Energy Policies for India's Conversion to a Net-Zero Economy (EPIC)

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ASHOKA UNIVERSITY
CENTRE FOR A
People-centric
Energy Transition

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Ashoka Centre for People-centric Energy Transition (ACPET) addresses itself to the challenge of 'how-to' design systematic transition strategies and programmes so as to stay on track to meet nationally defined climate and sustainability goals while keeping the human dimensions of such pathways in clear focus.

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Abbreviations used in this publication

2G	Second Generation
3G	Third Generation
AERB	Atomic Energy Regulatory Board
APM	Administered Price Mechanism
BESS	Battery Energy Storage System
BF-BOF	Blast Furnace-Basic Oxygen Furnace
CAFE	Corporate Average Fuel Efficiency/Economy
CBA Act 1957	Coal Bearing Areas (Acquisition and Development) Act 1957
CBAM	Carbon Border Adjustment Mechanism
CBG	Compressed Biogas
CCTS	Carbon Credit Trading Scheme
CEA	Central Electricity Authority
CERC	Central Electricity Regulatory Commission
CGD	City Gas Distribution
CIL	Coal India Limited
CMSP Act	Coal Mines (Special Provisions) Act 2015
CNG	Compressed Natural Gas
COP-26	26th United Nations Climate Change Conference
CPWD	Central Public Works Department
CSIR	Council of Scientific and Industrial Research
DAE	Department of Atomic Energy
DBT	Direct Benefit Transfer
DGH	Directorate General of Hydrocarbons
Discom	Distribution company
DRE	Distributed Renewable Energy
DSF	Discovered Small Field
E&P	Exploration and Production
E20	A blend of 20% ethanol and 80% petrol
EAF	Electric Arc Furnace
EBP	Ethanol Blended Petrol
ECSBC	Energy Conservation and Sustainable Building Code
ESG	Environmental, Social, and Governance
ESO	Energy Storage Obligations
EV	Electric Vehicle
FAME	Faster Adoption and Manufacturing of Electric Vehicles
FBTR	Fast Breeder Test Reactor
G20	Group of 20
GCV	Gross Calorific Value
GDP	Gross Domestic Product
GHG	Greehhouse Gas
GJ/tonne	Gigajoule per tonne
Gobar	Galvanizing Organic Bio-Agro Resources (Gobar)
GoI	Government of India
GRID-INDIA	Grid Controller of India Limited
GSI	Geological Survey of India
GW	Gigawatt
ICE	Internal Combustion Engine
IEA	International Energy Agency
IPP	Independent Power Producer
IR	Indian Railways
ISTS	Inter-State Transmission Services
Kg CO2/m2	kilograms of carbon dioxide equivalent per square meter
kW	Kilowatt
LNG	Liquefied Natural Gas
LPG	Liquefied Petroleum Gas
MEPS	Minimum Energy Performance Standards
MRV	Measurement, Reporting and Verification
MSME	Micro, Small and Medium Enterprises
MSW	Municipal Solid Waste
MT	Million tonnes
MW	Mega Watt
MWh	Mega Watt hour
MWe	Mega Watt electric
NCI	National Coal Index
NDC	Nationally Determined Contributions
NELP	New Exploration Licensing Policy
NITI Aayog	National Institution for Transforming India Aayog
NLC	NLC India Limited (formerly Neyveli Lignite Corporation)
NOCs	National Oil Companies
NRS	Non-Regulated Sector
NSRA	Nuclear Safety Regulatory Authority
NTP	National Tariff Policy
NTPC	NTPC Limited (formerly National Thermal Power Corporation)
OIL	Oil India Ltd
OMCs	Oil Marketing Companies
ONGC	Oil and Natural Gas Corporation Ltd
OTC	Over-the-Counter
PAT	Perform Achieve and Trade
Petcoke	Petroleum Coke
PFC	Power Finance Corporation Ltd
PHWR	Pressurised Heavy Water Reactor
PM-KUSUM	Pradhan Mantri Kisan Urja Suraksha evam Utthan Mahabhiyan
PMAY	Pradhan Mantri Awas Yojana
PMGRB	Petroleum and Natural Gas Regulatory Board
PMUY	Pradhan Mantri Ujwala Yojana
PNG	Piped Natural Gas
PPAC	Petroleum Planning and Analysis Cell
PPAs	Power Purchase Agreements
Pradhan Mantri JI-VAN Yojana	Pradhan Mantri Jaiv Indhan-Vatavaran Anukool fasal awashesh Nivaran (JI-VAN) Yojana
PSPs	Hydro Pumped Storage Projects
PSUs	Public Sector Undertakings
PWD	Public Works Department
RAP	Resource Adequacy Planning
R&D	Research & Development
RDSS	Revamped Distribution Sector Scheme
RE	Renewable Energy
REC	REC Limited (formerly Rural Electrification Corporation Ltd)
RECs	Renewable Energy Certificates
RTC	Round the clock
SATAT	Sustainable Alternatives Towards Affordable Transportation
SCCL	Singareni Collieries Company Limited
SDGs	Sustainable Development Goals
SECI	Solar Energy Corporation of India Limited
SERC	State Electricity Regulatory Commission
SHGs	Self Help Groups
SMR	Small Modular Reactor
State	State Government
STUs	State Transport Undertakings
TES	Total Energy Supply
ToD	Time-of-Day tariff
TSM	Technology Sub-Mission
TSO	Transmission System Operator
USDOE	US Department of Energy
UT	Union Territory
VGF	Viability Gap Funding

FOREWORD

The Epic Frame

THE Ashoka Centre for a People-centric Energy Transition (ACPET), at its launch event in March 2023, announced that its first research project would be on drawing up an integrated energy policy approach to achieving a net-zero transition by 2070, and other milestones, along the way. Prepared over a short period of just about six months, this output addresses itself to one of the most complex challenges facing India today—defining the policy environment that would open up potential energy transition pathways for more fully achieving India's stated goals in a cost-effective, inclusive manner. Undoubtedly, and as eloquently documented by several experts and institutions, much can be done to improve operational efficiencies across the energy system and to strengthen the many well-targeted reform initiatives already taken by the government to facilitate the

energy transition. This publication too has re-visited, and supported, such opportunities in a very select manner. However, it recognizes the larger narrative in this transition which highlights the unprecedented state engagement and, therefore, the abundant caution that needs to be exercised to ensure that incentives are efficiently, and transparently, allocated and delivered. It also attempts to go beyond by identifying the opportunities to take a coherent policy approach across the many sources energizing India and the supporting institutional framework, while acknowledging the significant potential that exists to decouple energy consumption from economic growth. This, we believe, will step-up India's energy transition story and possibly allow for greater ambition.

The overall approach to this project, thus, is anchored on several defining goals that India has adopted:

THE 2030 GOALS:

- 500 GW of Renewable Energy (RE)
- Reducing Emissions Intensity of its GDP by 45% from 2005 level
- Achieving about 50% cumulative electric power installed capacity from non-fossil fuel-based energy resources.
- The Net Zero target by Indian Railways
- Meet all SDGs

THE 2047 GOAL:

- To become a developed country and achieve self-reliance in energy

THE 2070 GOAL:

- Reach net-zero carbon emissions level

While each of the above milestone goals are premised on an effective energy transition pathway, the energy transition in India is also being driven by two other major considerations—energy security and energy access. While security considerations are driving the focus on round-the-clock (RTC) renewable energy, energy storage and energy efficiency with a considered phasing down of fossil fuels, energy access considerations are spotlighting costs, access to finance, capabilities and demand management. As such, climate driven energy transitions will necessarily have to be tempered by security and access concerns.

India has been at the forefront of the battle for recognition of common but differentiated responsibilities, and respective capabilities, in the international negotiations on climate action. In line with this principle, it has chosen 2070 as its target year for achieving net-zero emissions. This allows us the space to define a timeline for the energy transition—with the immediate to short term period harnessing the low-hanging fruit where economics and capacities are a given; the short to medium term options during which technology maturity and viability look promising, market development is achievable; the medium to long term wherein solutions that are still in an exploratory stage but seem essential for stability/security. Though the economics is prohibitive but global interest would align to mobilise requisite investments. The steepness of the fossil energy phase-out curve will be linked to the above trajectory and India's ability to telescope in the three stages.

Different countries and actors are interpreting just transitions as per their own contexts. For India, just transitions would need to be as much about equity and justice in climate expectations/actions and the threat of stranded assets as about impact on workers rights and livelihoods. In an ideal situation, an integrated energy policy approach to energy transition must also address the reparatory measures essential to ensure that we 'leave no one behind'. This would require India to define a judicious energy transition path that balances the aspirations of all its people with the necessary ambition of climate action. The Center hopes to carry forward this work to fill in some obvious gaps in the current work that would require more time to address.

The one pathway to a cleaner future, that is a given world-over today, is the large-scale electrification of the economy. Electricity generation in its current form is responsible for a large chunk of greenhouse gases emissions, while at the same time renewable electricity is the most mature and viable option amongst all renewable energies. In the Indian context, the barrier to its accelerated adoption lies in the state of the Indian electricity market, in terms of design, efficiency and financial viability. We have dwelt on these aspects, the ongoing reform measures to alleviate them and finally, suggestions to hasten the pace of Renewables capacity addition.

Beyond electricity, the key energy transition driver of decarbonisation has been visited across other energy supply and demand chapters and set against the prevailing transition-oriented government policies. This is resulting in recommendations focusing on ways to make the policies more effective, more integrated and cognizant of potential trade-offs vis-à-vis other SDGs. The publication has also attempted to identify common themes and challenges across the energy supply sub-

> “While security considerations are driving the focus on RTC renewable energy, energy storage and energy efficiency with a considered phasing down of fossil fuels, energy access considerations are spotlighting costs, access to finance, capabilities and demand management.”

sectors and energy consuming sectors to highlight key cross-cutting challenges and recommendations associated with them.

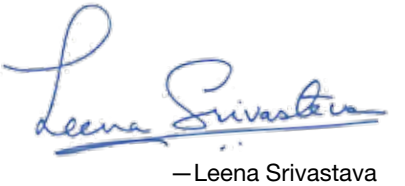
India has also made a strong case for climate finance to drive energy investments towards low-carbon actions. However, as is well recognized, the energy system in India is rife with multiple subsidies, designed over time and across energy sectors and levels, that put the efficiency of use of, and therefore access to, such finance under question. Given the fungibility of new energy sources to meet end-use demands, India needs to urgently address the issue of efficient and effective incentives to drive desired goals. Unravelling embedded subsidies, resultant distortions, if any, and bringing out the true cost of carbon-laden energy will vastly catalyse this effort.

As mentioned earlier, energy security concerns were a key driver historically for the energy transition efforts of India. Combining this with the goal of self-reliance by 2047, will also necessitate a careful consideration of technological dependencies and supply chain vulnerabilities of selected transition pathways—an aspect not too well covered in this phase of the project.

This publication has benefitted from the many multi-stakeholder consultations that were organized, spotlighting the enormous value of experiential learning and rigorous analysis in designing transition pathways. However, the publication has taken a rather deliberate approach to focus on what we believe are the key considerations around defining an energy transition pathway for India without attempting to make this either a comprehensive all-inclusive assessment or implying that we have the answers by making it prescriptive. It recognizes the substantial reform initiatives which the government has already put in place but also recognizes the enormous complexity of the Indian context that calls for a dynamic and continuous re-assessment and re-adjustment of transition measures based on incremental learning.

To navigate the vast array of issues, the publication is divided into eight chapters that capture a sizeable part of the economy from a demand and supply standpoint. This is followed by a chapter that captures the cross-sectoral needs and suggests recommendations.

The publication is targeted towards those decision makers who are fully familiar with the complexities and nuances of the energy sector—hence, the publication only provides necessary context or an explanation where there is a strong need to reinforce an observation or recommendation.



—Leena Srivastava

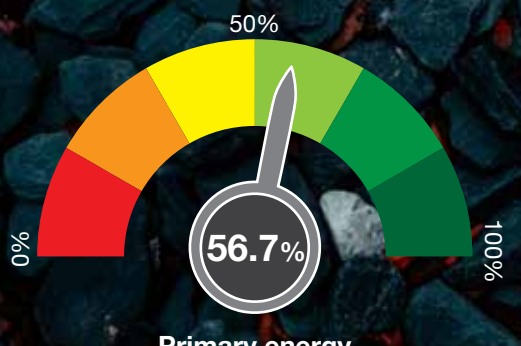
SUPPLY

The Coal Conundrum

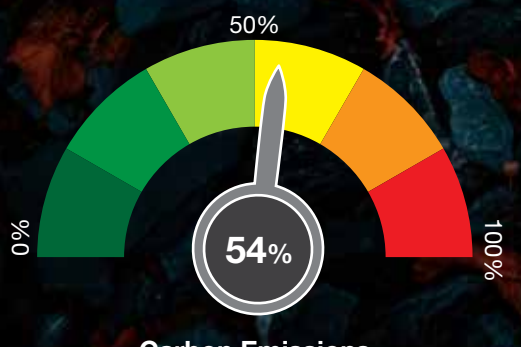
- India is the **second largest producer of coal in the world**. That, however, is not enough to help meet its electricity production and industry needs. The country **imports close to 21 per cent of its needs**, most of it to produce electricity. Together, this also makes it the second largest consumer of coal in the world.
- The **power sector accounts for 85% of coal consumed in the country** and about 50 per cent of India's carbon-dioxide emissions. Hence, in the drive to achieve carbon reduction targets, phasing down coal-fired power plants will play a pivotal role.
- Meanwhile, after power sector, the remainder use of coal in the country, that by industry, is itself not small by any measure, at about 10 per cent. This coal is largely consumed in hard-to-abate sectors like **steel and cement industries** where substitution, adaptation to lower carbon options is an ongoing challenge.

OBJECTIVE	To **phase down coal production** optimally while **safeguarding India's energy security**; to minimize stranded assets and associated social impacts; to determine import dependence with a **long-term strategic perspective**	
TRANSITION PRIORITY	Fast Track	Encourage market-determined operations of CIL subsidiaries
		Dynamic Roadmap for coal (domestic and imported) phase down
		Identification of flexible liquid coal assets as strategic storage
	Emerging Track	Value extraction from opportunities for black Hydrogen

Figure-1: **COAL'S CREDENTIALS**



Primary energy



Carbon Emissions

- Coal-fired electricity accounts for close to three-quarters of electricity sold by the distribution Utilities to its consumers. However, the **true extent of coal price does not reflect in consumer tariff**; the tariff subsidy bill picked up by the government is as high as around 18 per cent of Utility's total revenues. To that extent, coal-fired electricity is a competitively priced supply source.

- The **price of coal paid by the Utility does not include embedded subsidies** like the absence of coal washing. On the other hand, it attracts several high levies and in cases where the Utility's power plant is located away from the mines, Railways charges a high tariff that subsidies passenger traffic.

- While **renewable electricity is growing strongly in the country**, it is still only meeting incremental demand. Till the time that renewable electricity growth accelerates sufficiently to start replacing the 'base load' electricity demand, coal will be needed to balance demand and supply as well as provide energy security.

- Hence, going forward, **tapering the coal landscape needs to be calibrated to accommodate the energy security needs of the country** in its march towards becoming a developed country by 2047. With the per capita consumption of electricity at a mere third of the global average, coal fired electricity supply supports low-inflation growth.

- With rising Renewables capacity in the grid, the **coal-fired electricity offers 'base-load' stability** and reliability of continuous supply to consumers. While these have been dealt with in the electricity chapter, below, we scrutinise from a sectoral standpoint

Q1: Since coal-fired plants will be operating for a prolonged period, what further efficiency measures need to be imparted in the coal production business?

Q2: How should coal pricing and the coal market evolve, align, and catalyse a low-carbon economy trajectory?

Q3: Does coal supply security need to be enhanced in a tapering market?

Q4: How should the economy of coal producing regions be sustained?

BRIEF BACKGROUND

To address the above, let us review the prevailing ownership-production profile, pricing regime, demand side policy pointers and their implications:

Ownership-production:

One dominant player, one minority player and several new beginnings: The Union government-controlled Coal India Ltd (CIL) accounts for 78 per cent of India's coal production, amounting to nearly 79 per cent of supply to the country's thermal power plants. Singareni Collieries Company Ltd., a joint venture between Government of Telangana and the Union government, produces close to 8 per cent of domestic supply. It plays an important role in more than one way. The SCCL collieries ease the burden on Railways by supplying coal to power plants in southern India that otherwise must haul coal over rail and sea network from the eastern region, traversing long distances. Neyveli Lignite Corporation (NLC), yet another public sector firm, produces lignite in Tamil Nadu and operates power plants that support the southern grid in a significant manner. Lignite-based power is, however, not a major contributor on an overall basis.

