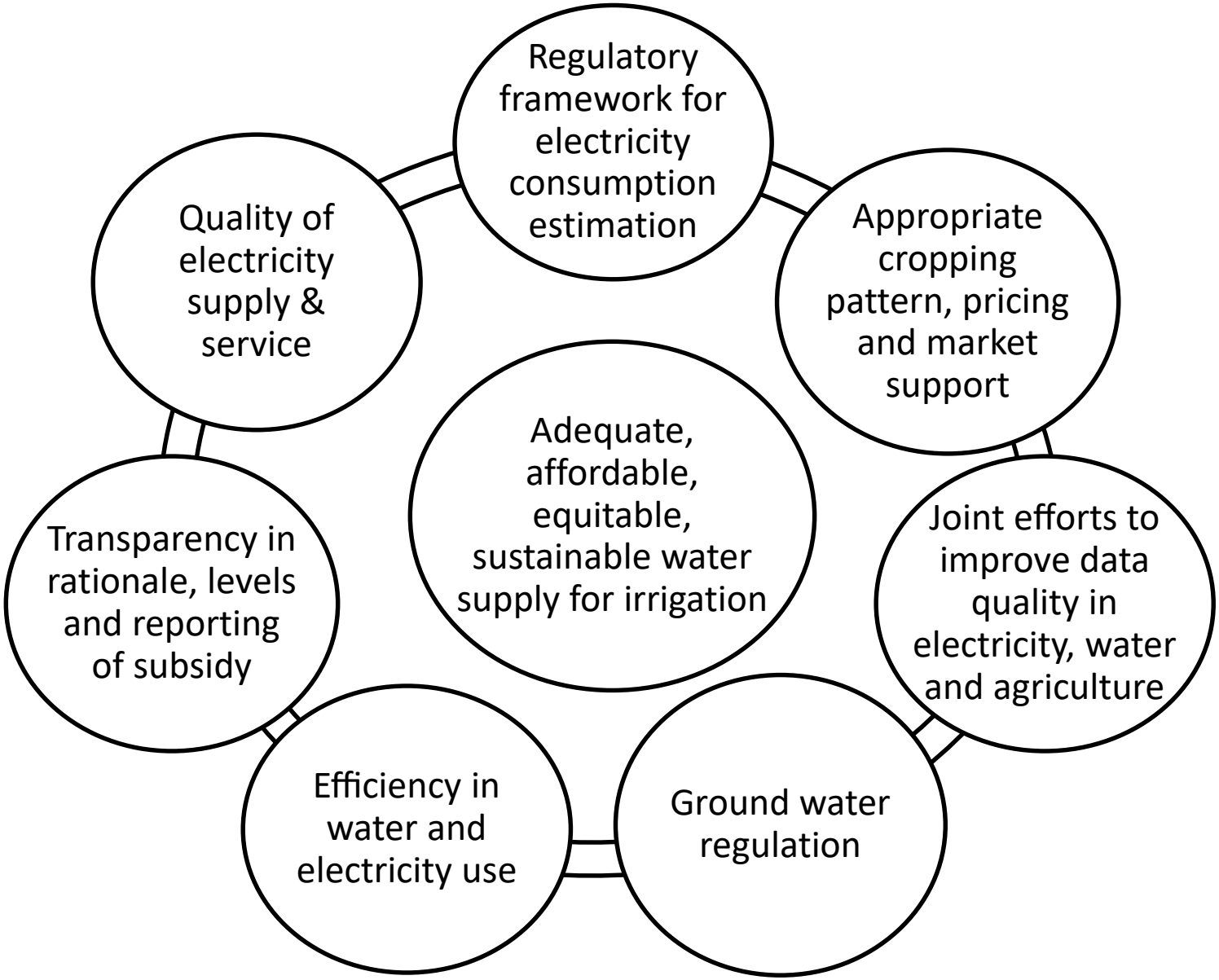
Distribution Transformer Associations

- Similar to Water Users Associations
- Link between DISCOM and farmers
- Distribution of bills, collection of payments and grievance redressal
- Address safety issues

Shift Towards Appropriate Cropping Pattern

- Price and procurement support/market support for region suitable crops
- Need to explore issues regarding regional MSP vs national MSP

Agriculture electricity supply - a comprehensive approach



Tariff and Regulatory Concepts

Towards improving service delivery and sector health through multi-disciplinary skills in electricity sector

Pune, February 11-12, 2019

Ann Josey and Manabika Mandal

Prayas (Energy Group)

Approach

Practitioners perspective

- Focus on public-interest engagement
- Improvement in operational efficiency and finances
- Need for increased accountability of institutions

Focus on DISCOM

- Interface and direct relationship with consumers
- Most important link in value chain→ buck stops here
- Public accountability higher due to tariff changes

Focus on regulatory documents

- Significant amount of information
- Tariff filings→ 400-600 page documents →painful to navigate
- Variation in terminologies→ over time and across states

Outline

- **Cost Plus Regulation and Tariff Determination Processes**
  - Tariff, Multi-Year Tariff
  - Gain and Loss sharing
  - Tariff and cost-vetting processes and timelines

- **Understanding tariff related concepts**
  - Key concepts and metrics with respect to thermal generation
  - Detailing of important concepts related to DISCOMs costs
  - Sources of revenue for the DISCOM
  - Handling revenue gaps

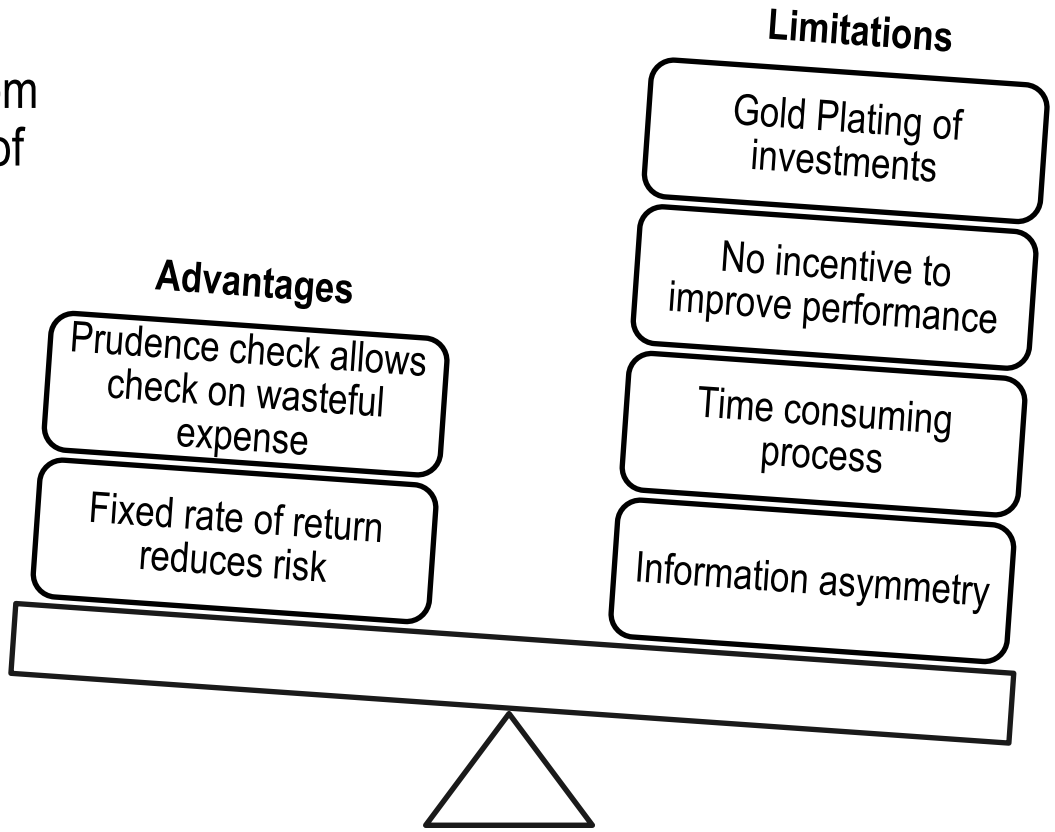
- **Learning and Sharing**
  - Checklist while reading a tariff petition
  - Information not easily available in tariff process
  - Which numbers to use when?

Cost-Plus Regulation and Tariff-related processes

Cost Plus Tariff Determination

Revenue Recovered = Prudent Cost + Fixed return on equity

- Prudent costs to be recovered from consumers with reasonable rate of return
- Regulator to determine cost prudence, disallow wasteful expenses
- Under Section 62 of E Act
- Applicable on generators, distribution companies, transmission companies



- **Under Section 63 of E Act, tariff can also be determined via competitive bidding (instances in generation, transmission)**

Multi-Year Tariff Determination and Performance based Regulation

- Multi-Year Tariff (MYT) Approach
  - Determination of costs, key performance parameters for 3-5 years
  - This time period is referred to as **control period**
  - This provides regulatory certainty to consumers, utilities and investors and facilitates sound planning practices
  - Based on MYT regulations of the ERC

- Risk sharing mechanism based on controllable and uncontrollable factors
  - **Controllable factors** (distribution losses, operation and maintenance expenses, coal transit loss)
  - **Uncontrollable factors** (fuel price increase, variation in sales)

- Regulator sets targets for performance and specifies norms for cost parameters
  - Addresses lack of incentive to improve performance in cost-plus approach
  - Incentives and penalties for exceeding or falling short of targets

Gain and Loss Sharing

- Gain and Loss sharing mechanism in-built to share benefits and risks
  - 2/3rd of benefit and 1/3rd of costs shared with consumers
  - 50:50 sharing in some states

- Example of distribution losses, a controllable factor

Illustrative Example for Gain and Loss Sharing (Rs. Cr)	Example 1	Example 2
Target given in MYT regulations for FY 18	18%	18%
Approved by the regulatory commission based DISCOM filings	**16%**	**20%**
Savings (-) /Increase in costs (+) due to deviation from target	-300	300
Sharing with consumer: 2/3rd of savings (-) and 1/3rd of cost (+)	-200	100
Retain by DISCOM: 1/3rd of savings (-) and 2/3rd of cost (+)	-100	200

Fuel Surcharge: Timely recovery of uncontrollable costs

- Uncontrollable costs are to be recovered from consumers

- Waiting for revisions at the end of the year to get additional revenue, difficult for cash-strapped DISCOMs
  - Strain in working capital→ increase in short-term borrowing

- Recovery of revenue required for such costs takes place through fuel surcharges
  - Per unit charge levied on consumers bills
  - Typically revised every quarter
  - Typically, limited vetting and verification by regulators

Key tariff-related regulatory processes to ensure accountability

- Tariff determination
  - Regulator approves costs and tariffs for the subsequent year
- Annual Performance Review
  - Regulatory assesses performance and costs of current year based on estimates submitted by licensee
- True-up
  - Assessment of performance and cost of past year based on audited accounts to determine costs which need to be recovered in subsequent years

For Multi-Year Tariff Determination

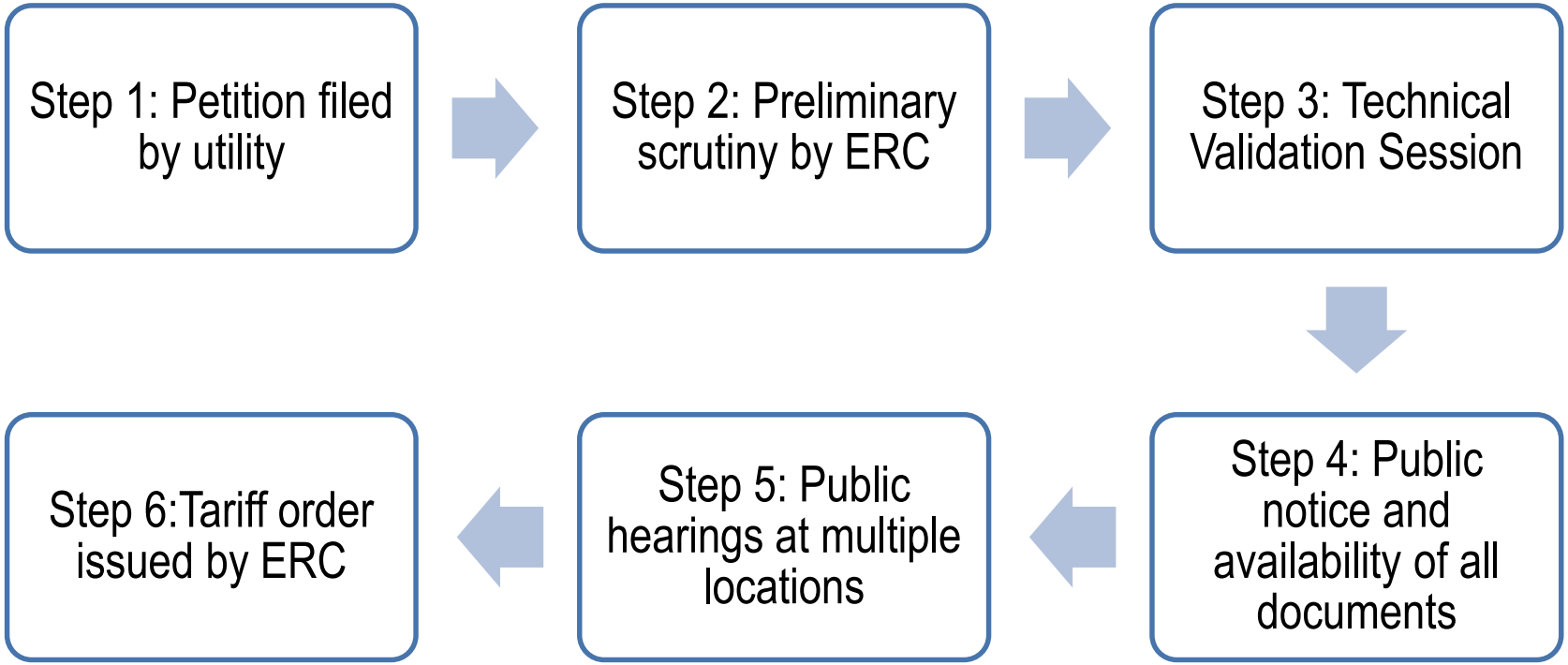
- Business Plan/ Resource Plan Approval
- Multi-Year Tariff Approval – can be for costs or both tariffs and costs
- Mid Term Review – revision of trajectories and true-up for previous years
- True-up for Multi-Year Tariff Control Period

Timeline for tariff related processes for FY20

FY19	FY20	FY21
Tariff petition filed	Annual Performance Review petition	True-up petition
Tariff order	Annual Performance Review order	True-up order

Tariff petition for FY20 will typically be filed with Annual Performance review for FY19 and True-up petition for FY18

Tariff determination process



E Act: Step 1-6 completed in 120 days

Understanding tariff and ARR related filings

Basic concepts
No state-specific focus

Key Concepts

Annual Revenue Requirement (ARR)

- All costs incurred by the utility for the year
- This includes power procurement, capital expenses and operation and maintenance costs
- Power procurement forms bulk of the cost

Revenue recovered to meet ARR

- Revenue recovered from consumer tariffs
    - Tariff for different categories are not the same- cross subsidy
- Non-tariff income
- Subsidy
- Revenue from sale of surplus

Revenue gap and carrying cost

- The difference between ARR and the revenue recovered for the year
- If there is a gap it can be recovered in subsequent years with interest costs

Key Metrics

- **Average Power Purchase Cost (APPC)** (Tool)
  - Power purchase accounts for majority of the cost
  - Metric measures per unit cost of energy procured by DISCOM from all sources
  - Power Purchase cost/ Power Purchase Quantum
  - Power Purchase cost used can include transmission costs

- **Average Cost of Supply (ACoS)**
  - Metric to assess the cost incurred by DISCOM to supply 1 unit of power
  - (ARR-Non Tariff Income)/ Sales

- **Average Billing Rate (ABR)**
  - Metric to assess the average revenue recovered from consumers
  - Revenue recovered from consumer tariffs/ Sales
  - Can be determined category/slab/area wise

Important cost related concepts for cost-plus generation projects

- *Tariff features*
  - Thermal: Two part tariff – annual lump-sum fixed cost, generation linked per unit variable cost
  - RE projects: single tariff determined competitive bidding or by the regulator based on the net present value over the lifetime of the asset.

- *Thermal Project tariffs*
  - Calculation of Net Generation and tariff (Tools)

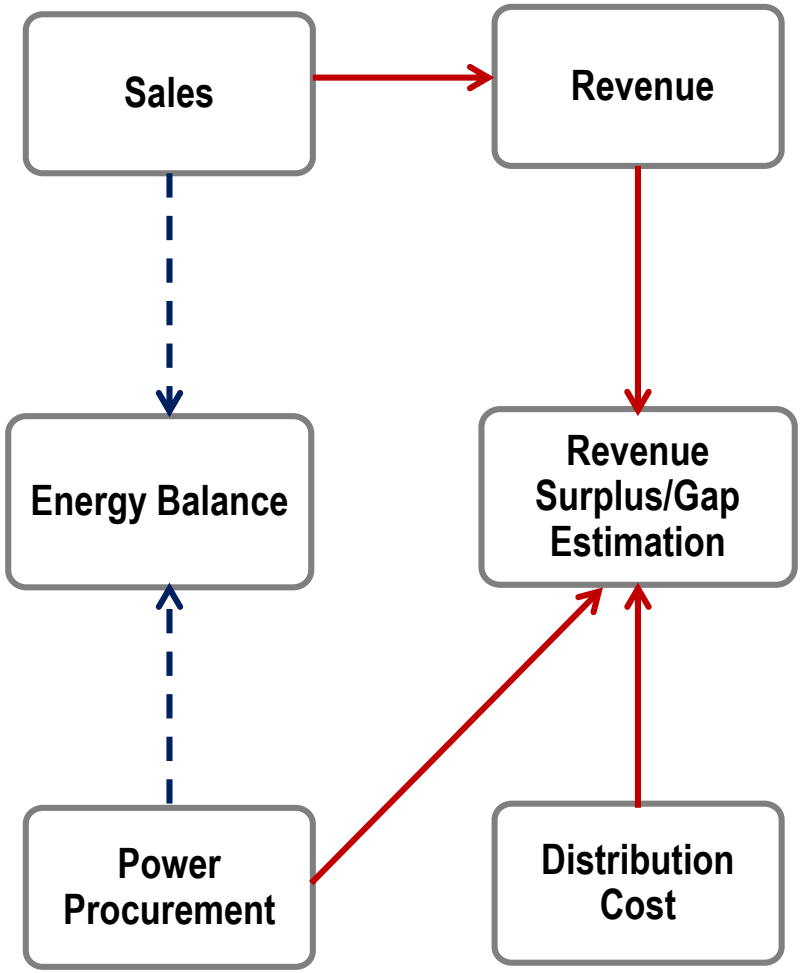
- *Power Procurement*
  - The total net generation from all contracted capacity and its costs is finally considered by the DISCOM for cost assessment.
  - Tariffs and costs for central sector projects and projects supplying to multiple states decided by Central ERC. For state sector projects, it's the State ERC

How is the ARR of the DISCOM determined?

- Category-wise sales projections
- Unmetered demand estimation

- Estimation of energy requirement and available
- Adjustment of marginal surplus

- From all long-term, medium-term and short-term projects
- RE procurement for RPO compliance



- Revenue from retail tariffs, subsidy, charges, sale of surplus, Non-tariff income

- Revenue gap carry forward
- Applicable carrying cost

- Capital Expenditure
- Operation and Maintenance
- Other expenses

Energy Financial

Estimation of Demand

- Sales Projections and Reporting
  - Projected based on past growth rates or other considerations
  - Unmetered sales estimated based on norms
  - Energy requirement (sales + distribution losses)

- DISCOMs have a tendency to over-project demand
  - Over-estimate cross-subsiding revenue
    - Despite open access and captive, HT sales projections always robust
  - Over-estimate subsidy and under-estimate distribution loss
    - Unmetered agricultural and domestic sales
  - Make a case for additional power procurement and thus cost
    - To meet growing demand in certain categories, which may not be realised

- True-ups and demand for scientific process for demand estimation crucial

Power Procurement (70%-80% of costs)

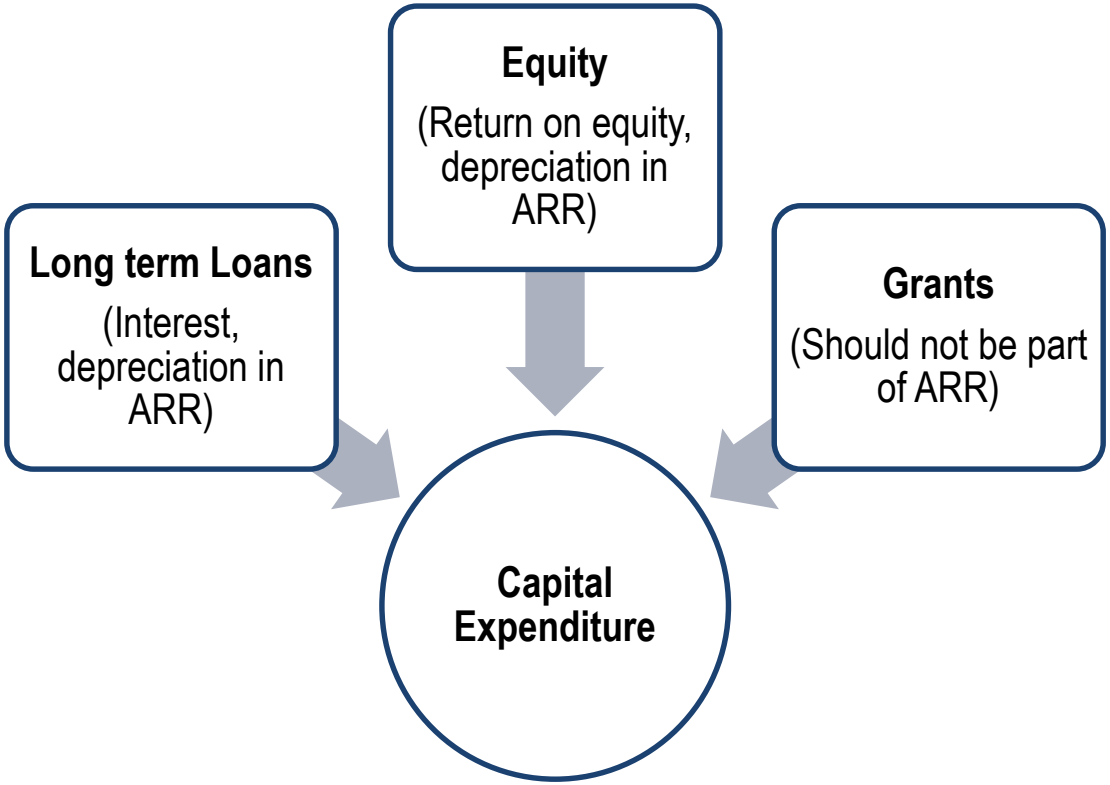
- Station-wise or source-wise projections and reporting of
  - Energy at generation bus-bar
  - Fixed cost and variable cost
  - Includes purchase from bilateral sources or power exchanges or DEEP
  - Includes RE purchase

- Important details to look for
  - Has capacity addition in the past been high cost?
  - Is there significant capacity in the pipeline? When is it expected?
  - Do DISCOMs project potential backing down?
  - Consistency with state-owned generating company petition?
  - Are fait-accompli costs being considered? (increase in coal cess, coal price, capex)
  - Is there significant dependence on short-term power procurement?
  - Is there significant surplus to be sold?
  - Is there RE capacity addition? Are RPOs being met? (Tool)

Energy Balance

- Useful key to understand demand and procurement requirement
- Energy balance consists of
  - Energy requirement (demand+ distribution loss)
  - Energy available (power procurement – inter-state, inter-state transmission loss)
  - Mis-match indicative for surplus/deficit
  - Surplus is to be sold. Deficit is to be met through short-term power procurement or remain unmet.
- The reporting and projections are annual and this is indicative
- Helps also assess the magnitude and impact of losses
  - How much does loss impact power procurement needs? (Tool)
- Possibility of under-estimation or over-estimation of losses
  - Interface metering issues
  - Estimation of unmetered demand
  - Sales migration
  - Distribution Franchisees

Capital Expenditure (10%-12% of ARR)



How does a DISCOM report having profit when having revenue gaps?

- 15% to 16% return on equity provided as per regulations.
- As this is fixed, profits can be made even with accumulating revenue gaps.

- If not financed via grants, capital investment -70% debt, 30% equity
- Interest on long-term loans are return on equity as per regulations
- Depreciation
  - Using straight line method
- Over-capitalisation, cost-overruns and delays have been noted- increasing capex requirement

Operation and Maintenance (7% to 8% of ARR)

- O&M expenses increases rapidly at 13% to 14% per annum
- Controllable expenses- can be linked to inflation or norms
- Often underestimated in petitions as compared to true-ups
- Note that this does not O&M incurred during capitalisation

Administration and General (A&G) Expenses

- 20% of O&M expenses
- Transport costs, rents, legal charges and audit fees, consultancy fees, admin expense, advertisements, training

Operation and Maintenance (O&M)

- 10% of O&M
- For lines, civil works, machinery, office equipment etc.