The coal demand projections made by the Union Ministry of Power shows an initial increase and thereafter a fall on the back of rising Renewables capacity. Hence, the role of Coal India Ltd, the dominant player, becomes that of a energy security provider, where it is expected to open new mines even at the risk of capacities becoming stranded in due course

EXPLORATION: Exploration of coal has led to ample discoveries of deposits of non-coking coal, the variety that fuels power plants and certain industries. However, the same cannot be said of coking coal and high calorific value thermal coal. For the former, the country is significantly dependent on imports, as high as 50 per cent to meet the demand of steel and allied sectors.

New Beginnings: Development of mines for captive use gained momentum following the Supreme Court striking down allotments in 2014. Some of these new awards were made to State-owned electricity generation firms and Union government owned NTPC Ltd under the Coal Mines (Special Provision) (CMSP) Act, 2015. Policy reforms followed a few years later in 2020, allowing 'commercial mining' wherein end-use conditions were lifted and open sale allowed. This hastened the pace of coal mining activity in the country and saw the entry of private sector in a big way, indicating the pent-up demand. Together, 'commercial mining' and CMSP Act-led mining activity produce 14 per cent of the country's capacity. In fact, these two supply streams have doubled over the last three years and will grow rapidly under contractual obligations.

Market Enabling:

- The Coal Ministry has conceived a Coal Trading Exchange which is to be set up shortly. Besides deepening the coal market, it will enable States to determine their rightful share of levies.
- The setting up of the National Coal Index (NCI), which has a major element of administratively (notified) priced coal (that ought to be phased out as it distorts the market determination of the index), is expected to provide a benchmark for revenue-sharing contracts to be executed after the auctions are held for 'commercial mining' of coal.

Pricing and supply regime:

- For the most part of its thermal grade supplies, Coal India Ltd allocates coal from specific mines to identified consumers to allow for better planning and economic use of resources. It arrives at a 'notified' price which is not market-linked.
- CIL auctions only a small portion of its coal production which fetches a price higher than the 'notified' price. This reflects the scarcity premium in the market.
- Producers of coal from 'commercial mines' are free to price their coal based on the alternate cost of supply from imports or what the market offers:

CIL'S THERMAL COAL PRICE

The 'notified' priced is below the open market level in order to soften the tariff burden on State Utilities. This is part of the Union government's large power subsidy regime.

The 'notified' price is arrived on the back of the average pooled costs involved in lifting coal to the surface across CIL's seven subsidiaries. This includes several loss-making mines. In the absence of price revision since 2018, the cross-subsidy burden has increased.

As royalty is on ad valorem basis, no revision in notified coal price over the last 5 years has been detrimental to coal-producing States.

However, owing to several cesses, and high freight tariff, the delivered price of coal is a multiple of the price received by CIL.

CIL'S SUPPLY CONTRACTS

The supply contracts with power producers are inefficient and do not effectively address deviations in quality and quantity. The lack of market pricing both in coal and power sectors, breeds inefficiency.

Its transport contract with Indian Railways (IR) is imbalanced favouring the latter. There are no penalties on pick-up default by IR or supply default by CIL.

Demand side Policy pointers:

ELECTRICITY: National Electricity Plan 2023 provides for about 50 GW of additional coal-based capacity between 2022-2032. This may even go up.

NON-POWER: Production of steel is expected to grow from 125MT/year to 250 MT/year by 2030, according to government estimates. While coal consumption in electricity production will reduce significantly, industrial demand (both as fuel and feedstock) is expected to rise.

Aluminum, cement, and steel production is poised to grow significantly. However, it is the steel sector where firms are working to reduce their coal use by injecting hydrogen into their blast furnaces. These aspects have been visited in the manufacturing section.

Recommendations

1. PRICE EFFICIENCY

A. CIL's subsidiaries should compete on price, quality, and quantity rather than the prevailing practice of a single pooled 'cost-plus' price. In the process, operations of loss-making mines need to be shut down. This will gear CIL's mining to become more efficient in the medium term when supply of domestic coal will outstrip demand.

B. As coal production rises and 'linkage' coal becomes a smaller part of CIL's sales, more coal will be sold on open market basis. With coal scarcity then abating, prices will soften, and the 'linkage' policy may largely lose its relevance.

C. In this pathway, the government may transition from the prevailing 'linkage' regime by way of a graded phase down mechanism. For example, in five years, the linkage regime could entirely give way to supply contracts drawn up on commercial terms. This would complement market reforms in the power sector.

2. SUPPLY EFFICIENCY

A. To reduce the slippage in calorific value of coal sold to consumers, the current profile of classification norms of coal into 17 grades should be reviewed by the government

B. For efficiency delivery, 'Linkage' contract provisions between the coal company and the Utilities should be improved. This will ensure leakages and defaults on the part of both parties, the buyer and seller, a point of discontent in the current arrangements, are identifiable and penalised.

3. SUPPLY SECURITY

A. Slippage in coal supply to power plants has crippling consequences for the Indian economy, not to mention consumer discomfort aggravated by climate change, for example, the rising need for air conditioning. Securing supply requires intervention at the following levels:

(i) Inland coal movement is no doubt the cheapest way to move coal to power plants located away from the mine mouth. While waterways is a viable alternative, Utilities do not consider this option since it is more expensive. To promote uninterrupted electricity supply, regulators should allow Utilities to cost this access in their tariff and penalise those who do not do so and load-shed instead.

(ii) During the monsoon period, coal mining and power sector work in a directly opposite manner. Coal mines are flooded, and coal cannot be swiftly evacuated, while on the other hand, thermal power demand is sustained. A solution lies in keeping large coal inventories outside the mines and near the power plants to avert electricity supply disruption. This needs to be paid for by suitable tariff compensations, approved by the electricity regulator.

(iii) The Railways need to augment their haulage capacity as well as rolling stock.

(iv) To minimise supply issues during monsoon, generation capacity addition should be restricted to pit head locations.

4. COAL MARKET DEVELOPMENT

A. Development of the nascent coal market is essential to the efficient working of the coal companies. Coal supplied under the Non-Regulated Sector (NRS) category to sectors like steel, cement, aluminium (excluding urea), is undertaken through an auction process. However, the price arrived at for the five-year supply 'linkage' is fixed. This arrangement needs to be more market-oriented to enable sustainability of commercial arrangements. Hence the following suggestion:

(i) The coal price needs to move in tandem with the NCI. Such an arrangement will prove equitable for both sides and will not result in coal buyers walking out of contracts when the coal prices drop due to market forces. And it would also not deny upside to coal companies when coal prices rise in the market.

(ii) To enable the above, the Government may consider directing that all mines that have been bid out on a revenue-share basis must maintain the floor value of NCI-based price for determination of levies and other payments to the States.

B. With rising 'commercial mining' contracts, a Regulator for the coal sector must be set up. This agency may also be entrusted with the role of managing the re-purposing of depleted coal mines with the help of the Coal Controller, the only government field agency under Ministry of Coal.

C. To enhance investor confidence in the coal sector, the government could consider setting up an empowered administrative mechanism that's seeks to sort out disputes, enforce contractual obligations with private players.

D. A chronic issue in the coal sector has been the conflict between coal consumers and supplier CIL regarding quality and quantity of supplies. While the government has made efforts to resolve these by introducing third-party sampling largely at Council of Scientific and Industrial Research (CSIR) laboratories, the following measures can further help improve the situation:

(i) Mutually agreed quality certification norms.

(ii) The two sides can agree to introduce a logistics company as an intermediary that can supervise the despatches for a fee from the consumers.

(iii) Indian Railways must enjoin the logistics arrangement. Currently, they are not responsible for quantity and quality delivered to consumers.

E. The re-purposing of old coal mines and Just Energy Transition imperitives needs robust planning and a strategic body to oversee it.

5. RESOURCE ASSESSMENT

A. Geological Survey of India needs to survey, and document established resources of the varieties of coal that India is currently import dependent on, such as coking coal and high Gross Calorific Value (GCV) thermal coal. Such land areas need to be further explored and offered for mining.

B. The government needs to assess if CIL is in possession of reserves larger than its planned growth in the medium term. If so, the same should be released and auctioned for 'commercial' mining. To undertake this exercise might require amendment to the Coal Bearing Areas (CBA) Act. This is desirable even from the standpoint of demand plateauing and then falling over the next 25 years, thereby avoiding fresh opening of coal-bearing lands.

6. ENERGY TRANSITION ALIGNMENT

1. Just Energy Transition

A. **Avert Social Shocks:** Coal companies should build-in a corpus of funds that may be applied for compensation in the event of retrenchment of coal mine workers before their age of retirement. Hence, the coal prices should be reflective of this future liability carried by the coal companies.

B. **Diversification:** Coal companies need to diversify into non-coal sector. They have an opportunity in the same regions that forms their operational areas. Their personnel have a long experience of mining and understand the local economy and culture quite well. Since coal bearing regions are in most places also endemic in other major minerals such as iron ore, bauxite, copper, and limestone, re-deploying the officers and workmen to develop the mineral sector will not be difficult to transition. Key to this endeavour is the reskilling of the existing work force which requires infrastructure and capacity ramp up.

C. **Cushioning mine phase down impact:** Mining operations are a major source of revenue for the States as well as the Union government. It's the principal cargo revenue earner for Indian Railways and subsidises passenger travel. Measures to compensate this loss of revenue need to be assessed and developed. The potential loss of employment calls for re-skilling, alternate avenues, and welfare measures as a comprehensive Just Transition Policy.

2. Development of coal mines

Given the ambitious pace of renewable capacity addition foreseen by the government, development of new coal mines to support coal fired plants might suffer at the altar of raising funds.

A. This can be alleviated if the role of coal-fired plants in the evolving short-to-medium term energy map is seen as one that offers robust, well priced round-the-clock supply that can complement infirm Renewables like solar and wind capacity.

B. Market and institutional mechanisms need to evolve to allow market determined contracts which the proposed National Coal Trading Exchange would enable.

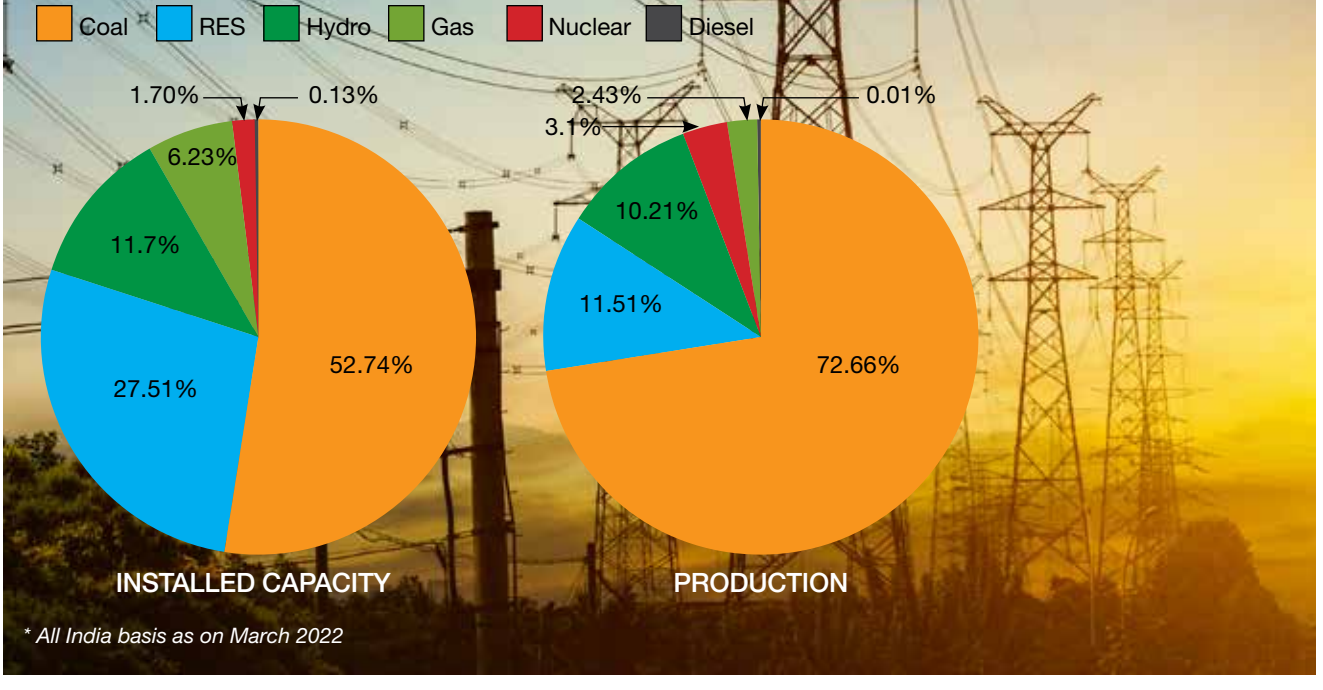
SUPPLY

The Electricity Equation

- The electricity supply sector has perhaps the **most transformative role** to fulfil in the country's efforts to realise its energy goals and carbon mitigation targets. At the same time, its secure, reliable, and affordable supply is vital to the economic growth aspirations of the country.
- A key lynchpin of the government's decarbonisation strategy lies in the **introduction of a large volume of Renewables**, the most mature of today comes in the form of electricity. Over the last decade, Renewables capacity in India has been growing at around 10 GW per annum. The government target set for 2030 translates to **adding 50-60 GW capacity per annum**—which is well within its reach. The required complementing capacity, which has a significant cost attached to it, will also need to be set up to ensure that consumers enjoy round-the-clock electricity supply.

OBJECTIVE	To facilitate effective financial flows and capacity building for a Green and efficient supply system while ensuring a robust grid to provide high quality, continuous supply of electricity	
TRANSITION PRIORITY	Fast Track	Renewable energy capacity addition through a slew of de-risking measures and complementary grid strengthening, enabling large-scale private sector participation
		Regulatory and operational capacity building for associated planning and management of the system
		Streamlining subsidies for efficiency and outcome-effectiveness
	Emerging Track	Mature the electricity and carbon markets
		Ensure coordinated functioning of electricity and carbon markets

Figure-2: **ELECTRICITY GENERATION LANDSCAPE***



** All India basis as on March 2022*

- A key hurdle in this endeavour, of integrating higher quanta of Renewables into the Discom supply mix, is the fragile financial health of the electricity distribution Utilities (Discoms) which are the gateway to **as much as 88 per cent of electricity consumed in the country**. While the annual aggregate losses of all the Utilities in 2021-22 dropped by as much as 20 per cent over the previous year's figure of Rs 28,700 crore, the indebtedness of Discoms has grown and capital expenditure has reduced. This reveals an unsustainable dependence on borrowing to meet current liabilities. In this supply arrangement, contracting large volumes of electricity has led to payments defaults and could potentially lead to higher defaults in the future (and its attendant knock-on effect on the market). There is, of course, also the risk of higher purchase cost due to the elevated risk perception.

- Another key hurdle in the transit of Renewables is the **preparedness of the transmission and distribution system** operated by the Utilities. As the economy gets electrified with Renewables, a robust electricity highway system is required to sustain the dynamic demand and supply needs, one that does not wilt under the strain of attendant variations and intermittencies, without over capacities leading to economic inefficiencies.

- Hence, a **robust electricity transmission and distribution sector** will be the key to an affordable, continuous electricity supply that is accessible by all. Enabling this is pivotal to a successful transition narrative.

Having placed the spotlight on the health of the Discoms, as they stand today, as core to the success of meeting the stated national growth, access, and carbon goals, let us begin by examining the challenges faced in its recovery, measures being adopted to improve health and finally, what further can be done to hasten this pace.

Going further, let us examine the needs of the inter-state transmission system in the emerging environment of rapid rise in Renewables generation. For example, how have the regulations kept up?

Distribution Sector

Consumer Tarrif: Barring captive supply, power producers can sell directly only to large volume consumers, and even there, the latter needs to pay a host of charges in addition to the 'Open Access' charge to the Discom, one that captures the latent cross-subsidy enjoyed by certain other consumer segments. For the rest, producers can sell only to the Distribution Utilities (Discoms), who, in turn, serve them. The cross-subsidised consumers are the farm segment, which accounts for around 25 per cent of supply as well as a section of the domestic consumers, who accounts for another 30 per cent. Hence, high paying consumers, typically industrial and commercial ones, find it hard to enjoy cheaper electricity supply options, which in turn affects their competitiveness.

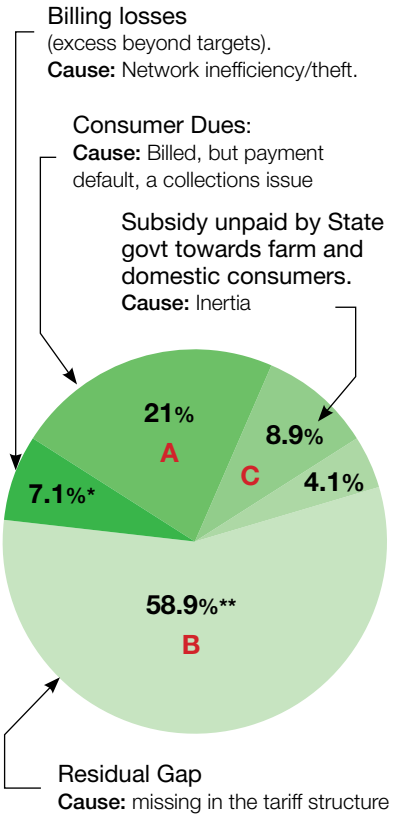
Subsidy Bill: The extent of the subsidy is well beyond the premium inflicted on higher tariff paying consumers. The State government is supposed to compensate the Discom for the difference. The former, however, often delays payments, which have snowballed to significant sums.

Financials: While the 'losses' estimated by the Union government are pegged at around Rs 5 lakh crore on an accrual basis, the Utilities' consolidated accumulated financial 'gap' is in excess of Rs 10 lakh crores on a cash basis. This can be allocated to five baskets and helps us set a sharp context to understand the measures needed to improve the Utilities health (CSEP, Rajasekhar, Tongia) (refer Figure 3).

DISCOM'S REFORM DYNAMICS

- Most Discoms are State government-owned and given the mass consumption

Figure 3: **Profile of Losses**



* For example, if the Discom bought 100 units, it sold only 93 and hence billed consumers only for 93—the gap is due to combination of theft, network inefficiency. The Discom is set targets by the Regulator and hence the normative calculation. This is above that target.

** Regulatory inadequacy in capturing the true 'cost-to-serve', delays in settling Utility generator bills, etc. For example, the Regulator approves the Discom's tariff petition based on assumptions. Often, costs rise, industrial consumers shift out. Hence, revenue recovery drops. Typically, this must be trued up at the end of the year, which often it is not the case. In 2018-19, it was as high as Rs 1 per unit.

nature of electricity, restoring their financial health is a challenge due to the forces of political economy at play. For example, as shown in Figure-3, the supply of free electricity to farmers whilst not being entirely compensated (C), inability to collect dues from all consumers (A), or for that matter, to ensure integrity in accounting at the government's end (B).

- Beyond the political-economy challenge lies the need for technical and financial resources for restoration, maintenance, automation of supply-related infrastructure and future investments. However, given the health of the Discoms, these are not independently supported by the financial markets.

INTERVENTIONS

Some of the Union government's key multi-pronged reform initiatives currently underway are:

Distribution-side reforms: Revamped Distribution Scheme (RDSS): Under this scheme, the Union government part-funds consumer metering and supply infra-structure in the States, in turn, reducing the collection and technical losses (A). The scheme is its infancy. Thus far, under 3 per cent of the country's meters have been replaced, while awards for replacement of 18 per cent meters have been made. Sanctions cover 92 per cent of meters in the country. The scheme has three novel features:

- It largely funds installation of only pre-paid meters, thereby directly reducing consumer collection defaults.
- Secondly, this scheme wedges open private sector participation in the distribution sector on a pan-India basis which has been resisted due to political economy considerations.
- To secure payments, service providers have a direct debit facility in an account held jointly with the Discom into which consumers pay to charge their meters.

Mitigate farm supply burden: The **PM-Kisan Urja Surkasha Evam Uthan Mahabhiyan (PM-KUSUM)** Programme seeks to solarize agriculture pump sets across the country. It involves grant and loan support to the farmers by the Union and the respective state governments. The schemes are based on the availability of grid supply to the farm, and the capacity of the solar system.

Easing consumer access to Renewables: The government has introduced Green Energy Open Access Rules, 2022. Under this:

- Discoms are obligated to procure and supply Renewables to Consumers on payment of an 'Open Access' fee and the threshold has been reduced from 1MW to 100 KW. This fee corresponds to the cross-subsidy burden as reliability for continued supply in case of failure by the 'Open Access' consumer to procure from generator directly.
- Such Consumers cannot be charged 'additional surcharge', a fee that otherwise goes towards meeting the 'fixed costs' commitments of the Discom's legacy power purchase deals.
- A cap on cross subsidy surcharge is imposed

Recommendations

To further hasten the pace of reforms, the Union government may consider to do the following:

- Raise the distribution loss reduction targets if the fund utilization is satisfactory under the RDSS scheme.
- Create strong disincentives for reform reversals. For example, if the Discom's adoption of reform measures slackens and consequently the supply losses rise, public sector PFC Ltd and REC Ltd, who are major working capital lenders, can raise the cost of capital.
- Promote private participation in those aspects of Discom management where managerial efficiencies can be harnessed. Besides the higher level of contractual compliance, they also provide a buffer to manage political considerations. Appropriate Payment Security Mechanisms (PSM) involving the State need to be devised where the business risk currently deters private sector participation.

1. SEGMENT LEVEL INTERVENTIONS

A. Improve Consumer billing and collection: The Union government's RDSS metering program, though in its infancy, has immense potential to transform the sector especially since it locks consumers to service providers for a sizeable period of ten years. The initial results are encouraging. However, at present, there are, understandably, few players in this business. To ensure a smooth pan-India coverage, the Discom must design its solicitation process to enjoin large private participation given the financial investments involved in the exercise.

B. Strengthen the Discom's supply backbone:

- With roof top solar generation gaining pace, consumers can turn producers. To facilitate this 'net metering' has been introduced across the country. The local transmission system should be planned, and investments enabled for moving these electrons efficiently to nearby consumers and further beyond, as and when required.
- Cater to the impact of electrification of the economy—for example, strong intra-day consumption variations resulting from, say, transportation charging needs.
- Strengthen distribution-level infrastructure to support micro generators to benefit from demand-reflective dynamic retail tariff {time-of-the-day (TOD) tariff} when introduced by the regulator.

C. Avert migration of 'cherry' consumers:

- Private companies are undertaking energy transition measures as part of their pledged Environment Social Governance (ESG) pathways and owing to stakeholder pressure. However, accessing a continuous supply of Renewables and Energy Storage through 'Open Access' is both costly and technically complex for most of them to manage. Utilities, despite their inefficiencies, offer the most optimal partnership for their transition. The State government, the Discom owner, should exploit this partnership potential to the fullest in view of the symbiotic nature of this engagement. Even if it goes beyond the immediate calculus of the Discom's finances since the larger knock-on implications include employment and associated economic prosperity. Hence, the following is suggested:
    - The Discom should consider procuring Round-The-Clock supply using appropriate payment security mechanisms to cater to this demand. This could include a direct debit facility (of the kind used for 'smart' meter adoption) for the power generation firm.
    - Utilities could consider laying out a tariff road map that immediately caps the cross-subsidy burden to the extent of the prevailing load for paying consumers, and going forward, charges only a cost-reflective tariff for the incremental load. This will ensure a financial soft landing for the Discom as other reform measures like 'smart metering' provide head room for reduction in cross subsidy.

D. Reduction of farm-supply burden: Farm subsidy is in the region of around 75 per cent of the total subsidy dues owed by the State government to the Discom. The following measures are suggested to manage it:

(i) Transfer in lieu of free power:

* **Direct Benefit Transfer:** As a first measure, in the short term, free electricity supply could be replaced by direct subsidy transfer to the farmers / agriculture labourers. This empowers the farmers to deploy their benefits judiciously, for example, the volume of water lifted to irrigate the fields. There have been experiments with DBT schemes but due to various, largely

administrative, problems these have not been able to go beyond the experiment stage - but are not insurmountable.

* **Escrow and Block chain:** Mapping end-use of resources transferred by State to the farmer will help target subsidies more efficiently.

(ii) Solarisation of farm supply:
(a) To improve the efficacy of the PM-KUSUM program, the Discom should convincingly engage with regulators to obtain an appropriate 'feed-in' tariff.
(B) Given the rather early success of the smart metering program in the urban areas, the execution model holds promise for replication in the farm segment. This can be optimally done at a feeder level for easier integration with the grid for a two-way flow and since the land availability at the small farmer's end is limited

(iii) Access carbon finance: The suppressed demand for grid connected power is immense, reflected by the long waiting list of applicants seeking a connection from the Discom. While the Union government's 'Kusum B' scheme addresses this demand, it could be further improved by enabling access to carbon finance to imrpove its success rate.

E. Reduce rural/BPL supply burden:

- **Solar roof tops:** State Utilities must develop an outreach program that is able to engage local entrepreneurs, energy service providers and Self Help Groups to finance and maintain roof top solar panels, both on a grid-connected as well as a stand-alone basis.

2. DISCOM-LEVEL INTERVENTIONS

A. Enable Resource Adequacy Planning (RAP):

(i) Capacity Building: The Union government, through its reform program, and State governments need to strengthen capabilities in Discoms for the following as the share of Renewables as Grid capacity grows:

* **Forecasting:** For the Discoms, the impact of rising Renewables will be felt at both ends—consumers adopting Distributed Renewable avenues like solar roof top and on the other hand, setting up of Grid-scale Renewables by producers. Secondly, the demand side shifts will be far more pronounced and volatile than before—rising manufacturing and cooling sector needs on one side and efficiency gains on the other. Hence, capacity building is required to enable Utilities to forecast demand with greater accuracy and dynamically and efficiently procure (and sell when required) electricity across various platforms and sources, especially Renewables, and energy storage systems, for short term and round-the-clock supplies. This includes margins required to provide for outages in the supply networks as well as generation side variability.

* As automation gains pace, beginning with the 'smart' meter at the consumer end and distribution supply and management systems at the other, there is need to ensure integration, so that there is seamless communication and inter-operability between different sub systems installed across the supply network, thereby creating a 'smart' grid. Key to this navigation lies in skilling the Discom personnel as they occupy the driver's seat in running the various aspects of the state grid system, for example, the demand side management systems.

A way to promote Farm Solar

In a few States, energy service providers are being idenitified to deploy solar pumps on the farmer's fields. To ensure viability of the intervention, the DIscom pays a higher procurement tariff for solar power generated from these pumps for a limited time period in exchange for transitioning farmers off the Discom's books.

B. Enabling Supply Choice:

- The foreseeable future augurs well for a 'content—carriage' separation narrative, where the business of procurement and supply of electrons is decoupled from the supply carriage, the transformers and wires needed to deliver it to consumers. The Ministry of Power should develop a pathway for Discoms to usher in optimally regulated energy service companies that compete to seek out electricity supplies, bundle them and cater to consumer demand for a fee.

- Consequently, the primary role of the State government / Discom pares. Its principal responsibility will then be to ensure direct subsidy transfer to the weaker sections, maintain stability of the electricity grid and reliability of supply carriage (even here, either directly or through service providers) and regulate the service operators. Critical to this will be the overall planning process, especially since it will involve sending out the market signals, whether in the form of weather forecasts to assess wind and solar supply or to capture demand

growth to augmentation of sub-transmission and distribution wires.

C. Promote supply efficiency:

- Discoms should provide free farm supply during time slots when the cost of procurement of electricity is at its lowest, for example, day-light hours when solar supply is plentiful. This will help lower the subsidy burden. Currently, due to transmission infrastructure overload, daytime supply is not possible in several States.
- Discoms should seek implementation of dynamic Time-of-the-Day tariff from the regulator for consumer segments where 'smart' metering is implemented rather than wait for its adoption across the entire consumer network. This will nudge consumers to shift their schedulable demand, resulting in a lower purchase bill for Discoms.
- The State and UT governments must implement a mission-mode policy that makes it mandatory for solar rooftop deployment in urban areas. This should cover:
  * All new buildings in urban areas
  * All industrial establishments.
  * Create new deployment models through adoption of Virtual and Group Net Metering while also promoting community solar. This will help maximise supply given the limited availability of roof top acreage by removing restrictions around colocation of rooftop systems with the load.

D. Regulatory engagement:

- Regulatory autonomy is one of the foundations of independent regulation. However, this is inadequate in the Indian electricity sector. In its composition and finances, the regulatory commissions are still directly and indirectly tied to the government. The CERC and SERC funds are meant to provide financial autonomy to ERCs but not all States have these in place or have them free from government control.
- Cross pollination: The Union and state governments could consider flow of talent across the regulatory commissions and the Central Electricity Authority, the planning arm of the Ministry of Power. This synthesis will help empower the regulatory personnel with greater depth in dealing with the complex issues and overcome inertial resistance to forward looking measures.

Transmission / Grid Management

- Historically, transmission system planning has been centered around inter-regional transfer of electricity and evacuation from pit-head coal-fired power plants, or hydel reservoirs to consumption centres and the cardinal need for grid safety, reliability, and security.
- A decade ago, the regional design of grids was integrated to operationalise one synchronous national grid towards the idea of 'One Nation One Transmission Grid'. Consequently, transmission congestion substantially reduced over time.
- With the opening of the transmission wires business to the private sector, the system operation role was cleaved to ensure independence of the electricity highways. Accordingly, POSOCO, later renamed as Grid Controller of India (GCI), was set up in 2010 to regulate inter-state transmission systems.
- In recent times, three key initiatives, one by the regulator and two by the government have catalysed the pace of Renewables capacity absorption in the electricity grid:
  1. Since 2018, the Ministry of Power has progressively allowed waivers of inter-state transmission charges for the gamut of new Renewable projects. The current dispensation ends in June 2025. This has been

extended to 2028/ 2038 at progressively reduced rates for different categories of RE generators.

2. In December 2022, the Ministry of Power published a Transmission System Roadmap specifically for integrating 500 GW of non-fossil fuel-based electricity installed capacity by the year 2030.

3. In November 2022, the Central Electricity Regulatory Commission issued the General Network Access rules that:

    - simplifies the ease of access for Renewables, especially given the inherent variability in its forecast to schedule despatch of electricity.

    - offers a clear and transparent information on congestion as well as underutilisation. This will be useful for systematic and pragmatic planning of transmission infrastructure to avert infructuous capacity creation.

Recommendations

- The Inter-State Transmission Services (ISTS) transmission waiver regime design has resulted in smaller projects being set up in few States and has resulted in highly inefficient location choices rather than those based on techno-economic viability. The waiver of transmission and other charges are in effect cross-subsidised by other users of the grid. To correct this anomaly, the current regime should be altered to provide a generation-based government subsidy. In the event of inability to compete in the market, carbon finance access should be enabled.