- 70% of O&M
- At par with pay commission revisions

Employee Expenses

Repair and Maintenance (R&M)

Need for accountability for poor supply quality even with rising O&M expenses

Other expenses (2% of ARR)

- Interest on Working capital requirement

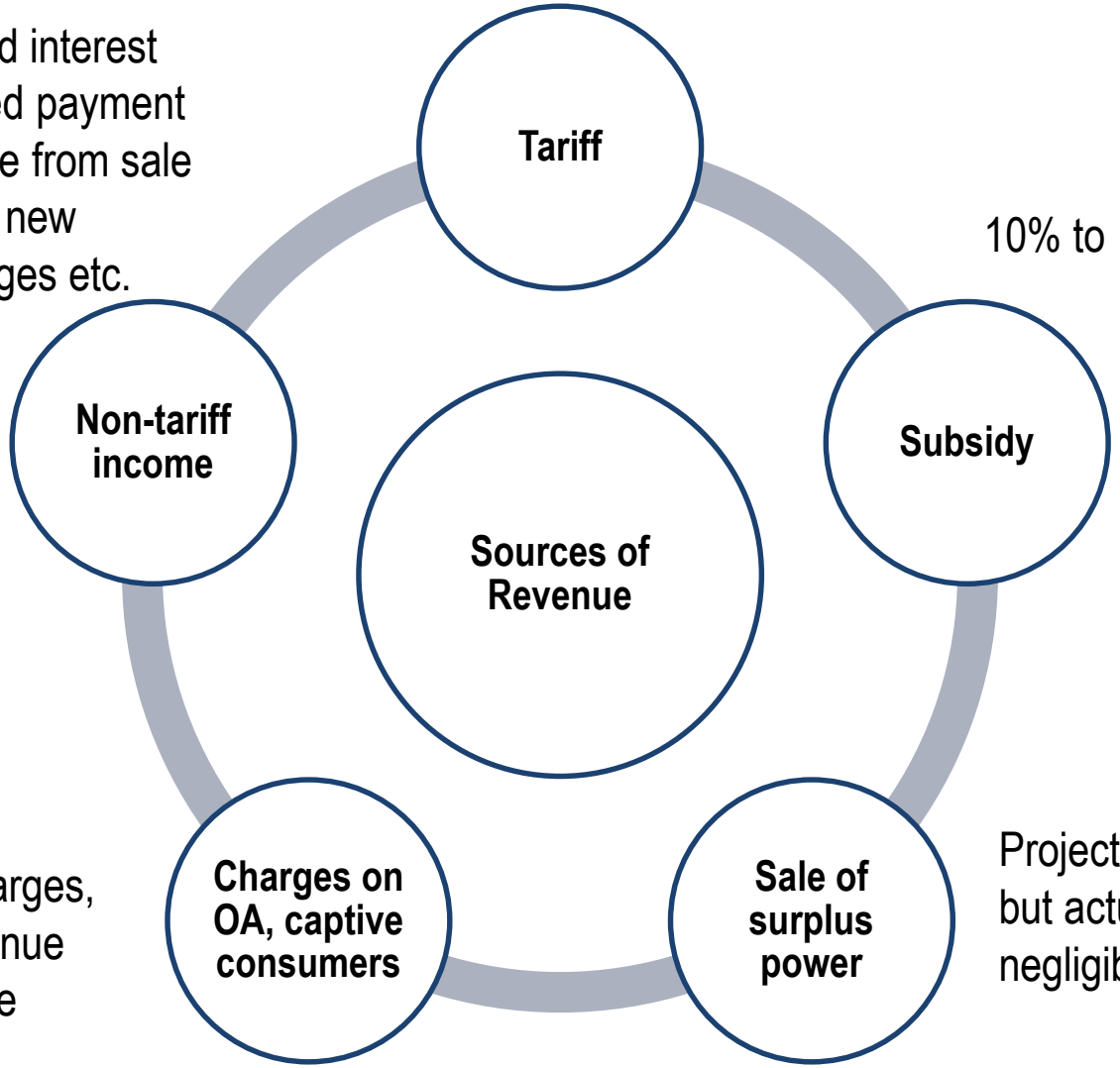
Normative estimation of working capital requirement	=	O&M for 1 month	+	Revenue expected for 1.5 months	+	Maintenance spares @ 1% of fixed asset	-	Security deposits from consumers	-	Power purchase cost for 1 month

- This is a regulatory dispensation
  - Not reflective of actual short-term liabilities
  - Can even be negative!
  - Interest charges as per rates specified by regulators

- Provision for bad and doubtful debts
  - At 1% to 1.5% of receivables or as per actuals
  - Impact of low recovery not passed onto consumers fully

Sources of Revenue

Includes rent and interest received, delayed payment charges, revenue from sale of scrap, royalty new connection charges etc.



10% to 15% of ARR

Projections are high but actuals are negligible

Higher the charges, lower the revenue recovered here

Tariffs and Subsidy

- Tariffs
  - Components of tariff
    - Fixed charges (per month, per kW or per kVa)
    - Energy charges (per unit basis)
    - Flat-rate tariffs – no per unit component
    - Fuel surcharge
    - Rebates of Penalties (Time of day, power factor etc)
    - Cross Subsidy (Tool)
  - Subsidy
    - Can be for a specific category or to waive a specific charge
    - For agricultural consumers or for fuel surcharge for domestic consumers

Observations regarding tariff

- Proposals to ↑ fixed charges to ↓ sales migration
- Fixed charges for HT based on billing demand, contracted demand etc.
- Tariff ↑ should be estimated on ABR
- Intra-category cross-subsidy as important as inter-category cross-subsidy

Observations regarding Subsidy

- Revenue from tariffs can include subsidy
- Delayed payment can add to working capital requirement
- Unclear if pending payment becomes part of revenue gap

Revenue from charges for sales migration

- **Cross-subsidy surcharge**
  - Per unit charge for the compensation of loss of cross subsidy due to open access
  - Not applicable on captive consumers
  - As per tariff policy it is
    - Tariff - Weighted average APPC+ per unit distribution cost+ per unit regulatory asset
  - Capped in many states at 20% of ABR
- **Wheeling charge**
  - Per unit charge for the use of the wires network to wheel power
  - Estimated as cost of wires network above 11 kV by total energy wheeled
- **Additional surcharge**
  - Per unit charge to compensate for backing down due to reduction in DISCOM demand due to open access
  - Fixed costs for backing down attributable to open access, is divided by applicable sales
- **Standby charges**
  - For providing power to captive and open access consumers at a short-notice over and above contracted demand

How are revenue gaps handled?

Annual revenue gap (Rs. Cr)	FY16	FY17	FY18	FY19	Total
Aggregate Revenue Requirement	10,000	10,600	11,200	11,900	43,700
Revenue recovered from all sources	9,000	9,540	10,080	10,710	39,330
Revenue gap for the year	**1,000**	**1,060**	**1,120**	**1,190**	**4,370**
Carrying cost and Cumulative revenue gaps (Rs. Cr)	**FY16**	**FY17**	**FY18**	**FY19**	**Total**
Revenue gap	1,000	2,160	3,456	4,931	11,548
Revenue gap recovery	0	400	600	800	1800
Carrying cost (%)	10%	10%	10%	10%	
Applicable carrying cost	100	176	286	413	975
Cumulative Revenue gap with carrying cost	**1,100**	**2,336**	**3,742**	**5,345**	**12,522**

- Carrying cost payments for the period 22% of revenue gap
- Carrying cost recovery fait accompli
  - DISCOMs can under-estimate uncontrollable costs and over-estimate controllable costs
  - Recovery of uncontrollable costs guaranteed with carrying costs
  - Provides space to ensure revenue gap projected is met without much tariff increase
  - The actual revenue gap during true-ups will be much more
- **Is there a difference btw revenue gaps with carrying cost and regulatory assets?**

Potential Impact on Revenue Gap : Maharashtra Case study

Financial Year	FY 17
Fuel cost increase (due to Coal cess and coal price increase)	2102
Loss of revenue due to reduction in estimated sales due to open access, captive	922
Levy of carrying cost on revenue gap (not accounted for my MSEDCL)	1366
Capital Expenditure funded through loans, not unapproved grants	220
Total Cost Increase	4610
Reduction in Operations and Maintenance if as per MYT norms (potential reduction possible with efforts)	-1443

- Revenue recovered to meet these costs in coming years
- Cumulative revenue gap alone > 10k Cr.

Checklist while reading a petition

- Read prayers and executive summary
- Major cost heads- focus on power procurement, capex, opex
- Tariff design proposals
- Compliance with directives
- Instances of under-estimation of fait accompli costs and over-estimation of controllable costs.
- Any other?

Some useful formats...1

Category-wise sales and revenue

Category	No. of Consumers	Fixed/Demand Charge		Variable Charges		Energy Sales (MU)	Connected Load/ Contract Demand	Revenue (Rs. Crore)						ABR (Rs./ kWh)
		Unit	Rate	Energy Charge (Rs/ kWh)	Wheeling Charge$ (Paisa/ kWh)			Fixed / Demand Charge	Energy Charge	Wheeling Charge	Total Revenue	ToD Rebate	Net Revenue	
HT Category														
HT I(A): HT - Industry (General)	14,091	Rs./kVA/Month	391.00	7.07	28.33	29,105.86	11,144,076.37	3,656.77	20,577.84	822.60	25,057.22	(543.08)	24,514.14	8.42
HT I(C): HT - Industry (Seasonal)	452	Rs./kVA/Month	391.00	7.34	28.33	101.98	58,208.75	19.43	74.85	4.96	99.24	(1.78)	97.46	9.56
HT I - Industry (Sub-Total)	**14,543**					**29,207.84**	**11,202,285**	**3,676.20**	**20,652.70**	**827.56**	**25,156.46**	**(544.86)**	**24,611.60**	**8.43**
HT II: HT - Commercial	3,060	Rs./kVA/Month	391.00	11.73	42.54	1,840.33	1,222,209.27	360.40	2,158.71	93.62	2,612.73	(6.38)	2,606.35	14.16
HT III: HT - Railways/Metro/Monorail Traction	76	Rs./kVA/Month	391.00	7.00	42.54	59.25	35,873.92	9.24	41.48	1.97	52.69	-	52.69	8.89
HT IV: HT - Public Water Works (PWW)	968	Rs./kVA/Month	391.00	6.30	42.54	1,647.46	446,414.25	157.09	1,037.90	69.74	1,264.73	(30.16)	1,234.57	7.49
HT V(A): HT - Agriculture Pumpsets	1,034	Rs./kVA/Month	69.00	3.77	42.54	804.12	583,322.92	26.74	303.15	13.71	343.60	-	343.60	4.27
HT V(B)): HT - Agriculture Others	390	Rs./kVA/Month	69.00	5.20	42.54	277.03	92,887.77	5.77	144.06	13.87	163.70	-	163.70	5.91
HT V: HT - Group Housing Societies (Residential)	394	Rs./kVA/Month	313.00	5.82	42.54	217.33	109,942.13	30.74	126.49	11.32	168.55	-	168.55	7.76
HT VIII(B): HT - Temporary Supply Others (TSO)	11	Rs./kVA/Month	391.00	12.00	42.54	4.32	3,180.25	1.05	5.18	0.20	6.43	-	6.43	14.89
HT IX(A): HT - Public Services-Government	351	Rs./kVA/Month	391.00	7.90	42.54	247.72	94,347.25	32.98	195.70	12.63	241.31	(2.63)	238.67	9.63
HT IX(B): HT - Public Services-Others	954	Rs./kVA/Month	391.00	9.70	42.54	769.01	363,990.53	125.84	745.94	32.49	904.27	(8.19)	896.09	11.65
HT - MSPGCL-Aux Supply	32		-	-	-	218.25	173,515.18	-	-	-	-	-	-	
Sub-Total HT Category	**21,423**					**35,292.66**	**14,327,968.60**	**4,426.06**	**25,411.30**	**1,077.12**	**30,914.47**	**(592.22)**	**30,322.26**	**8.59**
													-	
LT Category													-	
LT I(A): LT - Residential-BPL Category (0-30 units)	176,751	Rs./Connection/Month	25.00	1.10	-	54.35	18,544.60	5.30	5.98	-	11.28	-	11.28	2.08
LT I(B): LT - Residential	19,349,159					20,282.28	21,286,258	2,089.71	9,981.82	2,596.13	14,667.66	-	14,667.66	7.23

Some useful formats…2

Energy Balance

Particulars	Unit	Projected by Petitioner for FY 2016-17	Approved by the Commission for FY 2016-17
Energy sales	MU	7,195.23	7117.85
Less: Energy supplied to DF area	MU	644.59	749.87
Less: Sales to Nepal	MU	1,188.89	1188.89
Less: UI	MU	77.35	-
Energy sale excluding DF area and Nepal	MU	5,284.40	5179.10
Distribution loss	%	31.43%	19.25%
Distribution loss	MU	2,422.73	1234.65
Energy required (5+7)	MU	7,707.12	6413.75
Add: Energy to DF area including loss for DF area	MU	644.59	749.87
Energy required at Distribution periphery (8+9)	MU	8,351.72	7163.62
Add: Sales to Nepal	MU	1,188.89	1188.89
Total energy required (10+11)	MU	9,540.61	8352.51
State Transmission loss	%	4.74%	3.92%
State Transmission loss	MU	480.17	340.78
Add: UI sales	MU	28.74	-
Energy required at State Transmission periphery	**MU**	**10,049.52**	**8693.28**
Power Purchase from CGS, SGS and others	MU	10,311.36	-

Some useful formats...3

Category-wise Subsidy

Sr. No.	Category	Subsidy Approved by the Commission in Tariff Order dated 23.10.2017	Claimed by PSPCL in APR of FY 2017-18	GoP Subsidy to MS & LS Industrial Consumers (GoP memo dated 11.01.2018)	Subsidy now payable by GoP
1.	AP Consumption	5976.82	6252.05	-	5999.85
2.	Scheduled Caste (SC)/Domestic Supply (DS) free power upto 200 units with connected load upto 1000 watts.	1121.80	1359.34	-	1085.97
3.	Non-SC/BPL DS consumers free power upto 200 units with connected load upto 1000 watts.	87.24	84.71	-	67.85
4.	Backward class DS consumer free power upto 200 units with connected load upto 1kW.	707.98	707.98	-	73.95
5.	Freedom Fighters	0.83	0.83	-	0.83
6.	Subsidy for new/ prospective industry under Progressive Punjab summit, 2015	113.31	-	-	-
7.	Small Power (concessional tariff @₹499 paise per unit)	-	106.52	-	113.90
8.	MS+LS Supply Consumers subsidy on account of 50% share of arrears	-	-	300.00	300.00

Some useful formats...4

Historical information on sales, connected load and number of consumers

Table 5.1: Historical trend in category-wise units sold

(MUs)

Sr. No.	Category	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16
	LOW TENSION						
1	RGP	1602	1719	1818	1919	2130	2287
2	GLP	1067	1129	46	48	52	57
3	Non-RGP & LTMD			1119	1149	1250	1326
4	Public Water Works	156	167	174	183	199	220
5	Agriculture-Unmetered	473	474	474	473	473	472
6	Agriculture-Metered	389	451	513	447	579	710
7	Street Light	60	61	61	62	60	63
	Sub-Total	3747	4001	4205	4281	4743	5134
	HIGH TENSION						
1	Industrial HT	2221	2448	2454	2296	3161	3250
2	Railway Traction	361	376	372	378	391	291
	Sub Total	2582	2824	2826	2674	3552	3541
	TOTAL	6329	6825	7032	6955	8295	8675