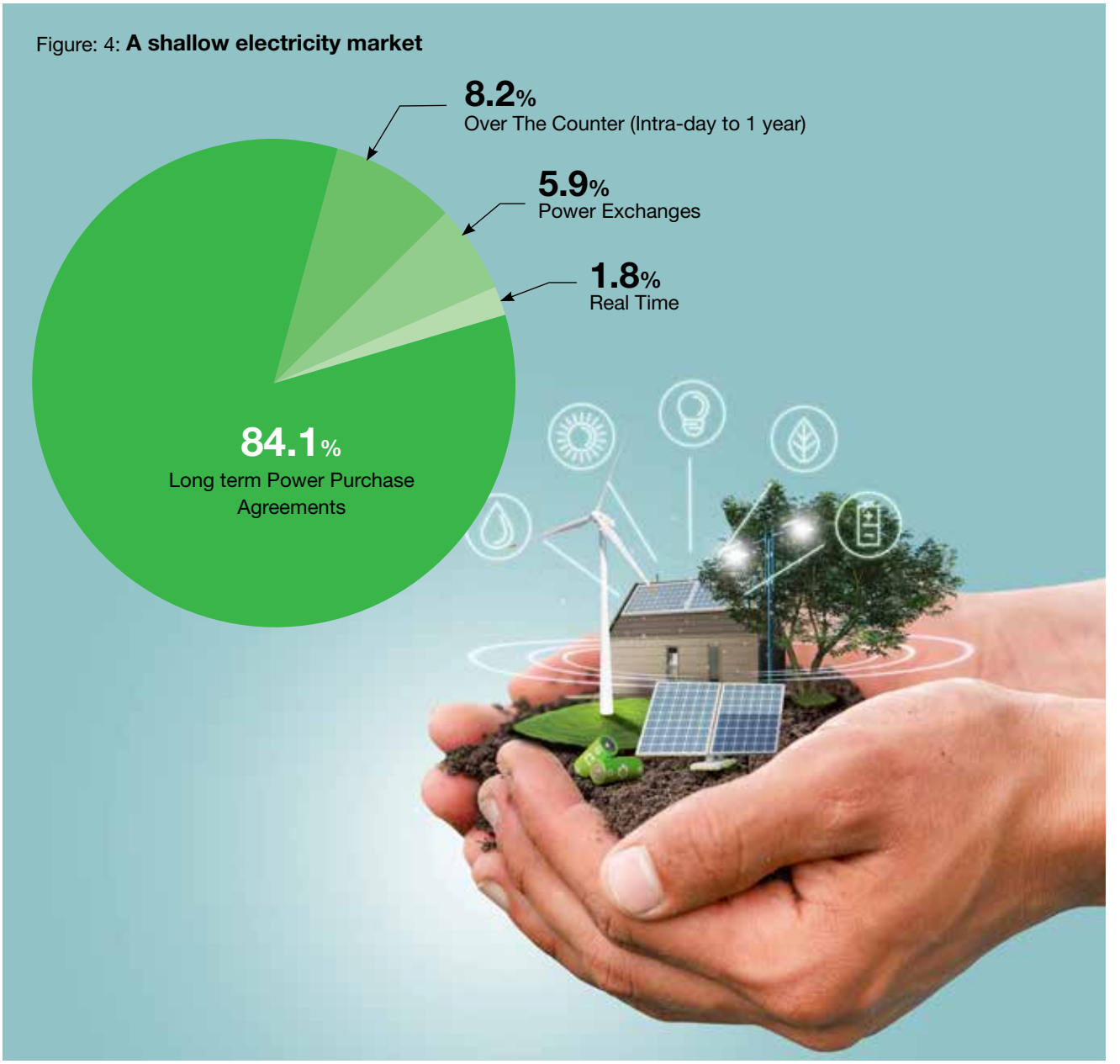
- **Resource Adequacy Planning (RAP):** Central and State-level sub-transmission systems need to be planned in an integrated manner and development must flow from a RAP standpoint.
    * Setting up transmission systems takes up to five years and they need to be commissioned before the generation plants come up. Hence, the planning process holds the key to optimal generation capacity addition and generation-mix to ensure adequate round-the-clock supply to consumers.
    * The efficacy of the planning process also lies in providing margins crucial to reliable Renewables supply -- weather forecast errors, Renewables variability -- as much as load and supply outages.
    * The planning process must be able to identify the extent of storage and other flexible supplies and demand response measures required to balance the variability and intermittency of Renewables.

Electricity Markets

- To enable sustained increase in Renewables in the overall energy mix, a robust market-based platform is essential. This will encourage new investments and enable 'balancing' of variability in the Grid by harnessing the diversity that an integrated market offers. Two recent Union government regulations have improved market access for the consumer (Green Energy Open Access Rules 2022) and Renewables producers (General network Access Rules 2022).

- Without adequate depth in power markets, market-linked dispatch mechanisms are unlikely to succeed. However, the prevailing Indian electricity market is shallow (see Figure-4 on the next page).

Figure: 4: **A shallow electricity market**



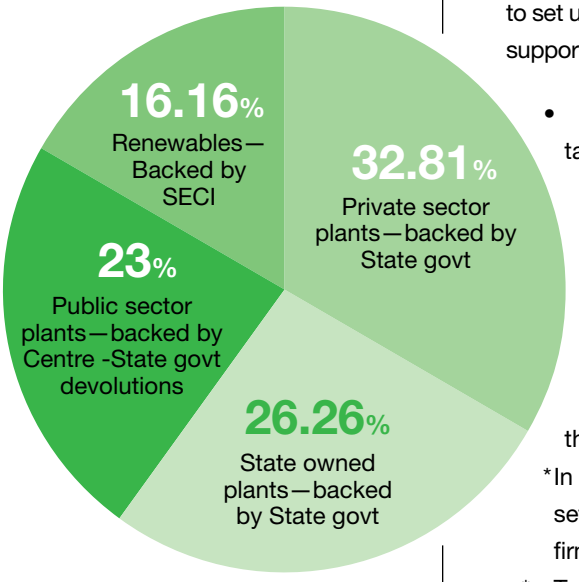
Recommendations for Developing Electricity Market

Short-term markets need to be further developed complementarily with long-duration contracts to help sustain equilibrium in electricity prices. Hence:

- The government could consider lowering or eliminating the period of extension of the Power Purchase Agreements (PPAs) between Discoms and the Union government-owned Public Sector generation firms. Currently, the policy provides for a five-year extension.
- Once Discom reforms have progressed to the point that the capital markets are comfortable engaging with the Discoms or their successors without any State support, 'merchant' plants will come up to populate the power exchanges. However, till this happens, the Union government could consider mandating that a minor portion of new capacities are placed on the market– either on the exchanges or outside them. The Union government's National Tariff Policy, 2006, had mandated that 15 per cent of capacity should be placed on the market—this has not been implemented and requires to be done.
- Introduce Derivatives trading in the electricity markets to enable hedging and other such instruments to provide greater depth and variety to the power market in India.

Generation Sector

Figure 5: **Payment Security Profile**



* SECI: Union government-owned Solar Energy Corporation of India

- As Discoms reform, their ability to procure electricity, independent of State support, will improve. However, that is unlikely to happen in the near to medium term. Hence, to set up 500 GW Renewables capacity by 2030, one needs to recognise that State support will be essential to address the financial fragility / risk posed by the Discoms.

- Another aspect of capacity addition, one that goes beyond the target, is its profile. The clutch of Renewables options –solar, wind, nuclear, biofuels, hydel - have their individual strengths and weaknesses. For example, solar and wind plants are the fastest way to get the electrons flowing. And consequently, there is currently strong State support to promote it, for example, exemption of inter-state transmission tariffs.

- Union government has inroduced generation sector-supporting measures, which seek to enforce commercial discipline in Discoms and thereby reduce the past burden. These are:
  - In April 2022, the government introduced measures that allowed Utilities to settle their sizeable past dues with electricity generation and transmission firms, amounting to around Rs 1,35,000 crore, in up to 48 equated instalments.
  - To avert defaults in this arrangement and future supplies, it also set in place sharp disincentives. This included regulation of transmission access for sale and purchase of electricity and the power exchanges themselves.
  - As a result, by December 2022, the dues owned by Utilities sharply dropped by a significant 22 per cent. It remains to be seen if the improvements can persist, even as reform measures are improving the Utilities' revenues.

- Several States will eventually develop their own 'Net Zero' pathways. This will begin with the survey of local resources like biofuel, land acreage available for solar plants and so on.

- The two most common storage systems are Hydro Pumped Storage Projects (PSPs) accounting for nearly 90% of global electricity storage, and Battery Energy Storage System (BESS). GoI has notified the trajectory for implementation of Energy Storage Obligations (ESO) by States till 2030.

- Although storage technology costs have been coming down, it continues to be an expensive proposition and therefore raises concerns about the economic viability of such projects. In Union Budget 2023-24, Viability Gap Funding (VGF) support for 4,000 MWh of BESS was announced.

Recommendations

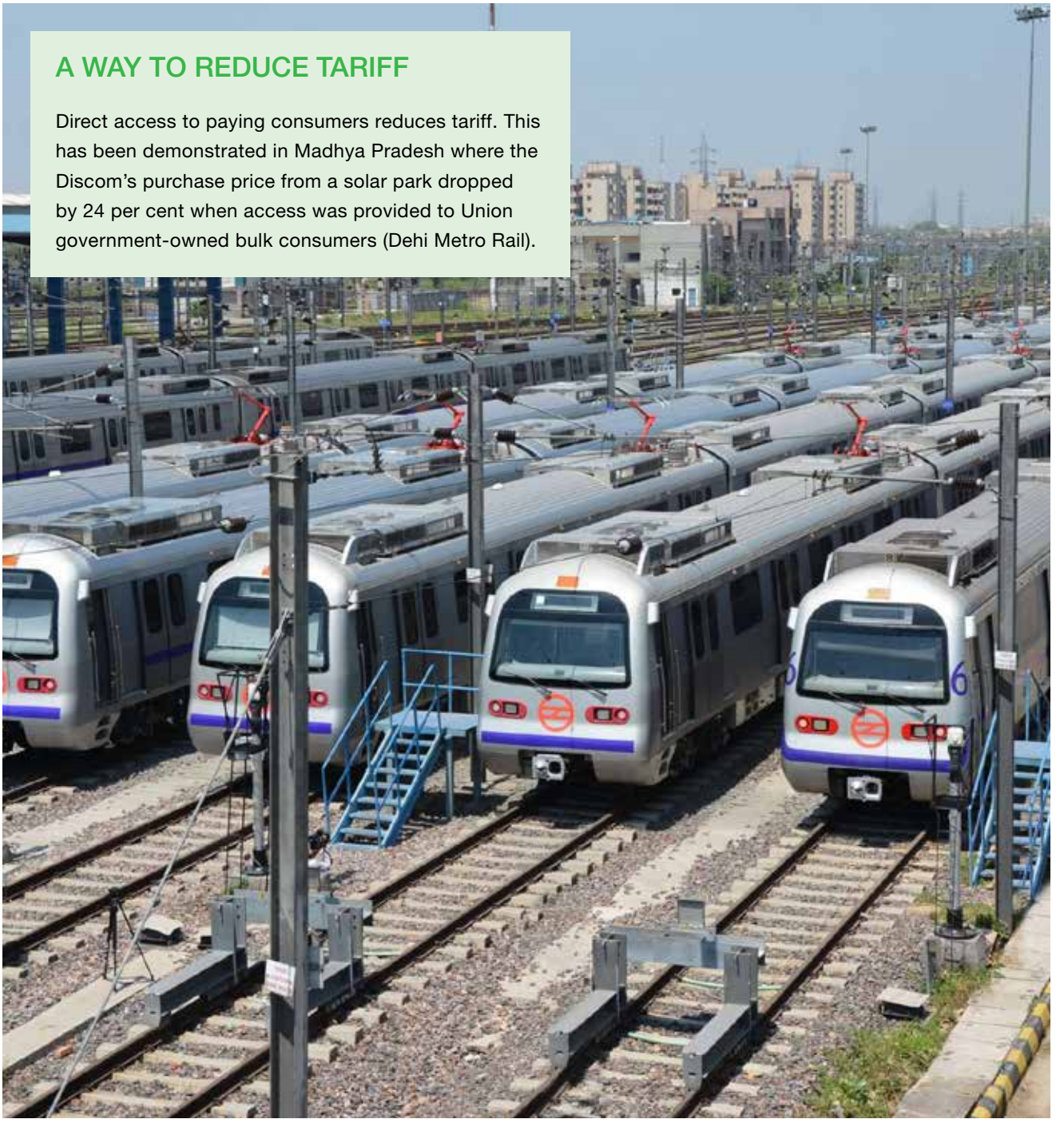
1. COVERING GROUND

To facilitate a supply side decarbonisation policy trajectory, the Union government should create a framework to enable planning for optimal medium, long term capacity addition on four key metrics—tariff, supply security, access, and carbon footprint. To achieve this, the framework should:

A. Harmonise with States: To address the consumer's demand for green electricity, the Union government has set up a central nodal agency, Grid Controller of India, the national grid operator to monitor and pursue unmet access requests. With the demand for Green energy bound to grow signficantly, the Union government should harmonise and integrate the State's industrialisation outlook into the central planning process. This is more so relevant since the

A WAY TO REDUCE TARIFF

Direct access to paying consumers reduces tariff. This has been demonstrated in Madhya Pradesh where the Discom's purchase price from a solar park dropped by 24 per cent when access was provided to Union government-owned bulk consumers (Dehi Metro Rail).



Union government's Hydrogen Mission seeks to produce 5 million tonnes by 2030, an activity that would require 125 GW of Renewables (the country's installed capacity stands at around 175 GW).

B. Review of Renewables options:

- **Cost:** Capture the true economic cost of production and delivery of technology on a life cycle basis, capturing the subsidies and the associated infrastructure required. For example, the transmission system investment (cost of access security) allows demand to follow the variability and intermittency of wind and solar that nuclear plants don't need.
- **Diversity:** Biofuels, notwithstanding their variability and uncertainty, can be used to produce gas, heat for industry, and electricity generation while heat from nuclear plants can be used to directly produce hydrogen through processes like thermos-chemical splitting.
- **Adoption:** Monitor phase-in of technology choices that are not on 'cost-parity', in a manner the tech adoption trajectory is well mapped, and the subsidy implications are quantified.
- **Supply Security:** Technology pairing options to enable round-the-clock supply of electricity.

C: Review of Fossil Fuel based capacity: Impact of moderation and phase out of coal, gas-fired plants.

- To minimize stranded assets, ensure that life cycle costs are tariff reflective, especially when their operational lives are kept shorter than the economic life of equipment.
- Develop a framework to assess and address socio-environmental impacts of retiring capacity after its useful life.

2. STATE-SUPPORT FOR CAPACITY ADDITION

- While electricity reforms will help improve the operational viability of the Discoms, they continue to be burdened under the weight of past liabilities. And while electricity tariffs should reflect the risk posed by the buyer, currently, of the entire Discom based generation capacity in the country, only 30 per cent capacity tariff reflects the risk posed by it (refer Figure 5). The rest is de-risked by the Union government (a fund under SECI, Devolutions). Given this context, and the ambitious capacity addition target, the government could consider the following two options:

1. Engage with the State: Provide the developer direct access to the consumers' payments, bypassing the Utilities. They have already allowed the same for service providers under the Union government's 'smart' meter program.

2. Fall Back Arrangement: If deployment of Renewables and storage does not take place at required speed and scale, thermal projects may be added if they are cost optimal. In the interest of transparency and cost minimisation, all new thermal plants should be selected through competitive bidding under Section 63 of the Electricity Act, 2003. Currently, Union government-owned public sector Utilities are exempt.

SUPPLY

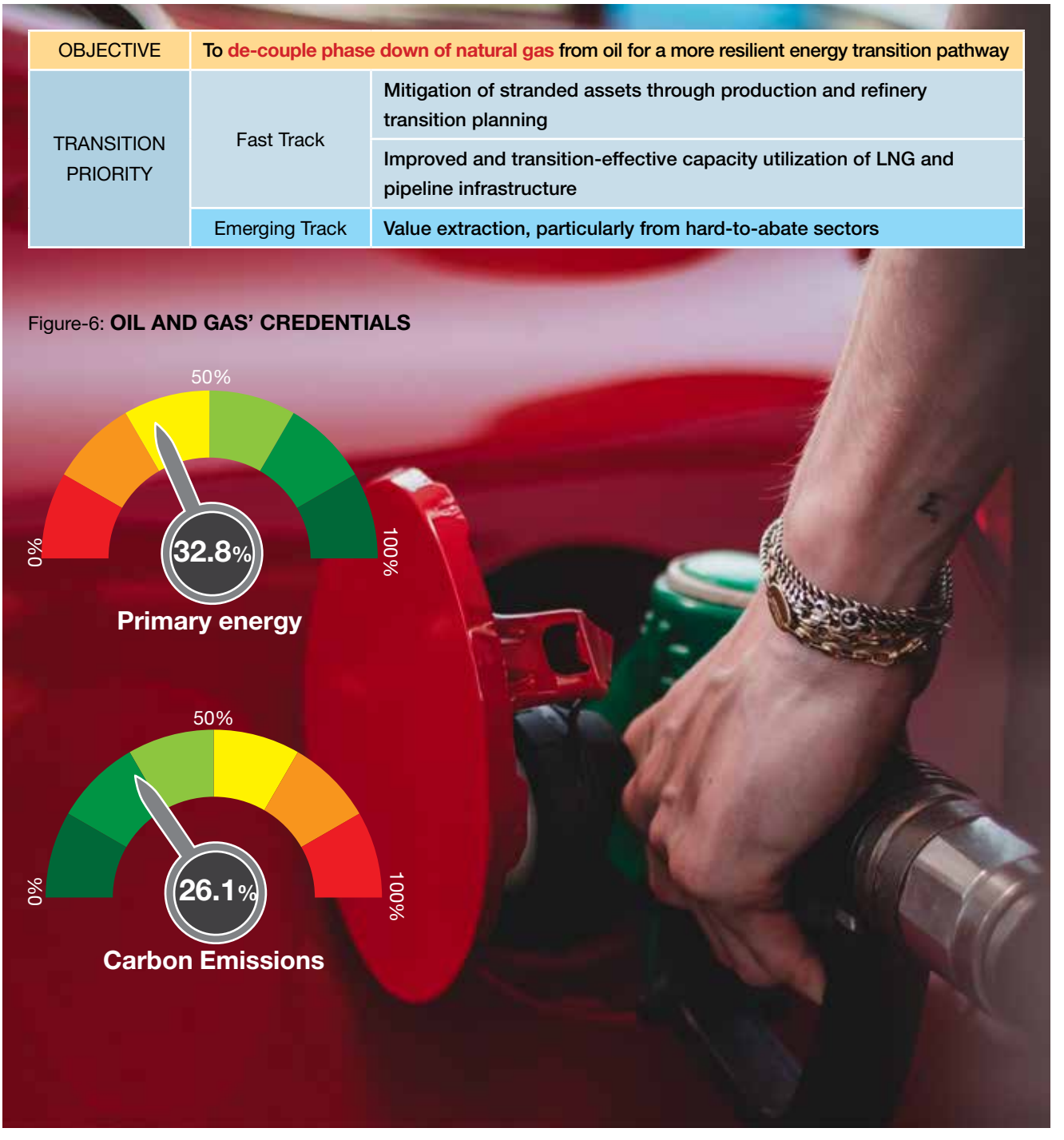
The Oil & Gas Play

- India is the **third largest consumer of oil** and amongst the fifteen largest of natural gas in the world. It is largely import dependent to meet these needs. During 2021-22, oil imports were as high as around 86 per cent of consumption, while in the case of natural gas it was around 48 per cent. These fuels contribute 26.1 per cent to the country's carbon emissions, of which oil contributes 21.4 and gas 4.7 per cent.

- While an aggressive, **accelerated transition towards zero-carbon substitutes for fossil fuel supplies** is the call, in climate discussions, practically this is extremely difficult for a large developing economy like India with significant energy access challenges and growth compulsions. With insufficient international support for the energy transition, India is building up to, both, step-up the share of the relatively low-carbon natural gas in its primary energy mix while also switching aggressively to renewable energy where feasible -- both in terms of electric and non-electric renewable energy.

OBJECTIVE	To de-couple phase down of natural gas from oil for a more resilient energy transition pathway	
TRANSITION PRIORITY	Fast Track	Mitigation of stranded assets through production and refinery transition planning
		Improved and transition-effective capacity utilization of LNG and pipeline infrastructure
	Emerging Track	Value extraction, particularly from hard-to-abate sectors

Figure-6: **OIL AND GAS' CREDENTIALS**



- The above two-lane transition pathway that is expected to eventually converge into a single 'Renewables Lane' has several challenges to surmount. While the electrification challenge has been dealt with in the preceding electricity chapter and biofuels in the one ahead, this chapter focusses on the other 'lane'—**enhancing the share of natural gas in India's primary energy mix**—and ultimately the switch to Renewables.

- Around **54 per cent of oil refinery products consumed in the country are used in the transportation sector** while another 12.5 per cent is used as cooking fuel (LPG). Both transportation and cooking fuel consumers are, for the immediate and short term, potential target audiences for the fuel switch to natural gas approach. For transportation, the routes available are in the form of CNG, LNG and Grey Hydrogen (produced from natural gas). Whereas PNG is already making a dent as an urban cooking alternative. This, however, begs the question on what happens to the refinery balances and economics in the future and consequent implications for crude oil production/procurement in the long term. Additionally, Grey Hydrogen can also substitute for coal in the hard-to-abate sectors.

- Additionally, within the hydrocarbon sector, **Petcoke**—a major carbon emission contributor widely used in the cement industry—is a good candidate to be replaced by natural gas.

- Recognising the need for a wider and longer continued role of the gas economy, the government has announced a target to **increase the share of gas in the primary energy mix** from 6.3 per cent to 15 per cent by 2030.

- The **prospects of finding hydrocarbons in India have been modest**. Barring a medium-sized gas discovery in the early part of the millennium, no significant reserves have been struck. This is partly due to the regulatory regime in the exploration sector. Besides setting a cap on the explorer's price, government also clamps down on the marketing freedom for discovered hydrocarbon reserves.

We now examine the following key questions that arise from the above framework against the backdrop of the prevailing government policies and the overarching need to enable a just transition:

Q1: What are the challenges faced in enabling the oil replacement endeavour? How should policies evolve to facilitate this?

Q2: The transition from oil to gas to renewable alternatives needs to be well planned to ensure that investments are not rendered infructuous. What policy measures are further needed to ensure this?

Q3: How can efficiency be introduced in the oil and gas sector?

Q4: What should be the scope of policy intervention to reduce the high level of import dependence on gas?

Q5: Given the capital intensity of refinery upgrades to match a changing demand mix, how do we minimise the threat of stranded assets? Since refineries are capital intensive projects, what is their future in the medium-to-long term?

CONTEXT

- The original impetus for City Gas Distribution (CGD) adoption was judiciary led, when in 2001, the Supreme Court mandated public transport fleets to shift from diesel to Compressed Natural Gas (CNG) primarily to bring down air pollution. While refilling infrastructure has been successfully rolled out by gas companies, the Union government has recently further strengthened its support by ensuring supply security and a price advantage (vis-a-vis alternatives) for the consumer (as explained below). As a result, the share of CNG vehicles in the passenger vehicle population has risen from 3.5 per cent in 2019 to 11 per cent in 2022. In the case of two wheelers and three wheelers, consumers are preferring going electric.

- While the peak utilisation levels of existing gas pipeline capacity reach over 80 per cent, the average gas pipeline capacity utilisation is less than half that. In this scenario, and with the present policy that lays all the throughput risk for erecting pipelines at the doorstep of the pipeline company, it is unsurprising that it is the public sector companies that are called upon to take on the market-related risks of laying such pipelines, also implying substantial cross-subsidisation across geographies.

- The demand for natural gas is rising rapidly from CNG and PNG sectors due to the government-supported expansion of trunk gas pipelines across the country and increasing allocations of subsidised gas to the CGD sector in response to demands from retailers. Currently, 90 per cent of gas supplies to the CGD sector is provided by government at subsidised prices from nominated fields owned by public sector companies ONGC and OIL. Combine the increasing demand with a projected medium-term decline in gas production from the nominated fields, and it is clear that the CGD licensees will need to blend in more of the market-priced imported LNG in the not-so-far future—which is more expensive to the tune of a factor of 2 to 3—in order to ensure a reasonable capacity utilisation. Since the government, despite providing them with APM gas, does not control the onward price charged by the licensees to the consumers the economic attractiveness of this fuel in the medium term is likely to come under question—thereby enhancing the risk of stranded assets.

- It should also be noted that while fertilisers are sold to farmers at subsidised prices, their production is significantly dependent on market priced R-LNG supplies. This dependence was as high as 63 per cent of its needs in 2021 due to non-availability of subsidised APM gas.

- If the country is to achieve the government ambition of 15 per cent natural gas in primary energy share by 2030, further LNG receiving capacity would need to be added. Presently, the import of LNG is just half of the regasification capacity of LNG terminals in the country and an equivalent of half of the existing regasification capacity is being set up. There is, thus, significant potential to quickly add to the gas supply in the country through imports. However, given the marginal increases in domestic gas production, this capacity may need to be augmented further. On the other hand, an import-dependent oil-to-gas and coal-to-gas economy shift comes with its attendant risks. Oil and coal markets are far more stable than the gas markets. Current and emerging geo-political tensions and global climate drivers are likely to exacerbate the uncertainty and volatility of gas markets.

- That said, the evolution of the natural gas markets and the receding oil economy will play a pivotal role in India's march to Net Zero Emissions. The State-led ascendence of gas is a transition to electric, hydrogen and other clean fuels like bio-energy. It also signals the retreat of the oil economy, heralding the imminent demise of the oil refinery as we know it today.

- From a production standpoint, close to 70 per cent of refinery products, namely transportation (non-aviation) and cooking fuels will see a declining consumer base. The phase down depends on the pace of electrification and gasification of the economy.

- Hence, in the medium term, it is expected that the refinery product slate wipes clean for a good part and the market narrows to feedstocks for petrochemical factories to produce plastics and chemicals. This is expected to create stranded assets since refineries are not geared to directly convert crude oil to chemicals. Furthermore, the ability to compress the asset cycle of refineries, especially the non-export-oriented ones, is restrained by the taxation regime.

- The government is, meanwhile, committed to raising the refining capacity by close to 80 per cent to meet the future petrochemical demand. The technology for direct conversion to chemicals remains in its infancy, and hence, once again, raising concerns of stranded assets.

Recommendations

1. Gas marketeers enjoy geographic exclusivity, thereby denying consumers the benefits of competition currently available in liquid fuel supply. At the same time, they benefit from access to a substantial volume of subsidised gas, while being free to charge what market determined prices. Under the circumstances, the Government needs to ensure adequate regulatory oversight and participatory processes to ensure fair, equitable and efficient operation of the CGD market.

2. APM gas constitutes about 60% of gas supplies in the country. The Government must prioritise the allocation of this gas to the most vulnerable sectors of the economy in a judicious manner, bearing in mind the need to optimise the overall economic efficiency of domestic oil companies.

3. Gas pricing is fragmented by source. There exist multiple domestic gas pricing regimes in the country, with APM gas price being capped. Imported LNG is freely priced by the importer-suppliers. Hence, government needs to institute a rationalisation exercise to ensure equitable pricing of gas for consumers across the country.

4. The government's stated vision of raising the share of gas consumption in the primary energy mix could be vastly facilitated by judiciously encouraging demand in select end-use sectors.

A. As against an approach of facilitating a country wide pipeline network, the Government should evaluate and prioritise interventions strategically for those sectors which would otherwise find it hard to abate carbon emissions, where substantial value creation opportunities exist as also where the demand for capex may be more optimal—bearing in mind the short-, medium- and long-term choices available to eventually transition to no-carbon alternatives.

B. In particular, the production of Grey Hydrogen based on natural gas can go a long way in meeting the above goal. The projections of viability of Green Hydrogen by mid-2030s, supported by a growing carbon market/taxes, would ensure that the hydrogen transmission infrastructure developed for Grey Hydrogen would have a life beyond.

5. The government should also address itself to opportunities, if and where economically viable, to blend Green Hydrogen with natural gas to use existing gas pipeline infrastructure but reduce import dependence.

6. Gas infrastructure including LNG terminals should be under regulatory oversight of 'open access' principle and tariff charged should be regulated.

7. As the national gas pipeline grid evolves, there will be need for an independent Transmission System Operator (TSO) for the same. The operator will be an entity on the lines of Grid Controller of India Ltd, the independent electricity grid operator to ensure non-discriminatory access for gas marketeers to procure supply and deliver to their consumers. This will be essential to avoid duplication in infrastructure creation and ensuring gas availability throughout the country.

8. India has chosen gas as transition fuel where imports are significant. Hence, raising domestic production will offer three key benefits—namely, supply security in the event of disruptions, and lower carbon emission since LNG supply chain produces more due to methane loss, directed supply to earmarked sectors. On the pricing front, since the contractor's price is marked to global LNG prices (with a cap set by the government), there are no significant financial benefits to the economy vis-a-vis LNG imports when the market is not volatile. Hence, measures to promote E&P activity needs to be viewed against the transitional and sectoral needs for gas.

A. Price caps and marketing controls need to be defined on a long-term basis to offer stability of regime for investors. Control on partial volumes may be adopted in this regard.

B. Exploration efforts over the last several decades in the public and private sector fold has yielded a large harvest of data. This entire body of data ought to be made available to interested companies for better appreciation of the areas held by others who are yet to make discoveries. This can complement the proprietary data of existing operators.

C. Over the last 25 years, the New Exploration Licensing Policy has been the dominant policy engine for leasing exploration rights. While several announcements of discovery were made, most failed to translate to production of hydrocarbons. This is often owing to the tight provisions on timelines/ cost recovery and other stipulations that have triggered default and imposition of penalties. The government may consider migrating these fields from the earlier profit-sharing regime to a less onerous royalty regime as an inducement to exploration firms to produce the hydrocarbons and thereby pluck these 'low hanging fruits'.

D. The policy to develop 'marginal' discoveries of National Oil Companies (NOCs) under Discovered Small Field (DSF) framework requires attention. A review by the government needs to be undertaken to ease the bottlenecks since this is yet another 'low hanging' fruit - the fields are discovered, and capital needs to be deployed to lift the hydrocarbons to the surface.

E. The ease of doing business in the exploration sector lies in independent arms-length mechanisms / institutions to resolve contractual issues that arise between the government and the contractor. Currently, the Directorate General of Hydrocarbons (DGH) supports the Government in administration of contracts, monitoring, and regulatory functions, with no independent authority. The government could examine the case to transfer those upstream regulatory matters to an independent authority.

F. To improve the explorer's ability to access capital to develop hydrocarbon fields, the Government should clarify that for the purpose of serving as a collateral, the reserves as certified by DGH may be allowed to be pledged just as other minerals are allowed in the case of mineral leases. Caution must be exercised to ensure that in the case of default leading to the lender taking over the asset, the government reserrves a veto right on selection of the new operator.

G. Where it involves transfer of contracts from one explorer to another, the conditionalities related to transfer of such contracts may be streamlined by the government so that the liabilities of the outgoing entity do not impede the exploration work programme.

H. National Oil Companies, namely ONGC Ltd and OIL, are the dominant producers of oil and gas in the country. They, however, produce a small yearly percentage of the reserves established by them yielding high reserves/production ratios compared to their global peers. It is as high as three-fold. These reserves need to be unlocked in an efficient and expeditious manner in view of the overall government policy outlook, that of developing the gas economy. NOCs have not been successful in getting full involvement of global majors which comes only when there is a financial involvement/ capital deployment of the latter. There is a need to enter into financial alliances with global majors as a partner rather than as contractors.

9. Government must ensure that the potential for stranded assets in the refinery sector are mitigated as far as possible through the possible measures:

A. For private sector to come forward and set up the capital-intensive refinery projects, the government must set out a comprehensive road map on the proposed policy measures to promote the gas, electric and hydrogen economies.

B. In the public sector fold, existing refineries have traditionally played a larger role in ensuring supply security, often foregoing higher profits in the overseas markets. Hence, financial support must be provided.

C. In regard to fresh capacity addition by public sector companies, since these firms are listed on the stock exchange, any techo-commercially sub-optimal decision will erode government's value as a shareholder. Hence, caution must be exercised.

SUPPLY

Cultivating Biomass

- Unlike other primary energy sources like coal, oil and gas, **biomass is a loose fuel definition** that largely captures plant and animal waste that can be processed and converted to energy. It extends as far as municipal solid waste.
- In the larger journey to reduce carbon emission, there are two challenges in the biomass segment. One, a **fuel switch for those using traditional biofuels**, like wood for cooking, that release a lot of harmful products due to inefficient combustion. The other lies in challenges in the **production of modern biofuels to scale and its adoption**. Production includes conversion of biomass to useful fuels which could be solid (pellets), liquid (ethanol) or gaseous (biogas), depending on the technology and type of biomass.

OBJECTIVE	To focus attention on the **opportunities and threats of large-scale dependence** on biomass as a low-carbon energy alternative	
TRANSITION PRIORITY	Fast Track	A national people-centric strategy to: • Increase biomass productivity while also enhancing ecosystem services • Optimize value creation from biomass while protecting food security
		Dynamic Roadmap for coal (domestic and imported) phase down
		Identification of flexible liquid coal assets as strategic storage
	Emerging Track	Leapfrogging the energy economy in rural areas
		Maturing the 2G bio-refineries and developing 3G biorefineries

- Union Government **policies are currently being implemented** to address all three challenges. In the case of firewood, it has thus far enabled a sizeable consumer switch to LPG. Until a few years back, more than half of India's rural population depended on biomass for cooking.