Table 5.2 : Category-wise CAGR of Units Sold

Sr. No.	Category	5 year	4 year	3 year	2 year	1 year
	LOW TENSION					
1	RGP	7.37%	7.39%	7.94%	9.17%	7.35%
2	GLP			7.32%	9.20%	9.69%
3	Non-RGP & LTMD			5.82%	7.42%	6.06%
4	Public Water Works	7.07%	7.08%	8.15%	9.44%	10.14%
5	Agriculture-Unmetered	-0.06%	-0.13%	-0.21%	-0.17%	-0.29%
6	Agriculture-Metered	12.79%	12.02%	11.45%	26.04%	22.72%
7	Street Light	0.91%	0.72%	0.96%	0.66%	4.99%
	Sub-Total	6.50%	6.43%	6.87%	9.51%	8.24%
	HIGH TENSION					
1	Industrial HT	7.91%	7.34%	9.82%	18.98%	2.83%
2	Railway Traction	-4.21%	-6.20%	-7.87%	-12.22%	-25.56%
	Sub Total	6.52%	5.82%	7.81%	15.08%	-0.30%
	TOTAL	6.51%	6.18%	7.25%	11.68%	4.58%

Some useful formats…5

Compliance with Directives

Sl. No	Description of Directive	Time Period for compliance from the date of issue of the Tariff Order	Status of Compliance as submitted by Petitioners in the Petition	Commission's Direction
7	The Commission directs the Licensee to evolve principles for prudent segregation of ARR towards wheeling function and retail supply function embedded in the distribution function in accordance with Clause 2.1.2 of the Distribution Tariff Regulations.	Within 4 months	The Petitioners submitted that UPPCL has been requested to carry out a joint study for all discoms for segregation of ARR towards wheeling function and retail supply function embedded in the distribution function in accordance with Clause 2.1.2 of the Distribution Tariff Regulations.	The Commission has addressed the same in its directives for FY 2017-18
8	The Commission directs the Licensee to submit a long term business plan in accordance with Clause 2.1.7 of the Distribution Tariff Regulations. The Licensee in such business plan shall identify capex projects for the ensuing year and subsequent four years and submit detailed capital investment plan along with a financing plan for undertaking the identified projects in order to meet the requirement of load growth, refurbishment and	Within 3 months	The Petitioners submitted that they are submitting the MYT Business plan along with this MYT tariff Petition.	Noted

For researchers: What is not reported well in ARR

- Actual Short-term liabilities and working capital requirement
- Pending subsidy payments in some states
- Pending payments to generators
- Progress under major programmes
  - Rural Electrification progress
  - Govt flagship programmes (IPDS, UDAY etc)
- Receivables from consumers / Arrears
- Parameters related to quality of supply and service, safety.
- Details on project specific investments
- Any other?

Additional sources of information

- CAG reports
- PFC/REC reports
- CEA reports
- SEWA Portal for coal related data
- DISCOM/Holding Company annual reports
- APTEL orders
- SoP reports

When to use which numbers ?

- Audited actuals- assessment of DISCOM performance
- Approved – assessment of consumer impact
- Estimates
  - Based on assumptions
  - Revised estimates: Half yearly actuals and Half yearly projections
- Projections – based on assumptions and past trends
- Keep in mind that approvals can also be subject to revision
  - Provisional true-up and Final true-up
  - Interim tariff and final tariff
- Any other observations?

Power Sector Planning – Why, What and How?

Training Workshop

Pune, February 11-12, 2019

Sreekumar N

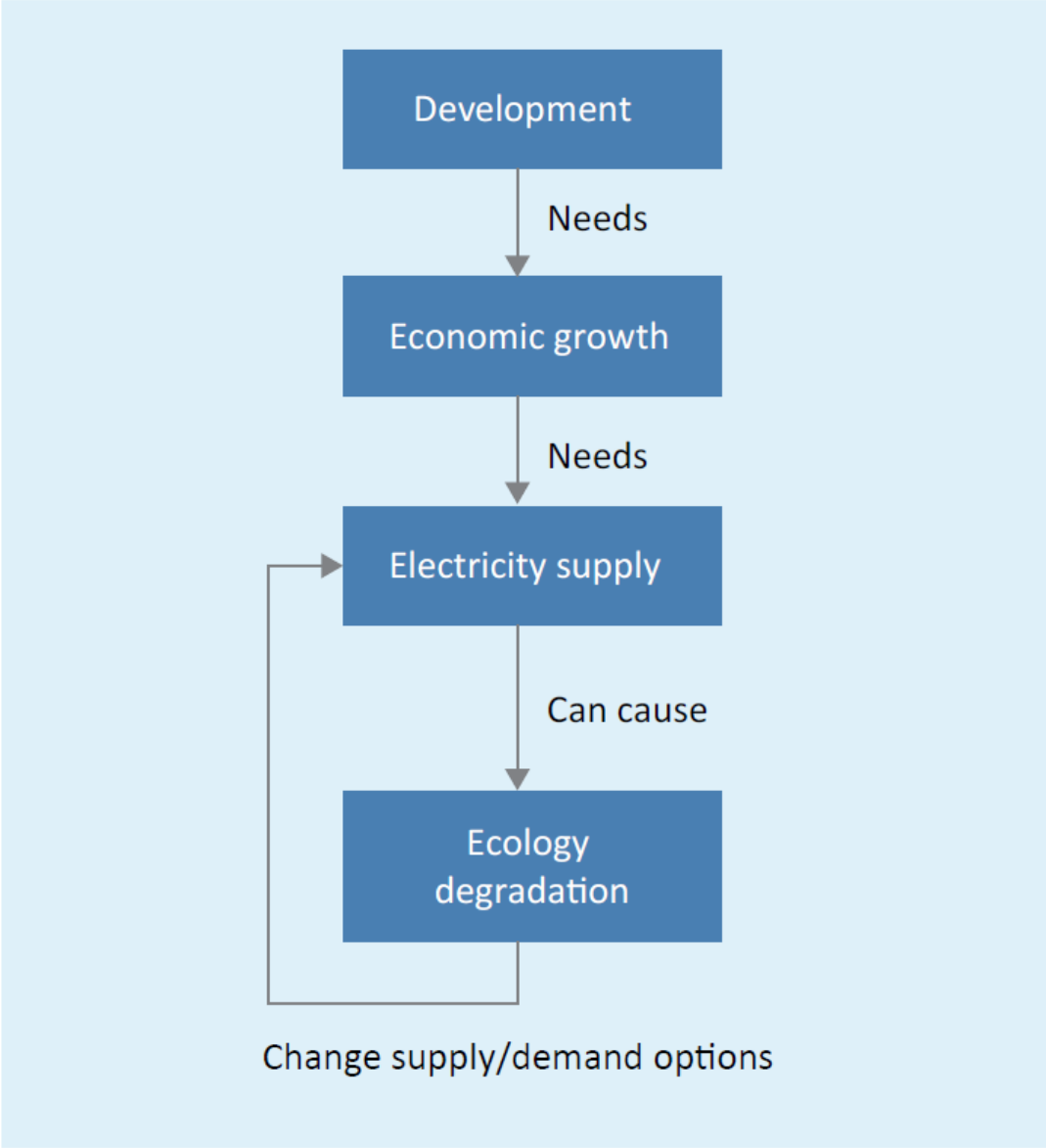
Does planning matter?

- Growth of market and private players, especially in generation, bulk retail
- Planning commission replaced by NITI Aayog
- But planning is crucial
  - A comprehensive approach to sector planning is crucial to ensure quality and affordable access with minimum social costs

Planning is crucial

- Significant investment
  - 5 lakh cr/year 2015-2040
  - Largely public
- Making mistakes will be costly
  - Long lead times, long life
- Significant impacts on natural resources, livelihoods
  - Need to minimise them
- Multiple actors, often with conflicting interests
  - Coordinated planning is crucial
- Challenges in connection and power shortage met, but
  - Challenges in quality of supply & service
  - Challenges due to growing market and renewables

Electricity sector planning framework



Links are flexible

Electricity sector planning – what is planned

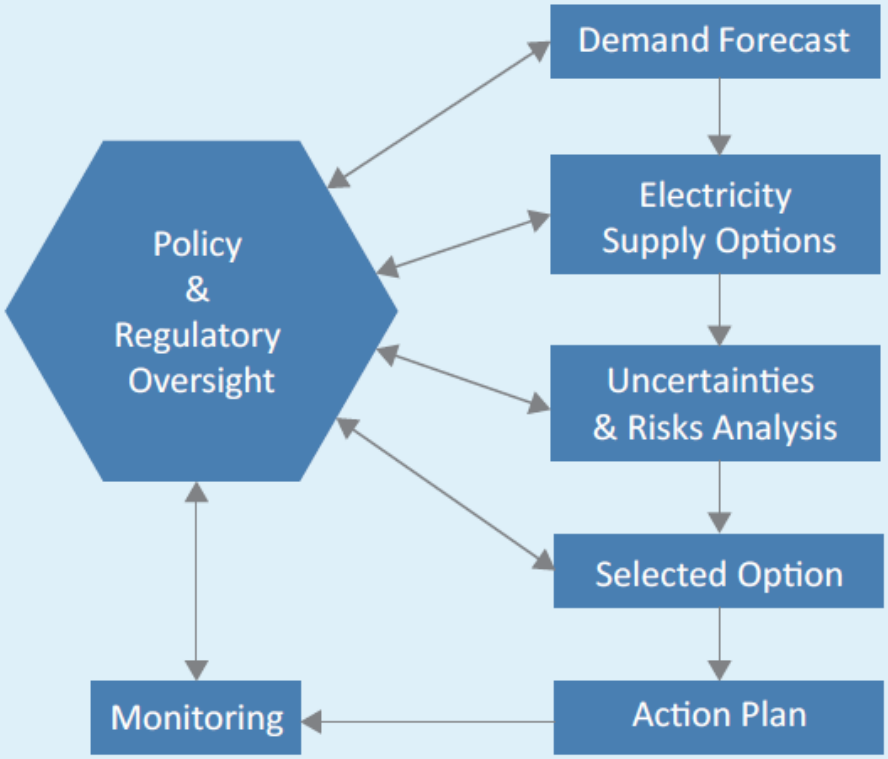
- Centralised generation, including fuel supply
- Distributed generation
- Demand side resources like energy efficiency and load management
- Transmission and distribution

- Support systems – not covered
- Planning horizons
  - Long term (10-20 years ahead)
  - Medium term (3-5 years)
  - Short term (from a few hours to a maximum of 1 year

Integrated Resource Planning - History

- Originated in the USA in 1970s
- Used by most utilities in USA, mandated by many Regulatory Commissions, Transparent participatory process
- Used in many countries
- India
  - Amulya K N Reddy for Karnataka 1990
  - Prayas for Maharashtra in 1994
  - IEI – West Bengal 1998, KERC 2008 staff paper, IRP cell in CEA 2009 – (National Electricity Plan etc)

Integrated Resource Planning – ideal approach



Energy Service needs, End-use efficiency impacts

Demand, cost, supply options, consumer behaviour

Centralised & Distributed generation, Fuels, Transmission, Ancillary services

Integrated Resource Planning - Steps

- 10-20 year time horizon
- Demand Forecast
  - Development oriented, end- use driven, bottom-up approach
  - Energy service, not energy supply per se
  - Output: Demand requirement in different scenarios
- Electricity supply options and costs
  - Centralised and distributed
  - Fuel, transmission and support systems
  - Competing efficiency options
- Uncertainties and risks analysis
  - Planned
  - Un-planned – quantifiable, not easily quantifiable
  - Reserves and back-ups to handle risks
- Selection of an option, Action plan
  - Minimise economic and social costs, while meeting demand
- Monitoring and Evaluation

Planning in India – National

- CEA
  - National Electricity Plan
  - Electric Power Survey (EPS)
  - Load Generation Balance Report
- Other
  - Integrated Energy Policy 2006
  - National Energy Policy draft 2017
  - National programs and missions
    - Solar, wind, efficiency missions
    - Rural electrification, 24 x 7 Power for All, Urban distribution …