- On liquid biofuels, policies have promoted the **blending of petrol and diesel with ethanol and non-edible oils**, respectively. For gaseous biofuels like compressed biogas, fiscal and financial incentives have helped develop and improve utilization of a wide array of waste resources, promotion of gas use for heating and cooking, of compressed gas in transport and conversion to electricity, besides utilization of its byproducts like slurry for use as organic enriched bio manure. State governments have played their` part in catalysing the growth in use of biomass and other organic wastes by enabling better supply chains, aggregation mechanisms, etc.

- With substitution of biomass by commercial energy, its share in primary energy is coming down. With the **high target of ethanol blending** as well as for bio-CNG, the decline may now be arrested. In the non-electric segment, biomass is the dominant fuel for heating needs across all industrial consumer categories, ahead of oil, gas, and coal. With the application of state-of-art technology, the efficiency in conversion of biomass supply to useful energy is set to rise significantly.

- Diversion of biomass towards **modern and efficient conversion processes**, wherein conversion losses will be much lesser, will have an added advantage of reducing the primary energy supply to meet demand. This will also improve the per capita supply numbers and meet demand via renewable sources.

- At the 18th G20 summit held in September 2023, Prime Minister Narendra Modi launched the **Global Biofuel Alliance**, where 19 countries and 12 international organisations have agreed to join. This aims to accelerate the pace of adoption and catalyse the development of newer technologies for biofuels.

- The **disaggregate nature of the bioenergy feedstock and its diverse use** pose a challenge and as much an opportunity to raise the presence of its significant renewable element in the country's energy basket. In pursuit of this, some of the key issues that emerge are:

Q1: For the short to medium term, as a low carbon transition fuel, how can LPG penetration in rural areas be improved to wean away consumers from freely available firewood, a polluting biomass paving the way for newer technologies? Or can we look at a leapfrog to renewable electricity right away?

Q2: What technology and market development measures are needed to improve the biogas and liquid biofuel production in the country, while maintaining our food security? What is the total supply potential bearing in mind other ecosystem services provided by biomass?

Q3: The competing demands on biofuels in the pathway to decarbonize the economy are being addressed by various government policy mandates. At an integrated level, is this being done in a transition-optimal manner? Is the farmer able to get the best value for his produce?

BACKGROUND

- Cooking gas: The PMUY (Pradhan Mantri Ujjwala Yojana) scheme is a successful welfare measure that subsidises LPG supply to the economically weaker sections of society. It has significantly contributed to the penetration of LPG in the country, rising from 62 per cent in 2016 to near saturation now.

- While access to LPG has increased substantially, the use patterns are yet to be established in order to determine if households can be declared to be pollution free.

Liquid biofuels:

- Petro blending: The government's Ethanol Blended Petrol (EBP) policy has helped achieve a 10 per cent blending in domestic petrol supply in June 2022. The target year set for achieving 20 per cent blending has been brought forward from 2030 to 2025, based on the early success of the programme.

- The policy allows for differential pricing that public sector oil marketing companies (OMCs) pay for different grades of sugarcane-based raw materials, for example, molasses, sugarcane juice, etc.
- The overall sector's outlook has also helped—sugar mills no longer see it a cyclical produce; factories are now running throughout the year. And fundamentally, this is the only crop where the law demands that the farmer is paid within fifteen days of selling his produce.
- To augment the availability of feedstock, the National Policy on Biofuels was amended in 2018 to extend government price support to crops. As a result, by 2021-22, supplies from sugarcane derivatives like molasses and sugar syrup dropped to 83 per cent, with the rest of ethanol supply being derived from surplus rice, damaged food grains/ maize.
- Overall, procurement of ethanol by public sector oil companies has jumped over eleven-fold since 2014.
- Diesel Blending: Blending of diesel with biofuels is around 0.1 per cent owing to non-viability of Jatropha, a non-crop oil plant.

2G refinery:

- To truly capture the potential of the wider basket of biofuel feedstock, processing requires newer and more advanced second generation (2G) bio-refineries. 2G bio-ethanol produced in the refinery uses ligno-cellulosic agricultural residues and by-products, organic wastes; most preferably woody, grassy and waste materials as a feedstock besides biodegradable fractions of municipal and industrial waste.
- To develop 2G refineries, under "Pradhan Mantri Jaiv Indhan- Vatavaran Anukool fasal awashesh Nivaran (JI-VAN) Yojana" government scheme, financial support is provided to set up pilot and commercial plants.
- OMCs are not only involved in procurement of bio-ethanol but are also driving the 2G refinery plant initiative as well. The first 2G plant, operating on rice straw feedstock, an agri-crop residue, was commissioned in August 2022.

Bio-Gas:

- The Union government has intensified its efforts to promote conversion of cattle waste-to-energy through biogas producing plants. The Galvanizing Organic Bio-Agro Resources (Gobar) - DHAN scheme, launched in 2018, seeks to keep villages clean, increase the income of rural households through generation of energy from cattle waste.
- The policy enables higher earnings for the farmer through the entire value chain by offering a slew of incentives, for example, financial assistance in the sale of organic fertilisers from the GobarDHAN plants.
- There is a strong policy impetus to promote supply of Compressed Biogas (CBG) for transportation and households.
- Under the Sustainable Alternatives Towards Affordable Transportation (SATAT) scheme, public-sector firms are mandated to purchase this gas from entrepreneurs who are willing to set up the processing facilities.
- The scheme offers a host of incentives, from access to loans under Priority

Sector Lending norms to inclusion of CBG under carbon credit trading schemes.

- It has yet to bear satisfactory results. Until March 2023, under fifty CBG producing factories were set up, against a target of five thousand. One of the key reasons has been technology risk, access to financing and long-term availability of feed stock. However, several large corporations have recently announced major plans to set up such plants and provide purchase support to the feed stock suppliers.

- The government is also considering schemes involving financial support for biomass collection and extension of pipeline connectivity from the CBG plants to the city gas distribution grid. Also, on the lines of Renewable Energy Certificates (RECs), the purchase of certificates by gas marketers from biogas producers is also contemplated for those who do not blend the mandated share of biogas.

- The approach to develop CBG supply sits well in the overall government outlook to raise the share of gas in the energy basket from the current 6.3 per cent to 15 per cent in 2030. There is, however, lack of clarity on whether this will count towards the target since natural gas from below the surface is viewed as a transition fuel in the carbon reduction narrative.

- State-level policy measures are largely geared to promoting biogas for electricity generation. This is done by offering attractive electricity tariffs. Several States offer tax incentives for setting up biogas plants, for example, stamp duty exemption on land purchase.

COLLECTION

Biomass:

- Given the disaggregate nature, collection of Biomass on a sustained basis is a major challenge. The logistics planning needs to dovetail seasonal supplies to ensure that the processing plants operate round the year for viability and marketability.

- Several Biomass aggregator firms in the organized sector collect Biomass and supply them to power plants. There are also equipment lenders who supply equipment like balers (to compact the crop reside) to small farmer who cannot afford them on ‘pay and use’ basis.

- Biomass has alternate uses in the rural economy. The emerging demand from biofuel processors is raising prices and fear of non-viability. This calls for a realistic assessment of the biofuel potential, especially accompanied by price support.

Municipal Waste

- India’s experience with Waste to Energy plants have been poor owing to poor quality of waste finding its way to the plant. This is owing to lack of adequate segregation and the resultant flow of inert non-combustible material. Besides, incineration causes pollution. Fuel generation from sewer gas has also been attempted, wherein methane is sought to be extracted using ‘biodigesters’. This approach has not met with much success owing to contamination of sewage management system with industrial effluents.

Recommendations

1. The Union and State governments must promote efficient cookstoves to help reduce noxious gases and lower the reliance on firewood. This, since rural households often use both fuels - LPG and firewood—for domestic cooking as the latter is available free of cost and therefore the attendant ambition to stack cooking fuels.

2. Given the diverse rural consumer base, State governments must promote local entrepreneurship to enable fuel choices for cooking. It is expected that electrification of rural homes will pick up through the Distributed Renewable Energy (DRE) route, wherein households will install roof top solar panels. Support must be extended to help develop business models to bundle electric cooking with the freely available biomass supply.

3. A well-developed strategy needs to be formulated by the Union and State governments to ensure the following:

   Promotion of crop-based biomass supply is undertaken in a manner that food security interests are preserved; soil degradation concerns are addressed.

   There are competing demands on biomass supply and this raises concerns from a Just Transition standpoint. For example, food grains are sold to distilleries at a price lower than the that paid by States for supply to the impoverished through the public distribution network diversion. Such aspects require the government's attention.

   - Enabling access to the carbon market to improve viability of biofuels production.
   - Currently 'Grey' Ethanol is produced since crop production involves use of diesel to pump water for irrigation or use of electricity from the grid which doesn't qualify as 'Green'. This needs to, and probably will soon, transition—a move that will must be enabled by access to carbon finance.

   Measures need to be adopted to recharge water table levels, for example, by building check dams. This is all the more necessary since sugarcane, a water intensive crop, is grown in several arid areas demanding large amounts of energy.

4. Given the local area nature of feedstock aggregation, the State government must enable private sector to develop robust supply chains and long-term linkages for feedstock supply through:

   Skill development to foster local area entrepreneurship, especially from the farmer populace.

   Benchmarking grain procurement prices for farmers to ensure that land use is not altered from food to fuel.

5. Historically, scaling the population and size of individual or local cluster development of biogas plants has been a challenge. This has been due to the well-documented reasons of lack of a robust ecosystem to manufacture plants, poor availability of skilled masons and the low cattle-per-household ownership. Policy intervention must enable greater participation from the organized sector in developing this segment, thereby resulting in percolation of capital, technology, farm equipment and practices into the value chain, down to the feedstock aggregation level.

6. Technology:

   2G & 3G bio-Ethanol: The Union government must facilitate technology adoption and facilitate enzyme supply access for the 2G refineries since access to enzyme production technology and biochemical conversion process is limited and expensive. Currently, the responsibility for enzyme supply currently rests with the refinery developer, a reason for the rather slow growth of this business. Measures include the promotion of inter-institutional, public-private arrangements to develop technology. In parallel, it should leverage the recently formed global biofuel alliance for the same.

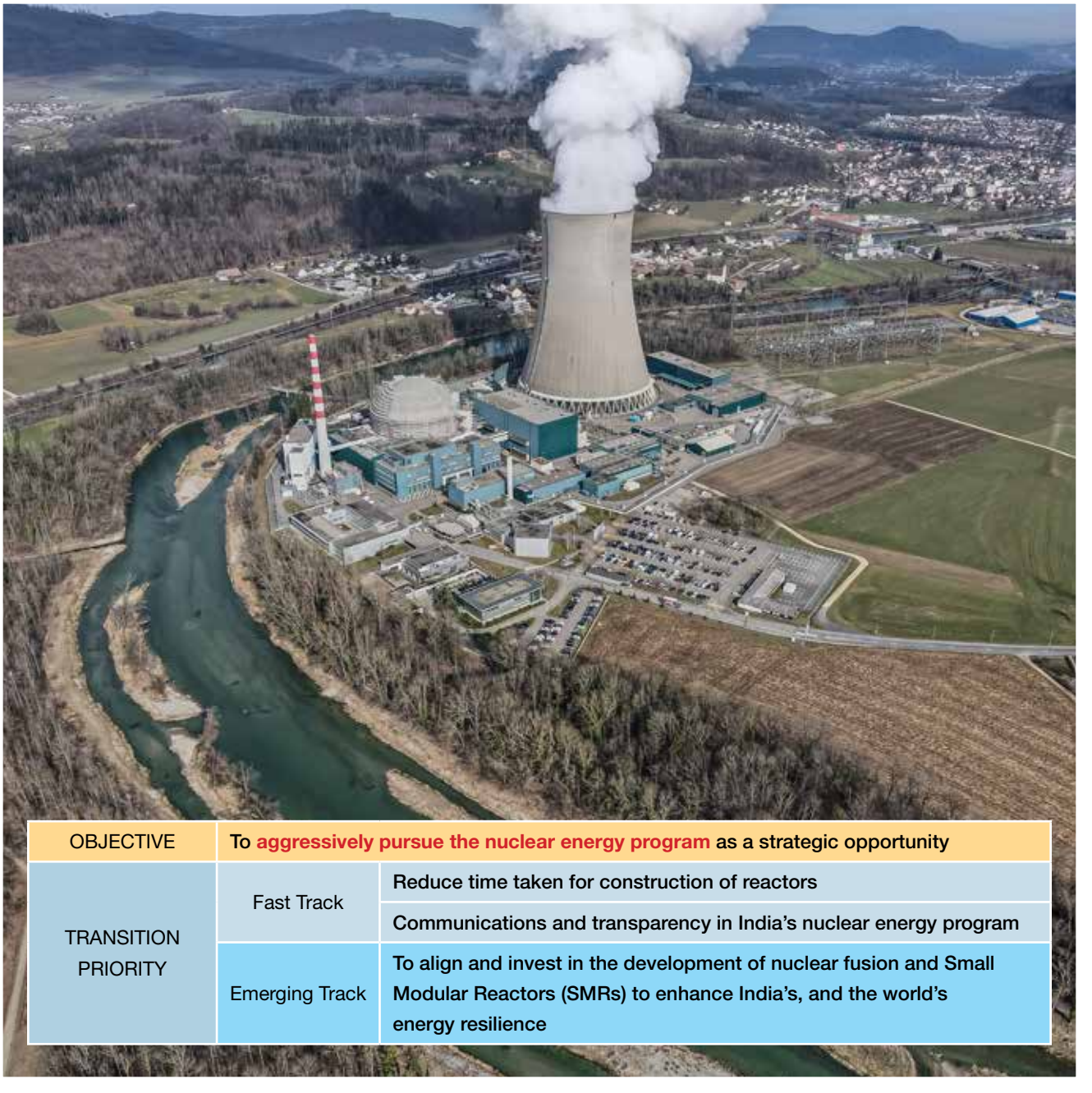
   Third generation bio refineries allow more diverse feedstocks like algae and convert them to Ethanol and chemicals. Policy measures suggested for developing 2G refineries could be extended to this sector, which is yet to debut.

SUPPLY

Nuclear Options

INTRODUCTION

- Nuclear energy has the potential to play a significant role in a clean energy transition narrative, especially one with a steep gradient where significant volumes of polluting fuels are replaced. It can replace coal-fired electricity and firmly offer supplies to complement the variable and intermittent supply of renewable sources like wind and solar energy and thereby ensure 'round-the-clock' supply security to the electricity grid. Nuclear reactors in India have operated continuously for as long as 700 days.
- All nuclear power plants in the country are owned by a public sector company.
- India's nuclear safety record has been impeccable. No lives have been lost due to release of radioactivity. However, the recent disasters in Japan and Russia have split the countries in the middle on adoption and even continuance of this technology.
- The project cost involved in setting up nuclear power plants is significantly high and have long gestation periods.



OBJECTIVE	To **aggressively pursue the nuclear energy program** as a strategic opportunity	
TRANSITION PRIORITY	Fast Track	Reduce time taken for construction of reactors
		Communications and transparency in India's nuclear energy program
	Emerging Track	To align and invest in the development of nuclear fusion and Small Modular Reactors (SMRs) to enhance India's, and the world's energy resilience

Hence, capacity addition policy outlook is modest, at 15 GW by 2035 as against 500 GW for Renewables.

- A key requisite for a transition to clean energy is the need for secure, stable, reliable, competitively priced electricity. While Nuclear power ticks off on these parameters, yet, it hasn't made much of a headway. This chapter examines key issues and suggests remedies that could potentially improve its share in the energy mix in the medium to long term. To enable a sharper discourse, we engage on the following issues:

Q1: How has the Indian nuclear sector evolved?

Q2: How can nuclear capacity be scaled up efficiently?

BACKGROUND

Industry Dynamics:

- Setting up a nuclear power plant, on an average, takes around ten to fifteen years, from acquisition of land for the project to producing the electrons. In contrast, solar and wind projects take less than two years. Unlike in the case of conventional fossil fuel-based generation plants, access to technology and fuel in the nuclear sphere is restrictive.

- India hasn't progressed beyond the first stage of a three-stage civilian nuclear program. Recently, a 700 MWe PWHR capacity was commissioned. The government is currently commissioning a 500 MWe prototype Fast Breeder Test Reactor (FBTR) at Kalpakkam, Tamil Nadu, the second stage. The project has been delayed by over a decade and there is a lot of uncertainty around the likely date of completion. And finally, the third stage involves large scale blending of the fuel, Uranium, with the widely available domestic resource Thorium. Each stage of this program is designed to feed into the next stage.

- In recent times, several major global manufacturers are developing smaller nuclear reactors, the Small Modular Reactors (SMRs), that take lesser time to set up. They hold promise for India, too, especially because they may not be as capital intensive as traditional nuclear plants.

Recommendations

1. Given the economic viability, safety, and reliability of PHWRs, capacity addition must be pursued aggressively to offer economically priced 'base load' electricity, as a crucial sustainable alternative to coal.

2. The government should set up an independent safety regulator. To this effect, it could take forward the Nuclear Safety Regulatory Authority (NSRA) Bill, first introduced in Parliament in 2012. The NSRA sought to replace the Atomic Energy Research Board (AERB), which reports to the Department of Atomic Energy (DAE).

3. Private ownership and management of nuclear power should also be allowed by the Government. Presently under the Atomic Energy Act, majority private equity ownership or foreign equity is not allowed.

4. The government must formulate a policy that catalyses private sector participation in the ancillary industries involved in nuclear power production. This will help improve management of current delays and impart efficiency. It can also help bring in new investments and technologies which can accelerate the nuclear energy growth in India.

5. As thermal power plants are retired, the sites could be leveraged to locate the under 300 MWe Small Modular Reactors (SMR) technology that offers crucial 'base load' support needed to anchor variable Renewable supply. This technology is emerging in the developed world and small-scale adoption has taken place. Unlike conventional nuclear plants, these take only a few years to be commissioned since they are compact in design and the reactors are factory fabricated that can be carted down to the site and installed. While global technology can be accessed for immediate use and Indian capabilities can be harnessed in the medium term, the challenge in adopting it lies in public perception on safety on the one side and ownership-related laws on the other.

DEMAND

Transport: Travel Light

- India's transportation sector, which accounts for **6 per cent of the country's GDP**, has witnessed sharp growth spurts in the last decade, be it road, rail, or air traffic. A robust economy, the arrival of widespread low-cost air travel and increasing urbanization has led to significant growth in vehicular movement. Consequently, energy consumption has vaulted.
- The transportation sector **contributes to 10.5 per cent of the country's carbon emission** and hence requires policy attention to shape the profile of its future. More so, since we will be witnessing increasing urbanisation, marked by frequent travel and over longer distances, thereby necessitating the use of motorized vehicles.
- Several policy initiatives, largely on the fuel supply side, have been formulated in this regard. For one, there is an overarching policy vision to increase the **share of gas in the economy from 6.3 per cent to 15 per cent by 2030**. Then,

OBJECTIVE	**To enhance affordable, inclusive access to mobility and markets while transiting to a zero-carbon impact**	
TRANSITION PRIORITY	Fast Track	**Shift of freight movement to Railways by (a) Creating business models for last mile connectivity; (b) Digitising and digitalising operations**
		Public Transport: (a) Introduce stringent service quality norms to induce greater passenger use; (b) Facilitate financial arrangements to promote private participation in smaller cities
	Emerging Track	**Safe, secure and affordable hydrogen fleets and operational capacities**

there is the Compressed Natural Gas (CNG) supply business that is receiving support by way of subsidised gas supply and an expeditious regime to award City Gas Distribution (CGD) licenses by PNGRB, the petroleum sector regulator, which also has specific targets for setting up CNG dispensing stations. These measures aim to reduce the use of the more polluting fuels, namely, petrol and diesel. Further, to deliver clean gas to retail outlets, the SATAT program provides incentives for aggregation and conversion of biomass.

- For a medium-to-longer intervention, a **Green Hydrogen Mission** has been set up. Given the outlook on adoption of emerging clean fuel technologies, Hydrogen appears to be a good option to move heavy haulage vehicles.
- On the non-fuel supply side, the Union government has formulated **Faster Adoption and Manufacturing of Electric Vehicles (FAME)**, a production-linked incentive programme for the manufacture of 2,3, 4-wheeler electric vehicles besides subsidy support to public sector firms to set up charging infrastructure.
- To improve and develop infrastructure to enable efficient multi-modal transport system across the country, the **PM Gati Shakti National Master Plan** is being implemented. Under this, the 'Sagarmala' policy seeks to improve cargo movement across national waterways, while the 'Bharatmala' policy is improving the road transport system.
- To promote electric public transport, the Union government launched the **National e-bus program** in 2022 with a target procurement of 50,000 buses. This met with little success since financial institutions were unwilling to finance manufacturers owing to the lack of confidence in the ability of the State Transport Undertakings (STUs) to make timely payments. In June 2023, United States and India agreed to support creation of a payment security mechanism for deployment of e-buses. A few months later, in August 2023, the '**PM-ebus Seva**' program was launched to financially support 10,000 buses on a public-private partnership basis. The details of this program are being formulated.
- Several demand side interventions to lower the carbon footprint have also been made on the policy front. Key amongst them is the Union government's **National Logistic Policy** that seeks to inject greater time and cost efficiency in the movement of goods on an end-to-end basis across the country. The policy spans across various domains—from digital platforms to provide real-time information on idling capacity/ empty return journeys, etc, to logistics human resource development and capacity building.
- The Union government's **Corporate Average Fuel Efficiency (CAFÉ)** norms set the higher limits for fuel efficiency in terms of carbon emission which keeps evolving with technological advancement. On their part, State governments offer incentives by way of lower or nil tax incidence on purchase of electric vehicles.
- The current **share of Indian Railways in the movement of freight** is around 35-36 per cent. One of the most vital transportation emissions mitigation strategies agreed to by the Union government as part of the Nationally Determined Contributions (NDC) was to **increase this to 45 per cent by 2030**. The movement of coal comprises nearly half of all the railway freight, and there is a policy push to shift a part of this to coastal movement, from Odisha to the ports on the west coast.

Against this backdrop, in this paper, we seek to evaluate the transport sector from the demand side end and suggest measures to lower the carbon footprint. In specific, we examine the following:

Q1: What measures are needed to improve utilisation of existing capacities across different modes of transportation?

Q2: How can policy improve the prospects of transport demand management, for example, shared mobility?

Q3: What are the measures needed to enable shift to lower energy needs, carbon footprint?

Q4: What are the opportunities and challenges in shifting to cleaner modes of transport?

To appreciate the challenges of the sector, we adopt a broad two-pronged scrutiny—that of the transport profile of goods and passengers, and the vehicular growth.

BRIEF BACKGROUND

Freight:

- Inter-city freight largely moves by road, accounting for nearly two-thirds the country's freight haulage. Rail, a more efficient mode on an economic cost basis, accounts for a mere 34 per cent due to legacy issues—including cross subsidising of passenger tariff, inadequate marketing initiative, delayed delivery, poor last mile connectivity, and slow pace of haulage.

- Inland waterways and coastal shipping, no doubt a time-consuming option, is perhaps the most inexpensive form of freight carriage. However, there exists a mismatch between the location of industrial zones and the waterways being developed in the country, apart from seasonal variations in the depth of water and flows. As such, even though there are 111 national waterways, with a length of over 20,000 km, inland waterway remains sparsely used. The share of haulage remains at less than 1 per cent.

Mass Passenger movement:

- On the passenger traffic side, as much as 85.5 per cent of haulage is undertaken on roads. Railways, a more efficient mode, accounts for only 13.5 per cent. While air services traffic has grown by leaps and bounds, with a significant share of the erstwhile rail traffic having moved to air. Furthermore, the entry of low-cost airlines has made air travel eminently affordable. Yet, the penetration remains at a modest 1 per cent. Passenger traffic through waterways is miniscule primarily due to its pace of haulage and is restricted to river crossings.

- In the urban mobility sector, the most energy efficient motorised carriage, namely, public transport, has a very poor imprint, recording less than 1 per cent haulage consistently over the last three decades. India has only 1.3 buses for every 1,000 people, much lower than other developing countries such as Brazil (4.74 per 1,000) and South Africa (6.38 per 1,000).

- The only significant attempt at improving mass transport haulage has been the setting up of metro rails in a few cities. Here as well, the results are a mixed bag owing to last mile connectivity.

Vehicular Growth:

- Ownership of motor vehicles has witnessed sharp growth rates. The per capita ownership has risen from 8.9 per 1000 population in 2006-07 to 22 per 1000 `population in 2016-17. By international standards this is still very low.

Energy consumption:

- Road transport accounts for 91.5 per cent of the transportation sector's energy demand.

- Rail, on the other hand, is at a distant second, at 2.9 per cent, due to its lower haulage share.

- The energy share of air transport, the most inefficient but fastest mode, at 2.84 per cent, is close to that consumed by the rail sector.

CHALLENGES

Freight:

- **Railways:** Rail movement offers higher efficiency on a per tonne basis. Nevertheless, share of road freight is much higher than in major economies like the United States and China. This is despite road freight being the more expensive mode than rail. The main reason for this is its ability to provide door to door service and the lack of mechanisms that enable better integration between rail and marine systems with road systems.

- **Inefficient trucking:** Medium and heavy-duty freight trucks contribute to 40 per cent of vehicular energy consumption in the country. Furthermore, trucks in India run an average of 300 km per day in comparison to the global average of 500-800 km per day, with empty running rates of 40 per cent. The trucking industry is dominated by many who own small fleets. With the high level of competition, their profit margins are squeezed and hence, do not have the muscle to replace old, inefficient, and polluting vehicles.

Inland water transport:

- The inland waterways authority of India has been set up to create the required infrastructure to make the national waterways navigable. However, lack of adequate operators is one of the key issues that limits its usage.

Capacity utilisation:

- Many personal cars have a single occupant despite having a capacity to seat four people. Buses can seat around forty people but often have fewer passengers. This kind of unused capacity is wasteful as the fuel for carrying this additional load has already been consumed.

- A similar problem in freight, where freight movements tend to be skewed in one direction and the reverse movement often involves empty haulage.

Public Transport:

- Public bus systems especially in urban areas are largely operated by publicly owned state transport undertakings (STUs). Their services have been incurring heavy losses, partly due their inefficient and high cost of operations.

- STUs are unable to afford purchase of buses, as it involves upfront high capital expenditure. Hence, they prefer to augment their bus fleet on a 'wet lease' mode.

- The current bus systems were put in place with affordability in mind as the objective was to offer a mode of travel to those who could not afford a personal motor vehicle. However, today, when we are looking for personal motor vehicle owners to also shift to public transport, the key determinant will not be affordability but quality.

Fuel Switch: A shift to clean energy in the transportation sector has several aspects to it. These are:

- While Railways is progressing to electrify its entire network in the next few years, the current power supply, as much as 2 per cent of the country's consumption, is primarily from non-renewable sources. However, as the grid goes increasingly

Green, Railways too has plans to increase both its generation of renewable energy as well as its uptake of Renewables through a slew of measures.

- In the road segment, the trucking and bus transport fleets are large emitters. Besides the problems posed by an inefficient fleet, a move away from diesel to a less polluting fuel like LNG, though financially viable for long distance heavy haulage, has its limitations. A further transition on to a clean fuel, namely, Green hydrogen or Green ammonia has cost ramifications.
    - The transition to natural gas for trucks and buses requires creation of LNG dispensing infrastructure which is yet to take off. Importantly, there is also a safety aspect involved in fuelling, carriage and in the in situ conversion in state from gas to liquid in a moving vehicle.
    - Compared to LNG, both Hydrogen and Ammonia are currently expensive by a factor of at least eight to ten, let alone the absence of domestic production and infrastructure.

Recommendations

1. DEMAND SHIFTS

ROAD > RAIL:

Freight:

- As coal capacities are phased down, Railways will be left with idle haulage capacity. Hence, it needs to draw up a medium to long term plan on measures to enable modal shift for freight from roads through better pricing and faster delivery.
- Eliminate cross subsidy and thereby improve competitiveness of rail freight haulage. While it is expected that the NLP will promote better integration of rail with road systems through digitisation, etc, Railways must introduce ‘deeper’ public-private participation in freight movement to enable consumer accessible, secure, timely, end-to-end delivery.

Passenger:

- While a payment security mechanism is essential for adoption of e-buses by the STUs on a public-private partnership basis, the State government should be nudged to price tickets on cost-to-serve basis and offer direct subsidy to consumers.

AIR > RAIL:

- Government policy should discourage short haul flights and persuade a shift to rail systems for distances of 300-350 kms and, as high-speed rail corridors get built up, these can be extended to 600-650 kms. This could be implemented by a phased reduction in the licenses given for short haul flights between airports such as Delhi-Chandigarh, etc and speeding up the plans for high-speed rail.

CAR > BUS (PASSENGER):

- State governments should implement policies that permit premium bus/rail services to be available in all cities to attract personal motor vehicle users. These services will help reduce the energy demand by drawing personal motor vehicle users towards shared modes and will not need subsidy support.
- Reduce overall mobility demand in peak periods by harnessing the opportunities being created in an increasingly digitised economy.

PRIVATE TRANSPORT > CABS, AUTOS

- **Shared mobility:** State governments should consider easing regulations and modifying regulations that impede development of shared mobility in aggregator businesses. The aggregator models reduce consumption of transportation energy. The aggregators must, however, be mandated to ensure a minimum social security net for the drivers, who are part of what is popularly known as the ‘gig economy’.
- To promote the use of high-end EV for aggregator use, State government should remove consumer price caps

2. EFFICIENCY

VEHICLES STANDARDS:

- Introduce fuel efficiency in trucking operations. Draft guidelines were issued by the Ministry of Road

Transport and Highways in 2022 for stakeholder consultation. Regulations must be finalised and implemented.

CAPACITY UTILISATION:

- As a short to medium term measure, aggregator systems should be encouraged for small sized buses as a premium bus service.
- As an immediate to short term measure, differential pricing between peak and off-peak periods for public transport and for parking charges must be designed to nudge better utilization of available capacity. State governments may consider introducing it.
- Capacity utilization could go up if suitable platforms are created for better information flow and dynamic pricing introduced to allow lower prices based on marginal costs, as practiced by the airline industry. This can be done both for passenger as well as freight traffic.

3. FINANCING:

- In road-based passenger traffic haulage, the highest travel intensity is witnessed in public transport and ride hailing services, and hence these segments offer better potential to reduce carbon emission. While government policies are being evolved to address the needs of the public transport system, attention needs to be paid for the ride hailing segment, especially since ownership largely rests in the hands of low-income individuals. Secondly, lenders view EV financing risker if the owner defaults owing to lower equivalent resale value compared to ICE vehicles.
- To promote EVs, the government had introduced the FAME program, which has just concluded its second iteration. The program offers production linked incentives to manufacturers. This was essential to promote investments and attract private capital. However, this benefit needs to be more efficiently directed from a carbon reduction perspective, the very raison d'etre for its existence. However, it has been observed that manufacturers use this subsidy to produce vehicles for the high-end segment, a business marked by low-volume and high-margins. Hence, from an investment promotion standpoint, the policy must have a taper and from a tax beneficiary standpoint, it must be directed towards manufacture of vehicles for the middle, lower-middle class income bracket.
- Secondly, incentives are more 'carbon-efficient' when directed at urban commercial vehicles rather than personal vehicles that travel far less and consequently burn far less polluting hydrocarbon fuels. Hence, future iterations of the FAME program's production-linked incentives should be directed at commercial vehicles production and not at personal vehicles.
- Finally, to promote demand, incentives are better placed in the hands of the consumer, which is currently absent. Hence, the government must consider credit-linked incentives to promote EV adoption.

4. FUEL SHIFT:

- It is expected that the government will, over time, enforce stricter emission norms to nudge heavy haulage long-distance vehicles to adopt cleaner fuels to align with the country's carbon emission reduction trajectory. This will involve shift to technologies that are more expensive than the more polluting counterparts. For example, batteries chemistry technology evolution, which is fast paced, packing in more energy in the same space, may become viable for short hauls, say 100-150 km. Hence:

  A. Given the low margin, highly competitive trucking business, truck owners will need financial assistance to adopt such measures. Hence, tightening emission norms should be applied, after giving due consideration to both the maturity of technology, for example, its robustness, as well as its timing. Early adoption will imply higher costs, and, in turn, a higher burden on the taxpayer.