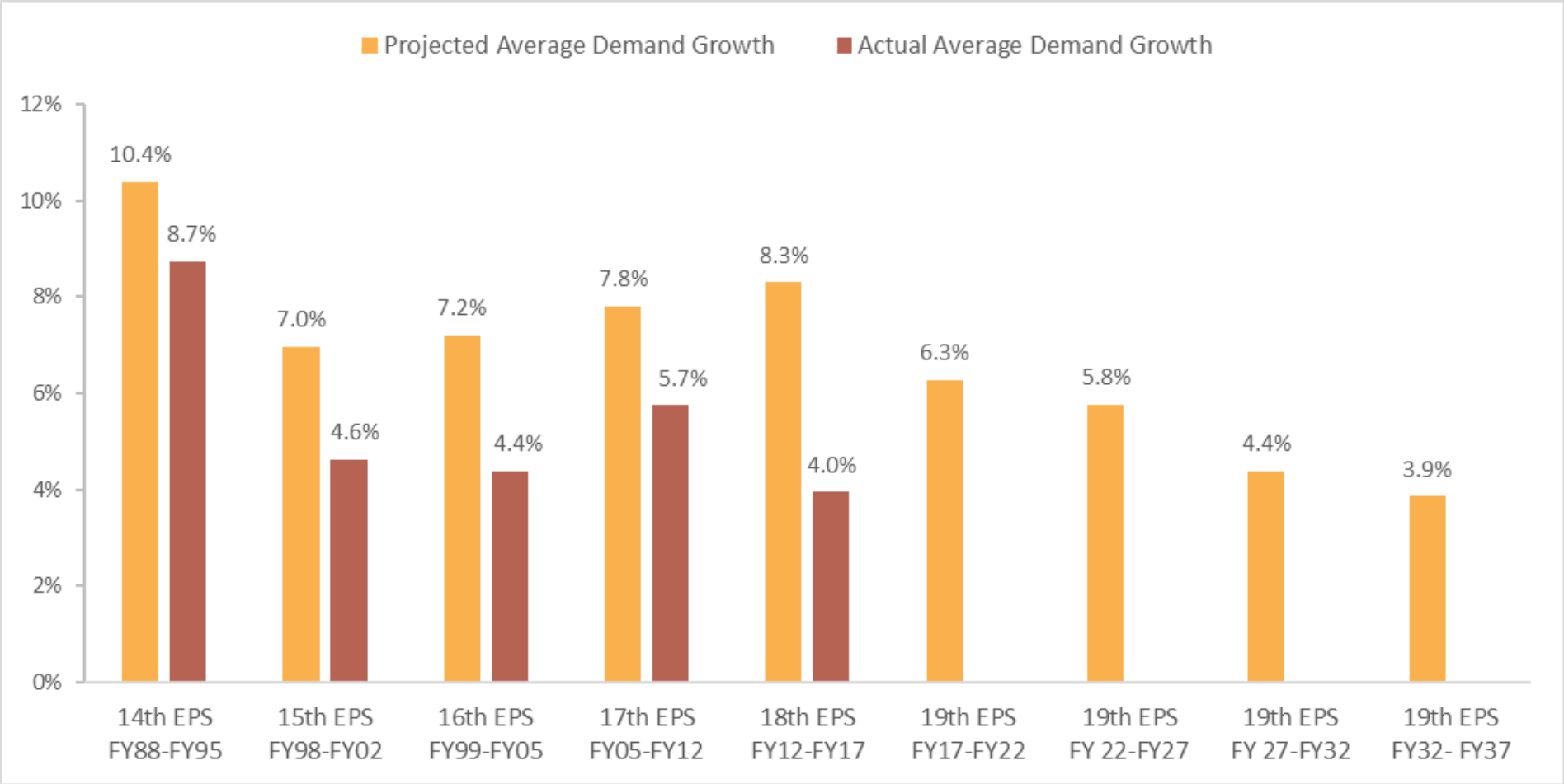
CEA – Electric Power Survey

- Once in 5 years
- Demand forecast for next 5 years, perspective plan for 10th and 15th years
- Based on data from DISCOMs
- Demand forecast for 8 categories
  1. Domestic
  2. Commercial
  3. Public lighting
  4. Public water works
  5. Irrigation (agriculture pumps and lift irrigation)
  6. Industry (LT, HT with less than 1 MW connected load, and HT with more than 1 MW connected load)
  7. Railway traction
  8. Bulk supply

EPS methodology – partial end use

- For each DISCOM
  - For each category, forecast energy demand based on a combination of historical trends and expected changes (efficiency, railway electrification, lift irrigation, make in India …)
  - Calculate total annual energy requirement of consumers
  - Add T&D loss to calculate generation requirement
  - Calculate peak generation (demand) requirement using load factor (= average load/peak load)
- Calculate State peak load using diversity factor, energy by adding DISCOMs requirements
- Calculate Regional and Country peak demand using diversity factors, energy by adding State/Region requirements

CEA – Electric Power Survey – over-optimistic



National Electricity Plan - CEA

- As per E Act – 2007, 2013, 2018
- 5 year plan and 15 year perspective plan
  - Demand
  - Generation
  - Transmission
  - Fuels
  - Funds
  - Research and Development
  - Human resource

National Electricity Plans

- Integrated Energy Policy – Planning Commission 2006
- India Energy Outlook, IEA 2015
- Plans and programs for renewable energy expansion, rural electrification, urban distribution, electric vehicles, energy efficiency etc
- National Energy Policy draft – NITI Aayog 2017

State planning exercises

- Multi-Year Tariff framework
  - 3-5 year time horizon
  - Business plan with demand, power procurement, capital investment, financing, performance targets
  - Annual expenses and revenue requirement plan
  - Controllable and uncontrollable parameters
  - Review of Plan
- SERC processes on load forecasting and power procurement
- Power For All plans prepared by states and central government
- Load management, Restriction and Control measures
- Annual tariff revision process

Improving the planning process -1

- National
  - Improve consultative process of CEA and NITI plan processes
  - Independent studies using models – scenarios, better coordination
  - Improve demand and supply estimation
    - Load surveys
    - Peak and base load requirements
    - Accounting for open access, captive, distributed generation …

Improving the planning process -2

- State
  - Improve demand and supply estimation
    - Unmetered consumers
    - Load surveys
    - Peak and base load requirements
    - Accounting for open access, captive, distributed generation …
  - Periodic revision of MYT regulations
  - Linking quality of supply to capital investment and O&M expenses
  - Better participation in MYT processes
  - Independent studies using models – scenarios, better coordination
  - As or more important than annual tariff revision process

Understanding and planning for the energy transition

Ashwin Gambhir

Towards improving service delivery and sector health through multi-disciplinary skills in electricity sector

Training workshop for civil society and electricity sector professionals

12th February, 2019, 1430-1515

Outline

- Changes underway and expected in the long run

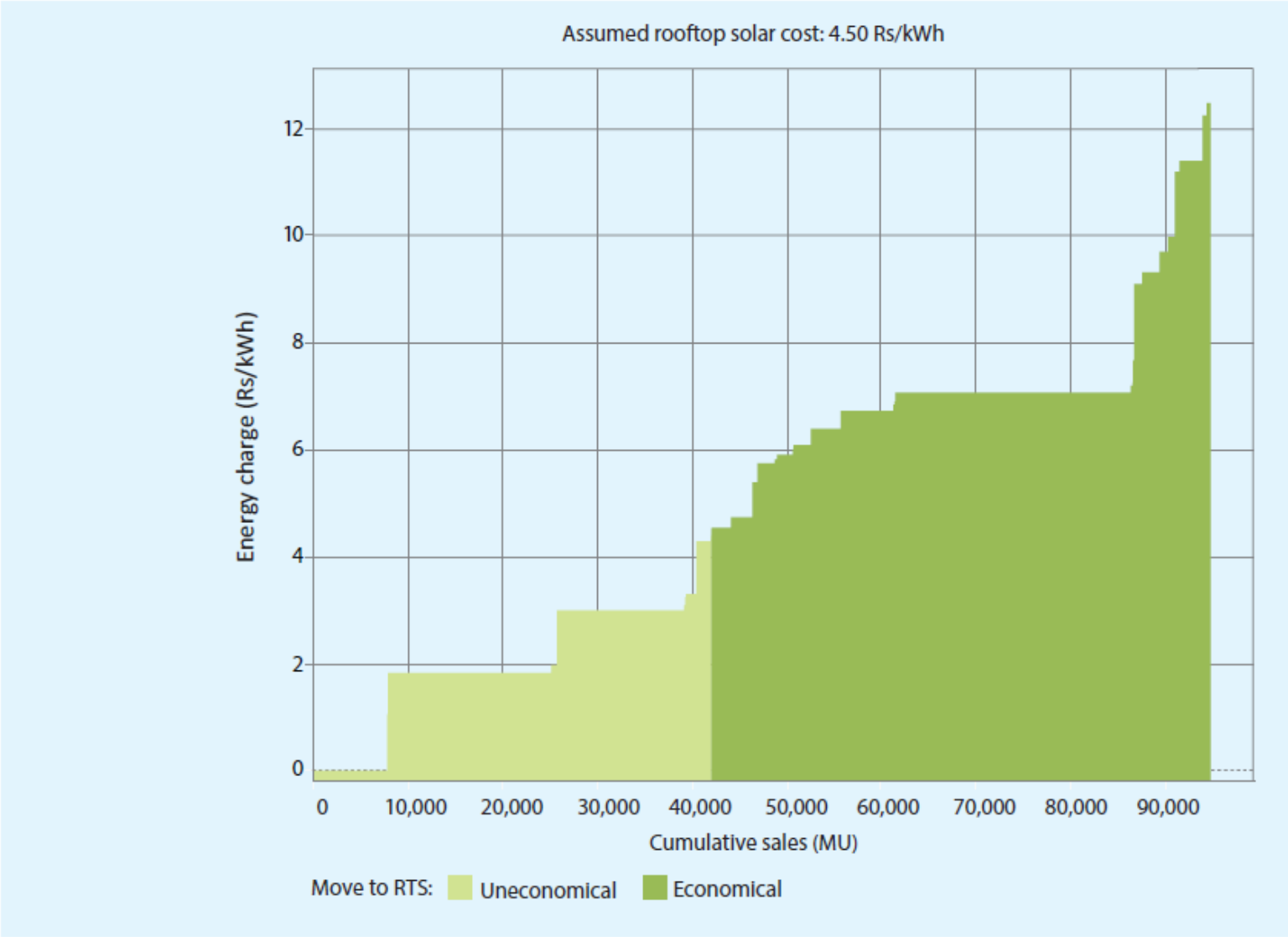
- Changing nature of the electricity grid

- Preparing for an uncertain future and shaping a just transition

Changes underway, expected in the long run

- Traditional grid
  - network wherein electricity flows from a few centralised, large electricity generators - mostly powered by coal and large hydro - over long distances through high voltage transmission lines to crores of consumers.
- Changes underway
  - Universal access: 99.99% HH electrified
  - Competing supply options: rooftop PV, OA, CPP
  - Increasing renewables: 21% RPO by 2022, by 2030?
  - New coal becoming increasingly un-competitive, pressure to price/include externalities: MoEFCC norms
  - Storage, EVs: Ever reducing costs.

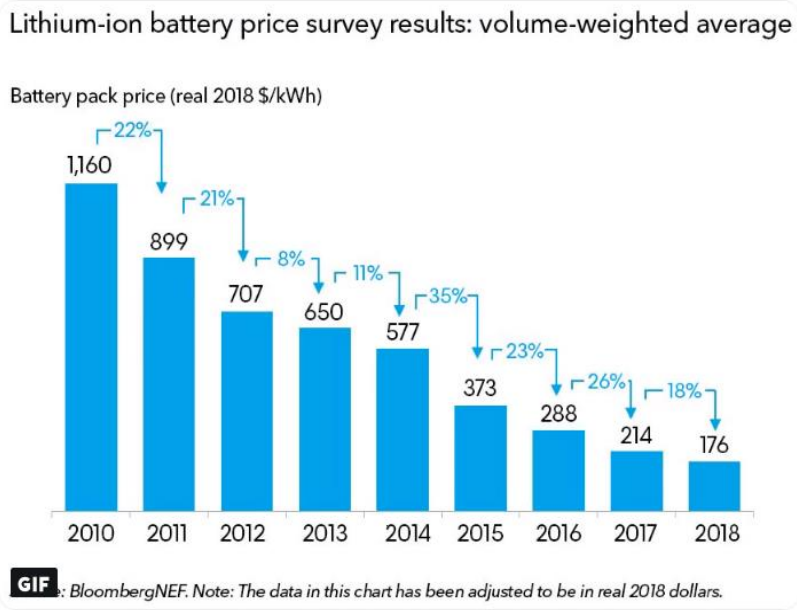
Figure 10.2: MSEDCL DISCOM sales which can cost-effectively move to rooftop solar



Source: Prayas (Energy Group) analysis based on MSEDCL and SECI data.

Electric Storage, esp. Li-ion batteries

- 1160 – 176 **$/kWh** (2010-18), 85% reduction, @ 21% annual avg. reduction
- Expected at $ 100/kWh by 2020/22
- Long term price trend
  - 70-50 $/kWh by 2030
  - 40 $/kWh by 2040
- Extremely modular, low gestation period and multiple applications



Can fundamentally change the sector planning, operation and business model of utilities.

Changing nature of the electricity grid

- Large number of new entities
  - 40 GW rooftop solar ~ 10-20 lakh projects compared to 1250 large generating units today. Similar for EVs etc.
  - Smart grid, smart meters
- Weather dependency and reliable integration of renewables
  - Will need more system flexibility
- Changing nature of grid
  - From selling energy to grid services (access to markets, supply quality, reliability and back-up services, Optimal sizing / operation of the distributed energy systems with grid support
  - 2 existing examples – energy banking, transmission wires for OA
- Growing complexity and importance of sectoral planning
  - limited rigour in critically evaluating and prioritising needs, anticipating changes and risks, and preparing for them.
  - More comprehensive and multi-sectoral

Figure 10.5: Changes and challenges in distribution sector

Source: Prayas (Energy Group)

Reimagining planning

- For an era of increasing uncertainty, risks and fast paced changes.
  - *The most important lesson of both experience and analysis is that societies' abilities to cope with the unknown depend on the* ***flexibility of their institutions and individuals****, and on their capacity to* ***experiment freely with alternative forms*** *of adaptation to the risks which threaten them.* (W C Clark, 1980, paper on risk management)

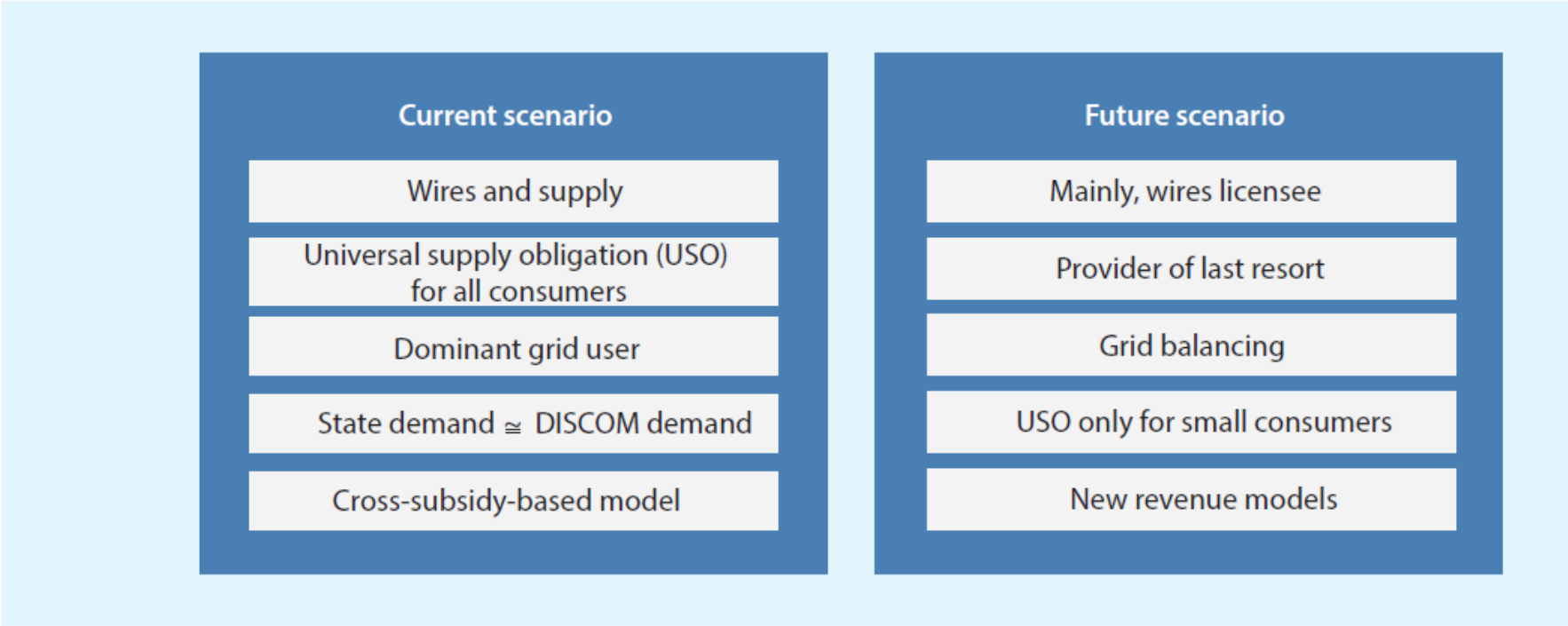
- Thus, it is our collective response through policy, regulation and pro-active preparation which will determine whether reliable, affordable and sustainable electricity can be provided to all.

Preparing for uncertain future, shaping a just transition (1)

- Preparing for a ‘future’ electricity distribution sector
  - Loss of cross subsidising consumers, more uncertainty in planning power procurement; rise in small consumer tariffs/increase in direct state govt. subsidy
  - E Act amendment focus on Carriage and Content Separation, emphasis on markets

- New tariff models
  - Considering prosumers, partial dependence on DISCOM, focus on grid services and not just sale of electricity

Figure 10.6: Changing nature of the DISCOM



Source: Prayas (Energy Group)

Preparing for uncertain future, shaping a just transition (2)

- Need to monitor and improve quality of supply for small consumers
- Greater emphasis on data
- Grid integration of renewable energy and energy efficiency uptake
- Rethinking the institutional framework for planning and operation
  - 175 GW RE and increased coal/thermal power
  - Electrification of transport and ambitious plans for petroleum refinery/biofuels.

Preparing for uncertain future, shaping a just transition (3)

- Reducing the relative significance of coal and petroleum in the long run
  - *Importance of a just energy transition (jobs, geography…)*
  - *Coal and petroleum taxation*
    - *Coal – 66k crore/year and petroleum – 5.5 lakh crore/year (25-30% of total country tax base)*
  - *Railways dependence on coal freight*
    - *30% of revenue from coal*
  - *Flexible coal power for grid reliability*
    - *Lower PLFs, two cycle daily shift operation? Newer tariff structures?*
  - *Environmental and social concerns*

- Implications for governance, politics and equity.

Figure 9.2: Public financial institutions financing stressed and non-performing assets

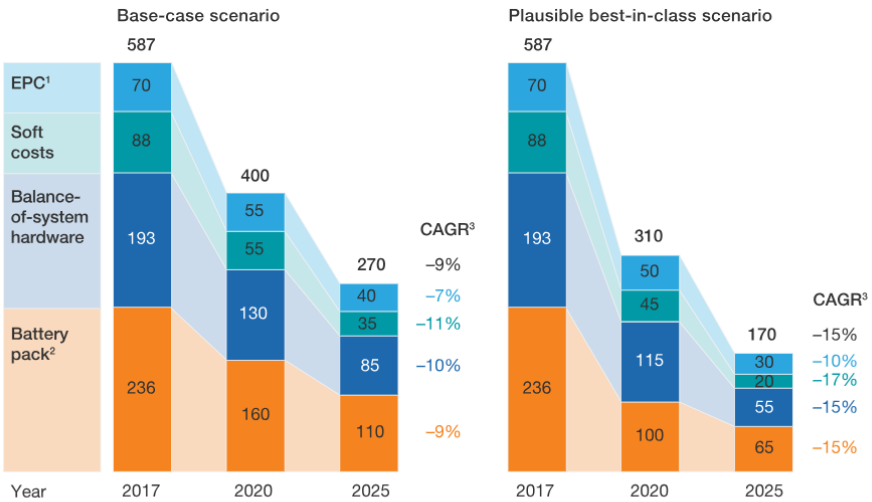
Source: Prayas (Energy Group)

Figure 10.4: Issues with quality of supply

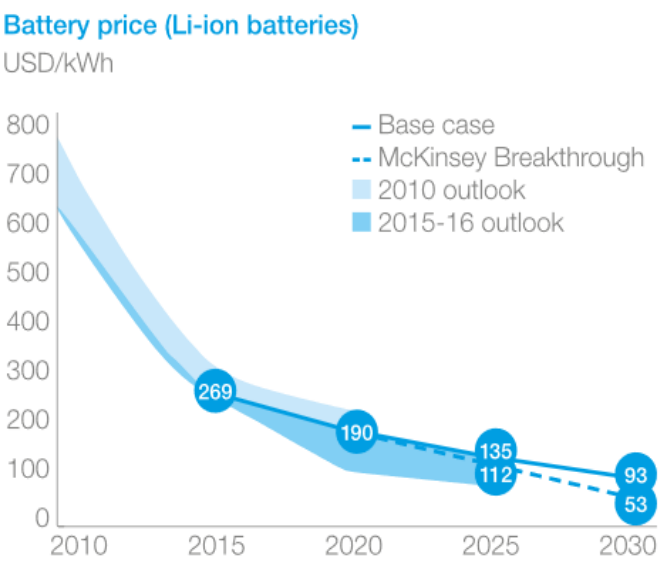
Source: Electricity Supply Monitoring Initiative (ESMI) www.watchyourpower.org

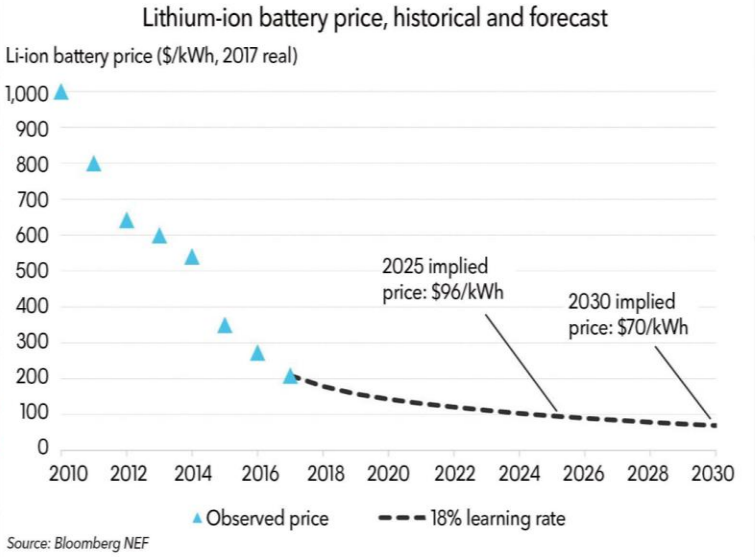
The per–kilowatt-hour cost of an energy-storage system could drop to $310–$400 by 2020, on a path to $170–$270 by 2025.

Cost of a 1-megawatt energy-storage system with a 1-hour duration by segment,
$ per kilowatt-hour/% change



¹Engineering, procurement, and construction.
²Battery-pack cost includes battery-management system, cells, and modules.
³Compound annual growth rate, 2017 to 2025.





Electric Storage unique: Load & Generation

- Not a standard product, has multiple
  - ***applications*** (energy /load shift, RE integration, power quality and reliability enhancement, congestion management, infrastructure deferment etc.);
  - ***uses, i.e. public*** (power quality, reliability etc.) or ***private*** (backup power etc.)
  - ***scales*** (MW/kW); modular nature
  - ***interconnection voltages*** (Transmission, distribution, consumer);
  - ***ownership possibilities*** (Transco/DISCOM/IPP/consumer etc.);
  - ***revenue streams*** for different value propositions possible ***simultaneously***;

- Regulating such a complex system difficult. Significant scope for work.

Solar + Storage (recent bids from US)

- Excel Utility, Colorado latest bids (2018)
  - Solar-560 MW, Storage 275 MW, 4 hours, i.e. 1100 MWh (operational in 2023)
  - Solar: 2.3-2.7¢/kWh (i.e. Rs. 1.5-1.76/kWh)
  - ***Solar + storage: 3-3.2¢/kWh (i.e. Rs. 1.95-2.08/kWh)***
  - 100% of its existing coal generation is now more expensive than these bids.

- NV Energy, Nevada, PPAs signed in May, 2018
  - 3 solar + storage project filed for regulatory approval
  - Solar – 401 MW, at 2.65-2.99 ¢/kWh
  - Storage – 100 MW, 4 hours, i.e. 400 MWh
    - 2 contracts are for 15 years, for a capacity payment charge of $ 6110-6200/MW-month escalating at 2%/yr. Implies a LCOS of 5.7 ¢/kWh. This configuration of storage adds ~ 0.7 ¢/kWh (Rs 0.5/kWh) to solar PPA.
    - Incremental PPA price adder for storage has fallen to ~$5/MWh.
      - *Source: Bolinger et. al, Utility-Scale Solar: Empirical Trends in Project Technology, Cost, Performance, and PPA Pricing in the United States – 2018 Edition. 2018.*

Tools for engagement in the power sector

Srihari Dukkipati

Training Workshop

Pune, February 11-12, 2019

Tools for power sector engagement

- Potential advantages
  - Time saving
  - More robust analysis
  - Insights which are otherwise difficult to see
- Potential pitfalls
  - Need for expertise and computing resources
  - Can be black box in nature
  - Increased complexity can make them inaccessible
- Two examples
  - Power sector modelling
  - Utility financial model

Power sector modelling

- Dispatch modelling – typically a year or shorter
  - Electric grid and market simulation
  - Optimal maintenance schedules
  - Hydro-thermal coordination
  - Role of storage
  - Transmission congestion
  - Zero schedule
- Investment optimisation – over many years
  - Optimise generation/transmission capacity addition

Key data inputs and outputs

Inputs

Load: energy, profile, growth over years

Generators: capacity, technical characteristics, cost trajectories, profiles

Contracts

Model settings: horizon, interval, steps, etc.

Scenarios

Outputs

Shortage and Surplus

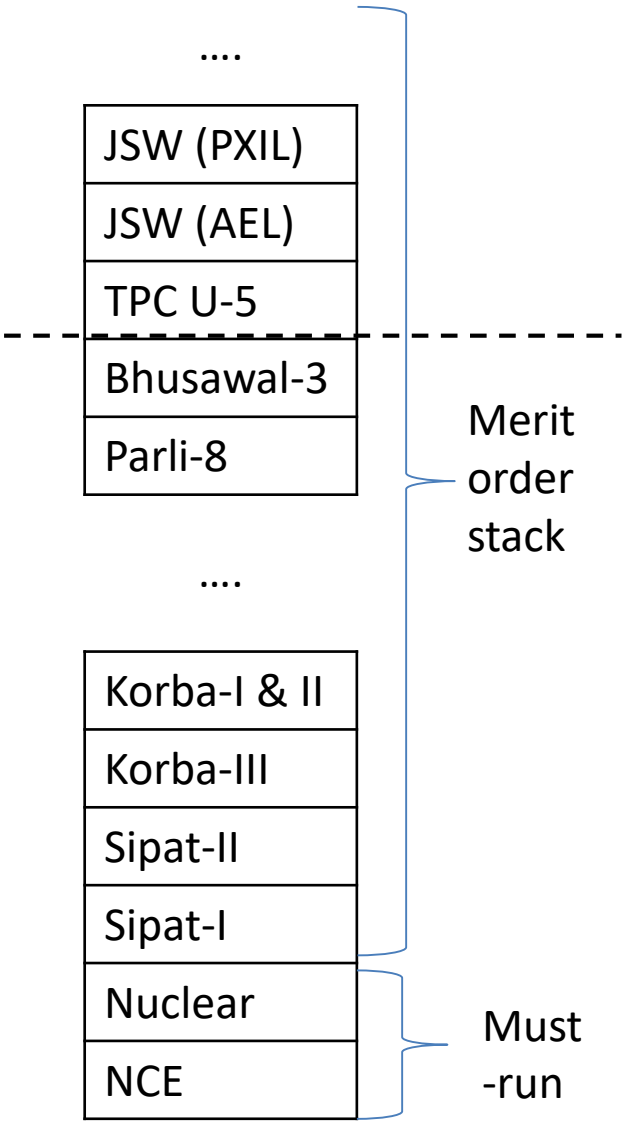
Generator-wise availability, generation, outages, etc

Costs

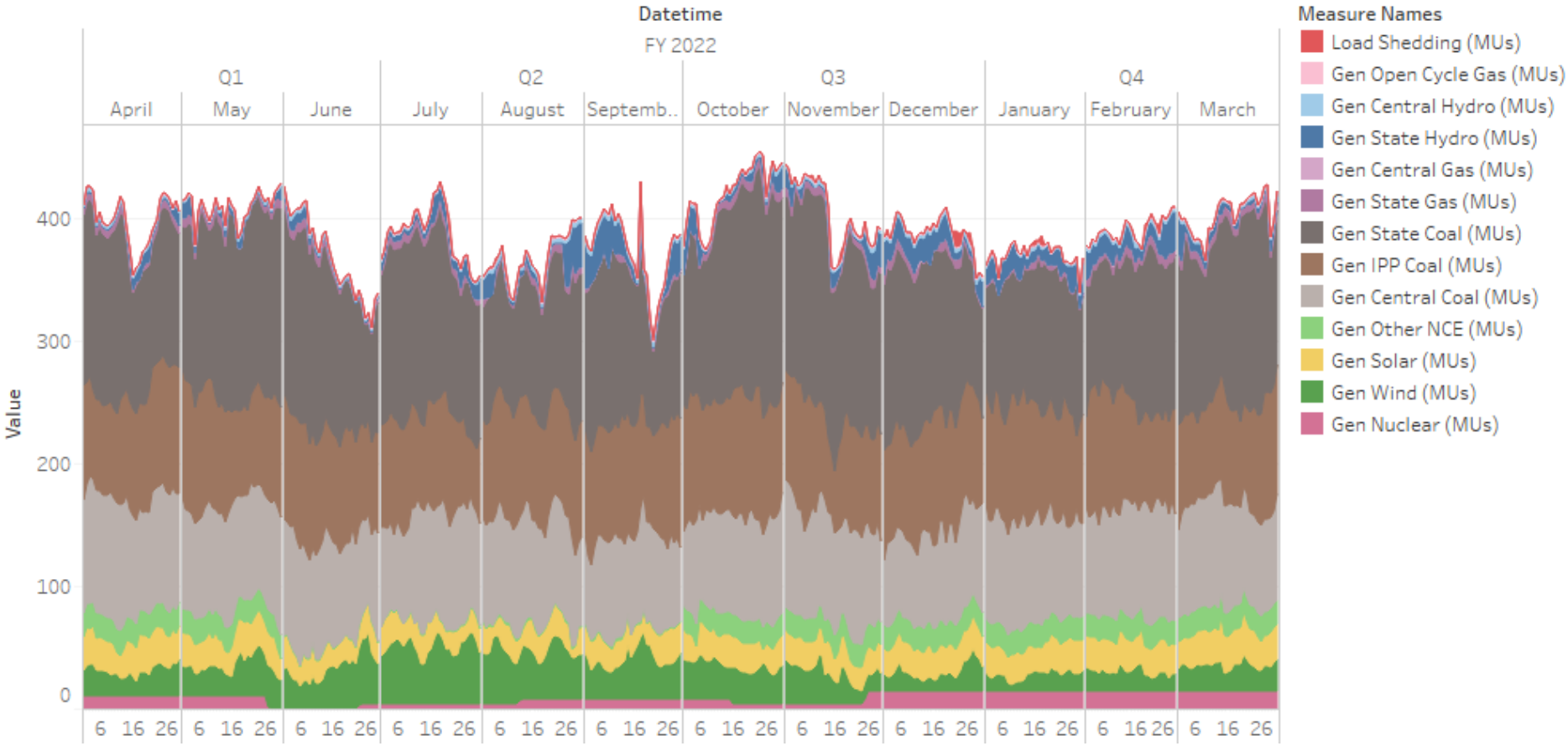
All of the above at each 1 hr/15 or 5-min interval

Merit order stack-based dispatch

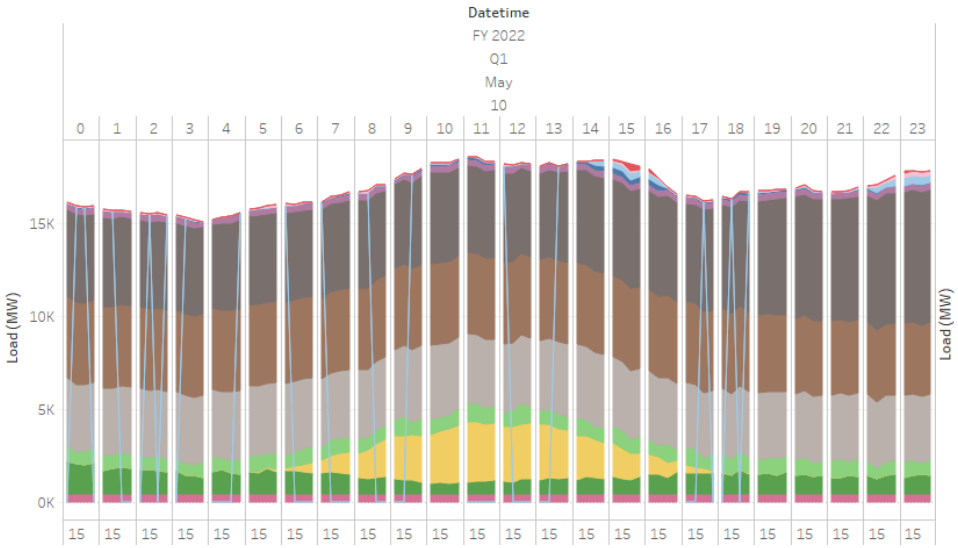
	Above Rs. 4				
1	KAWAS (RLNG)*	CS	xxx	Gas	7.5973
2	GANDHAR (RLNG)*	CS	xxx	Gas	7.5130
3	TPC U-7 (RLNG)	TATA	xxx	Gas	7.0530
4	SOLAPUR STPS U-1	CS	344	Coal	4.3053
5	TPC U-8	TATA	250	Coal	4.0160
	Between Rs. 3 to 4				
6	DTPS REL U-1 & 2	AEML(REL)	500	Coal	3.9565
7	PARALI U-6 &7	MSPGCL	500	Coal	3.9203
8	JSW U-2,3 &4 TO AEML (PXIL)	STOA	125	Coal	3.8700
9	JSW U-2,3 &4 TO AEML (AEL)	STOA	250	Coal	3.8700
10	TPC U-5	TATA	500	Coal/Oil/Gas	3.7002
11	BHUSAWAL U-3	MSPGCL	210	Coal	3.3892
12	PARALI U-8	MSPGCL	250	Coal	3.2747
13	NASIK U-3,4 & 5	MSPGCL	630.0	Coal	3.1846
14	RATTANINDIA U-1 TO 5 (PPA-1200 MW)	IPP	1200	Coal	3.1621
	Between Rs. 2 to 3				
15	KAWAS (GAS)-NAPM*	CS	xxx	Gas	2.9332
16	GANDHAR(GAS)-NAPM*	CS	xxx	Gas	2.9281
17	MOUDA (MSTPS) STG-II	CS	285	Coal	2.9201
18	VIPL U-1 & 2	AEML(REL)	600	Coal	2.8936
19	MOUDA (MSTPS) STG-I	CS	424	Coal	2.8541
20	BHUSAWAL U-4 & 5	MSPGCL	1000	Coal	2.8135
21	KHAPERKHEDA U- 1 TO 4	MSPGCL	840	Coal	2.7889
22	JSW-Ratnagiri U-1	IPP	300	Coal	2.7839
23	ADANI (TIRODA 440 MW PPA) U 1,4 & 5	IPP	440	Coal	2.7212
24	KHAPERKHEDA U-5	MSPGCL	500	Coal	2.6767
25	KAWAS (GAS)*-APM	CS	204	Gas	2.6680
26	CHANDRAPUR U-3 TO 7	MSPGCL	1920	Coal	2.6678
27	KORADI U-8 ,9 &10	MSPGCL	1980	Coal	2.6389
28	GANDHAR (GAS)*-APM	CS	200	Gas	2.6314
29	KORADI U-6 & 7	MSPGCL	620	Coal	2.6282
30	CHANDRAPUR U-8 & 9	MSPGCL	1000	Coal	2.6279
31	ADANI ,TIRODA U-1, 4 & 5 (PPA-1200 MW and 125 MW)	IPP	1325	Coal	2.5575
32	PARAS U-3 & 4	MSPGCL	500	Coal	2.5063
33	GTPS URAN	MSPGCL	672	Gas	2.3542
34	KAHALGAON-ER (KHTPS) - STG.-II	CS	148	Coal	2.2592
35	TPC U-7 (APM)	TATA	180	Gas	2.1645
36	EMCO (WARORA) (MTOA) (PPA-200 MW)	CS	200	Coal	2.1423
37	CGPL Mundra UMPP	CS	800	Coal	2.0640
	Below Rs. 2				
38	ADANI (TIRODA 1320 MW) U 2 & 3	IPP	1320	Coal	1.7677
39	VINDHYCHAL STG-I	CS	461	Coal	1.6224
40	VINDHYCHALSTG-V	CS	176	Coal	1.5300
41	VINDHYCHAL STG-II	CS	357	Coal	1.5238
42	VINDHYCHAL STG-IV	CS	324	Coal	1.5238
43	VINDHYCHAL STG-III	CS	296	Coal	1.5196
44	KORBA (KSTPS) STG-I & II	CS	667	Coal	1.4553
45	KORBA (KSTPS) STG-III	CS	135	Coal	1.4366
46	SIPAT (SSTPS) STG-II	CS	294	Coal	1.3246
47	SIPAT (SSTPS) STG-I	CS	616	Coal	1.2734

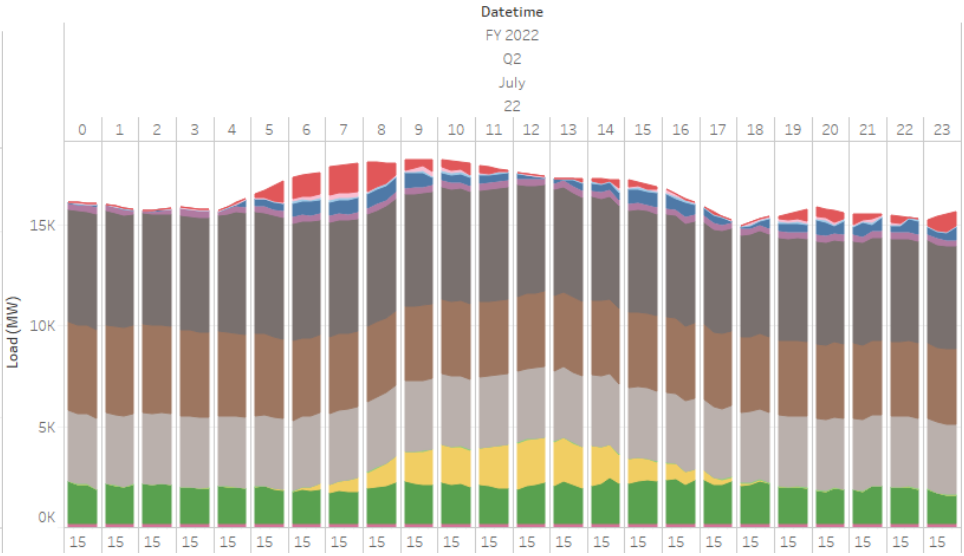


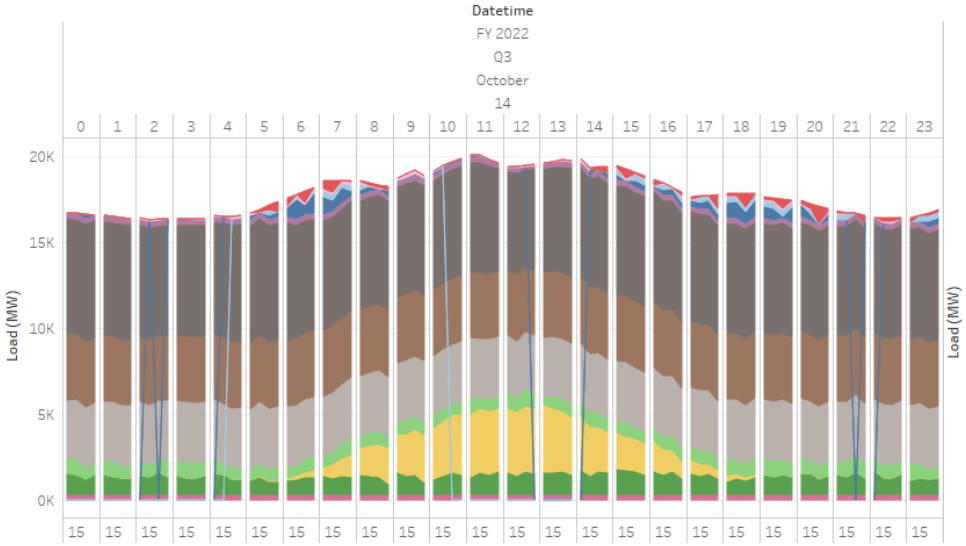
Example: Daily load, generation and shortages

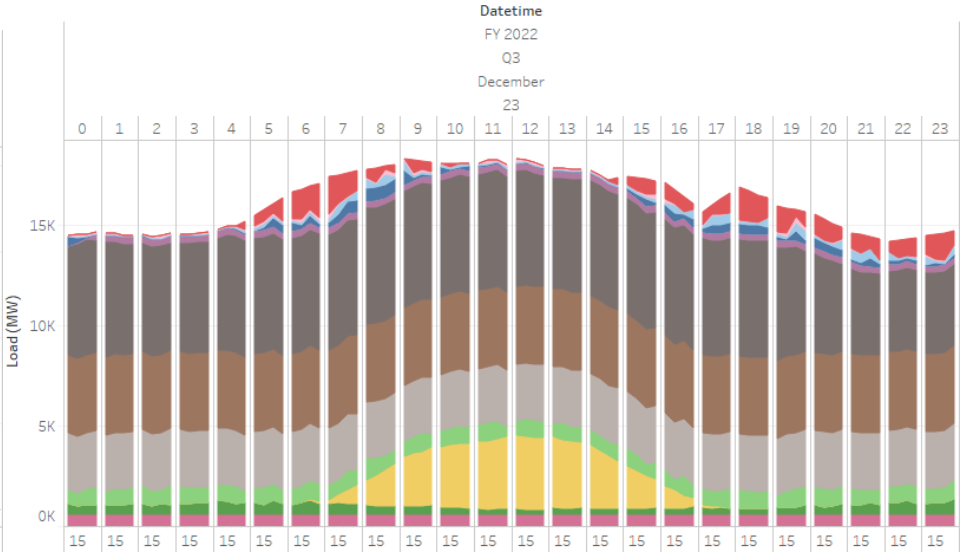


Example: Snapshots from sample days

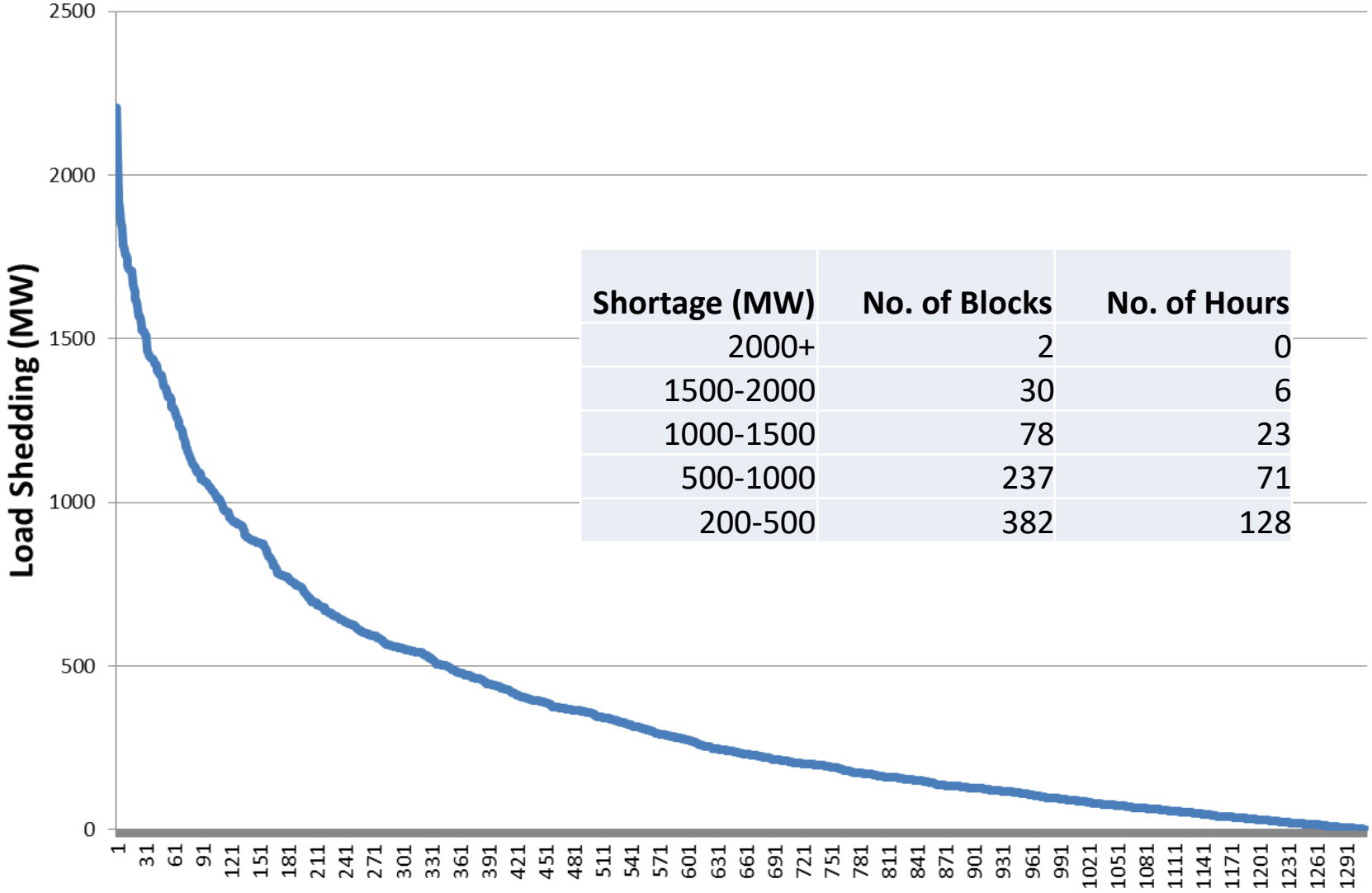






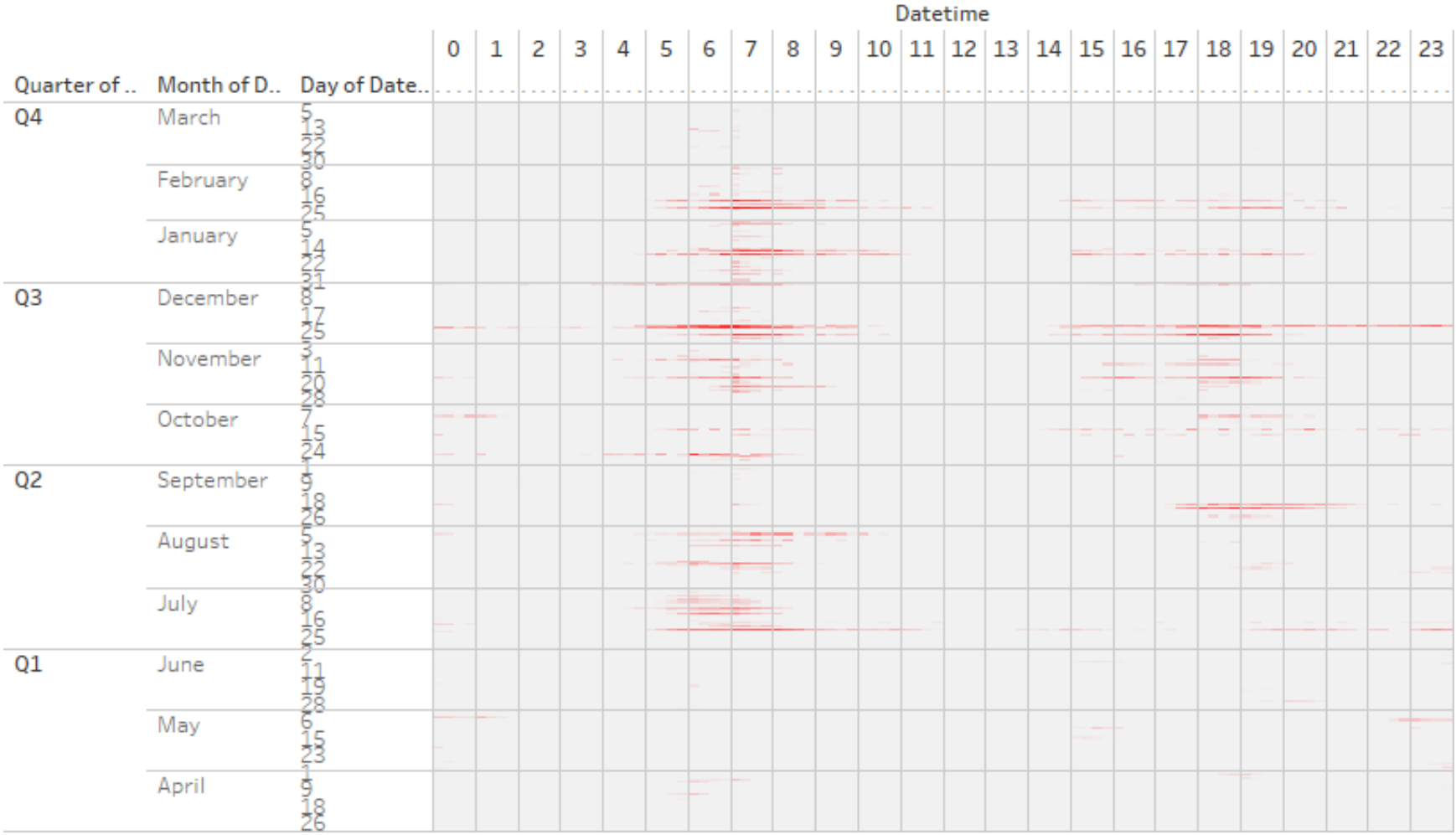


Example: Shortage profile



Shortage (MW)	No. of Blocks	No. of Hours
2000+	2	0
1500-2000	30	6
1000-1500	78	23
500-1000	237	71
200-500	382	128

Example: Shortage profile



Some applications of power sector models

- Better estimation of seasonal and diurnal variation in shortage and surplus
  - need for short term power purchase
  - possibility of surplus sale
  - Medium term supply options to address recurring seasonal and diurnal shortages
- Impact of changes in regulatory approach
  - Technical minimum, ramp rates, RE banking, MoD
- Impact of short-term and long-term open access on system operation and costs
- Comparison of different capacity addition strategies
  - Different RPO trajectories, different RE mix (wind vs solar, diff. wind profile sites), storage, thermal

Utility financial model – RATE

- Rapid changes in electricity sector
  - Higher RE due to falling prices and policy push
  - Uncertainty in demand growth due to sales migration, EE initiatives and unmetered demand
  - Lower thermal PLFs → higher per-unit fixed costs
  - Implications for power procurement and tariff design
- Inter-related trends, hence need to assess cumulative impacts
- RATE: Evaluate impact of 'what-if' scenarios (different DISCOM strategies) on consumer tariffs and DISCOM's financial health

RATE Model: Features and Possibilities

- Excel-based DISCOM financial and performance analysis model developed by Prayas
- Provision for disaggregated inputs for various components of utility operations
- Structured to assess cumulative impacts of changes in various parameters
- Useful for medium term sense making (5-6 year time horizon)
- Annual treatment of most cost and performance heads
- Customisable to suit ERC/State/DISCOM/Genco/CSO needs

What RATE can help with:
☑ 'What-if?' scenario impacts
☑ Understanding cumulative impacts
☑ Identification of key issues
☑ Evaluate innovative ideas, regulatory decisions
☑ Sense making for different stakeholders

What RATE does not include:
☒ Merit Order Dispatch
☒ Accurate ARR estimation
☒ Monthly, quarterly, seasonal analysis
☒ Transmission pricing
☒ Load profile estimation

Scenario Assumptions

Assumptions by FY 22	Baseline Scenario	High RE Scenario	Sales Migration Scenario	Sales Migration + High RE Scenario
RE Capacity Addition	4,687 MW	15,053 MW	Same as Baseline Scenario	Same as High RE Scenario
Sales Migration	HT sales: 9-10% RTPV: 1.3-1.6%	Same as Baseline Scenario	HT sales: 46-50% RTPV : 6.3-8.8%	Same as Sales Migration Scenario

Analysis of AP DISCOMs using RATE

Particulars	Year	Baseline	Sales Migration	High RE	Sales Migration + High RE
% RE Generation	FY 22	17%	21%	44%	52%
Surplus (MU)	FY 22	8,800	21,300	31,600	45,200
APPC (Rs./unit)	FY 22	4.10	4.25	4.23	4.52
Power procurement cost (Rs Cr.)*	FY 22	34,700	-11.6%	3.2%	-6.0%

**Order of magnitude analysis- all numbers rounded off to nearest hundred. All % to one decimal point*

- **Revenue gap**:
  - Over 5 years, revenue gap after subsidy ↑ from Rs. 3,800 cr. to Rs. 32,000 cr.
  - This accounts for about 13% to 68% of total expenses.
  - Revenue gap higher in scenarios due to significant increase in costs (RE capacity addition) and fall in revenue (sales migration)
  - Sales migration scenarios responsible for highest losses

RATE-AP: Strategies to bridge revenue gap

Tariff increase required to eliminate revenue gap over five years	Scenarios
23% to 24%	Baseline
26% to 31%	High RE, Sales Migration
37% to 38%	Sales Migration + High RE

FY 22	Unit	Baseline	Sales Migration	High RE	Sales Migration +High RE
Revenue Gap	Rs. Cr.	32,100	40,100	40,000	49,200
Additional Subsidy	Rs. Cr	8,600	10,900	9,800	12,900

Order of magnitude analysis- All numbers rounded off to nearest hundred. Rates specified up to two decimal points.

Thank you