  B. The associated transition cost should also account for stranded assets and these need to be suitably compensated. To minimise it, a guiding policy road map should be drawn up by the government. For example, an efficient carbon reduction pathway lies in limiting road transport for long distance haulage and enabling a modal shift to Railways. This, since even though the range anxiety posed by batteries in an electric vehicle is reducing, the demands of heavy long -distance haulage are unlikely to be satisfied. Other options like LNG and going forward, Hydrogen, will remain expensive compared to haulage by Railways.

DEMAND

Agriculture: Harvest Timely

- The **agriculture sector accounts for 18 per cent of the country's GDP and employs 40 per cent of the workforce**.
- It also accounts for around **17 per cent of electricity and 4.8 per cent of diesel** consumed in the country.
- Farmers are largely **resource poor producers** and the very nature of **their operations are risk laden**, from sowing to harvesting to combating pests. They face significant risks in both production as well as sale of produce. The industry is hence conservative in its practices.

OBJECTIVE	To **empower farmers** to emerge as winners from the energy transition	
TRANSITION PRIORITY	Fast Track: **Integrated Resource Management Strategy for the agriculture sector in India**	To design delivery of assured, reliable, good quality renewable power
		To reduce demand for energy through enhanced water supply and availability and affordable access to organic fertilisers
	Emerging Track	To make farmers partners in the emerging bio-fuel story in India

- To a large extent, farming practices such as **choice of crops are determined by government policies**.
- Blanket approaches often result in **intensive water crops being grown in arid areas**. This results in higher electricity consumption.
- Policies such as **Ethanol blending program** are aimed at producing biofuels to substitute polluting hydrocarbon fuels.
- As much as policy impact, **consumer preference also plays an important role**. Indians are large consumers of two water intensive crops—rice and wheat.
- Agriculture consumes **80 per cent of the country's freshwater**. Estimates indicate that by 2050, the supply of water will be significantly less than required.
- **Two-thirds agriculture land is held by marginal farmers**, with less than one hectare ownership. Farm Mechanisation, which leads to efficient operations, is low in this segment.
- Broadly, **energy consumption in the sector can be divided into two segments**—direct and indirect use. Energy used for agriculture pumps, tractors and other farm equipment constitutes direct use. Indirect use applies to that spent in the manufacture of fertilisers, pesticides, etc.
- Overall, the **carbon imprint of the agriculture sector is significant** due to the livestock sector, its demand for irrigation, fertilizers, land tillage practices, crop choices as well as storage and the supply chain of food. Of these, the key energy related GHG contributors are the activities of fertilization and irrigation.
- The political economy dictates that **farm subsidy** by way of low or nil power tariff, water subsidy and urea subsidy **is likely to continue** in the foreseeable future.

Given the above contours of the sector, the following questions arise:

Q1: What measures must the agriculture sector adopt to pursue a clean energy emission trajectory?

Q2: How can the farmer be incentivised to adopt efficiency/demand reduction measures?

CONTEXT

- Since electricity supplied by the Utilities is either on a flat rate based on irrigation pump capacity (hp), or supplied free of cost, there is little incentive for the farmer to adopt efficiency measures or switch to cleaner energy.
- This arrangement also virtually eliminates the political challenge to charge farmers the price of round-the-clock 'Green' electricity. Hence, government schemes, both at the State and Union level, are aimed at converting the farmer into a 'prosumer' to hasten the pace of decentralised renewables adoption in rural India, for example, financing of solarized pumps.
- These approaches have been discussed in the electricity chapter as part of the larger architecture of electricity sector reforms and are key to accelerating the pace of a low carbon pathway in the single largest sectoral contributor to carbon emissions.
- Farmers are comfortable growing Paddy, a water intensive crop, since the yield has gone up 16 per cent in the last three years and profits have risen around 70 per cent owing to higher procurement prices.

Recommendations

1. EFFICIENCY

A. States like Punjab have shifted the supply of free electricity closer to the sowing season, thereby minimizing inefficient use of ground water and its consequent depletion. Other states should consider rationalising supplies, more so since in several places, canal water and rain-water have a primary irrigation role.

B. Given that majority land ownership is with marginal farmers who have limited resources, State governments may support delivery of efficient crop practices like micro-irrigation, direct seeding, and Mechanisation. Currently, only a few states have comprehensive programs.

C. To reduce the embedded carbon imprint of fertilisers, consumption efficiency needs to be improved. For example, the ratio of NPK fertiliser use needs to be balanced through price cues. Further, only a third of Urea binds to the crop. The rest is released into the air as ammonia or leeches into the soil as nitrite mineral. Use of nitrogen inhibitors improve the 'digestibility' of Urea, reducing consumption by a third and hence needs to be promoted.

2. FUEL SWITCH

A. To catalyse the adoption of electricity tractors which are more expensive than their diesel counterparts, the government may consider production -linked incentives of the kind given to other electric vehicles like two wheelers, etc, under the FAME scheme.

B. Government needs to evaluate and thereby ensure that the larger imperative of the country's food and water security are not sacrificed while pursuing programs to grow biofuels to help reduce carbon emissions.

DEMAND

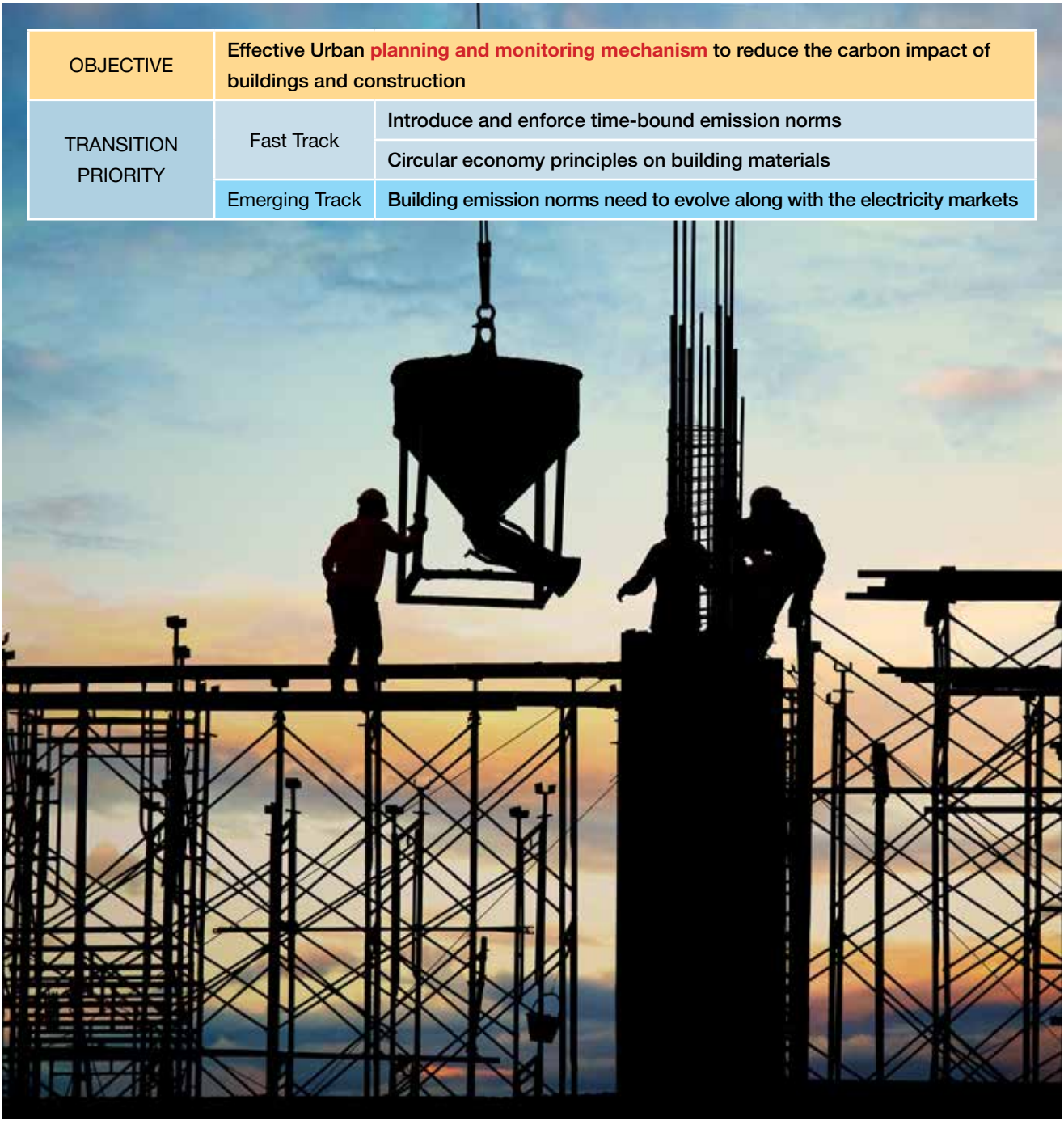
Building it Right

- The **Buildings sector is a key energy consumer**. Energy is used in both its construction and use. A sizeable share of the country's economic activity occurs in buildings. For example, the digital economy, which accounted for 4.5 per cent of GDP in 2014 and has risen to 11 per cent of GDP in 2022-23, operates from commercial and residential buildings. The two segments, in turn, account for 24 and 9 per cent of electricity consumed respectively in the country. The government expects the share of digital economy to increase 20-25 per cent of GDP by 2025-26, pointing to more demand for buildings and energy.

- The **current level of urbanisation is estimated at around 35 per cent against the world average of 52 per cent**. Economic prosperity and increasing population will drive the need for more urban space. This will result in cities expanding, improving their urban infrastructure, and new ones being created.

- In Rural India, **more "pucca" buildings are expected to be built**, with concrete replacing traditional local materials.

OBJECTIVE	**Effective Urban planning and monitoring mechanism to reduce the carbon impact of buildings and construction**	
TRANSITION PRIORITY	Fast Track	**Introduce and enforce time-bound emission norms**
		Circular economy principles on building materials
	Emerging Track	**Building emission norms need to evolve along with the electricity markets**



- With rising income levels and the changing climatic patterns, the **heating and cooling energy needs are expected to rise**. India's per-capita energy consumption for space cooling is currently only a quarter of the world average.
- Government has policies governing urban planning, energy efficiency, and housing. While Urban/ town planning is driven by the States, the **Union government does influence the norms for energy efficiency in buildings**. The Energy Conservation and Sustainable Building Code (ECSBC) sets minimum energy standards for buildings and has been adopted by several States.

It is evident that energy use in buildings is likely to look very different in the future. From expanding urban areas, to rebuilding rural buildings, to increased appliance use, energy use will increase. This proves to be a challenge and an opportunity for reducing carbon emissions in a significant manner, especially given the Net Zero goal by 2070. The following are, therefore, key aspects that come to the fore:

Q1: How can the urban planning process be improved to reduce the energy intensity of buildings and cities?

Q2: What are the measures needed for large scale adoption of energy efficiency in buildings?

Q3: How can policy measures enable a switch to less carbon intensive construction materials and methods?

BACKGROUND

1. Despite the rapid pace of urbanization, energy use and carbon intensity are not a priority for regional and urban planning agencies.
2. Building energy demand is rising sharply due to increasing cooling and heating needs, and accelerated adoption of electric vehicles and other appliances.
3. Roof top solar offers inexpensive and clean electricity, however, there has been limited adoption in urban areas.
4. Construction is an energy intensive process. Production of major building materials like cement and steel releases large volumes of carbon. Mitigation involves investments in carbon technology.
5. There is no energy efficiency target set for the building sector.
6. The uptake of building energy policies (like ECSBC) and implementation of energy efficiency programs in the building sector has been slow. Buildings and their energy impact span multiple domains. Lack of integrated approach to policy and program design, low priority accorded by the government, and multiplicity of agencies, are some of the main reasons for this situation.
7. Government is a key consumer and demand driver in the construction sector

Under the Pradhan Mantri Awas Yojana—Gramin and Urban—scheme, the Union government has so far provided financial assistance for the construction of 3.1 crore 'pucca' houses in rural and urban areas

Under the Smart Cities Mission, the government is aiding redevelopment, retrofitting and green-field development in 100 selected cities

Both these projects are expected to lead material and technological innovations and their adoption in the sector.

Public buildings (central, state, municipal, PSUs, etc) constitute a significant proportion of buildings and energy use in the country.

CPWD and state PWDs directly influence construction practices, cost, and specifications even for the private sector.

Recommendations

1. BUILDING ENERGY EFFICIENCY

There are two ways to implement energy efficiency measures. One is to mandate and enforce a minimum standard. The second is to provide incentives for higher efficiency gains.

- **Baseline Measure:**

The Government should mandate 100 per cent building energy code compliance for all new and existing buildings. There is potential to further improve the performance levels and efficiency of buildings by progressively making ECSBC norms stringent.

Air-conditioning will be the largest end-use appliance in residential buildings. ECSBC must directly address this by ensuring that the buildings are designed to minimize cooling requirements.

The ECSBC must evolve to be an outcome-based metric, based on the actual energy use of the building, so that it can account for the way in which a building is occupied, operated, and maintained to reduce annual energy use.

The Standards and Labelling program, which sets the Minimum Energy Performance Standards (MEPS), should be driven by the best-available technology, with a progressive long-term target to drive industry and the market.

Energy audits should be mandated for all buildings every five years. Retrofits must be mandated in a time-bound manner, where they exceed the energy intensity norm.

- **Rewarding Gains:** Buildings represent the largest consumers of the distribution Utility's electricity supply. Hence, the following measures are suggested

Roof top PV systems produce low-cost and clean electricity for buildings. While State governments must mandate new buildings to set up these, the Discoms must provide incentives for existing buildings to do the same.

With rising share of Renewables in the Discoms' supply, consumers need to be signalled to align their consumption to time-periods when Renewable energy is available (for example when the sun shines or wind blows), to benefit from low-priced Renewables tariff. For this to happen, Discoms need to move to dynamic Real-Time Tariff along with Real-time carbon intensity of the energy provided.

Grid interactive buildings must be rewarded for managing their energy consumption profile, responding to the utility load and carbon intensity of the energy mix in real time

Grid-Interactive Net Zero Energy Buildings can serve the needs of consumers and distribution utilities while reducing the overall energy consumption, balancing the energy demand, and providing best economic value to the energy supplier and the customer. Buildings should be able to switch and select Discoms and energy providers based on electricity tariff or carbon intensity.

2. LOW CARBON BUILDING MATERIALS

- Low carbon materials and circularity should underscore policies governing the construction industry. For example, while disposal norms exist, there are none for its end use. Norms need to be set out for construction and demolition waste, to ensure circularity of concrete use. Carbon markets will improve the viability of these businesses.

- Under the PMAY Mission, a Technology Sub-Mission (TSM) has been set up to facilitate the adoption of innovative, sustainable, eco-friendly, and disaster-resilient technologies and building materials for low-cost, speedier, and quality construction of houses. This needs to be expanded to develop the use of materials and construction methods that lower energy consumption and carbon footprint. Targets must be set for reduction of carbon intensity of primary construction materials, say 50 per cent (in terms of Kg CO2/m2) of the business-as-usual methods being used currently.

- The Union government must introduce an emission accounting and disclosure system for buildings with emissions labeling of building materials and products. Given the sizeable use of cement and steel in the construction industry along with the rapid increase of glass, aluminum, and other metals, the

embedded carbon in buildings materials is significant. At a building unit level, the State government must consider developing mechanisms to validate the building's composite carbon labeling and thereby enable owners and developers to earn carbon credits on cleaner choices.

3. URBAN PLANNING:

The planning process in cities should be based on an ecological approach. Furthermore:

- While most urban planning policies focus on the urban areas and cities, an approach for rural areas and villages must also be developed. In this manner, the planning process will account for the different scales of settlements including large metros and Census towns.
- Planning policies enable continued economic expansion not just as a problem-solving strategy but as a transition mechanism to a sustainable society that carefully balances short- and long-term goals with an emphasis on sufficiency, social equity, and quality of life rather than quantity of outputs. Hence, they should:

  Promote low-rise high-density walk-ups as far as possible to address population pressure and build walkable cities.

  Provide decentralized local water supply and sanitation systems, based on circular-economy principles (reusing wastewater).

- Optimal planning of new cities and expansions holds the key to a low carbon transition across several consumption sectors. Hence, the planning process must incorporate the following:

  Promote urban designs that enable lower operational energy, for example, air conditioning and heating needs by balancing the size and density of cities through low-rise high-density development.

  Ensure mixed land use design to reduce intracity travel need.

  Adopt transit-oriented development with a focus on mass transport and non-motorized transport.

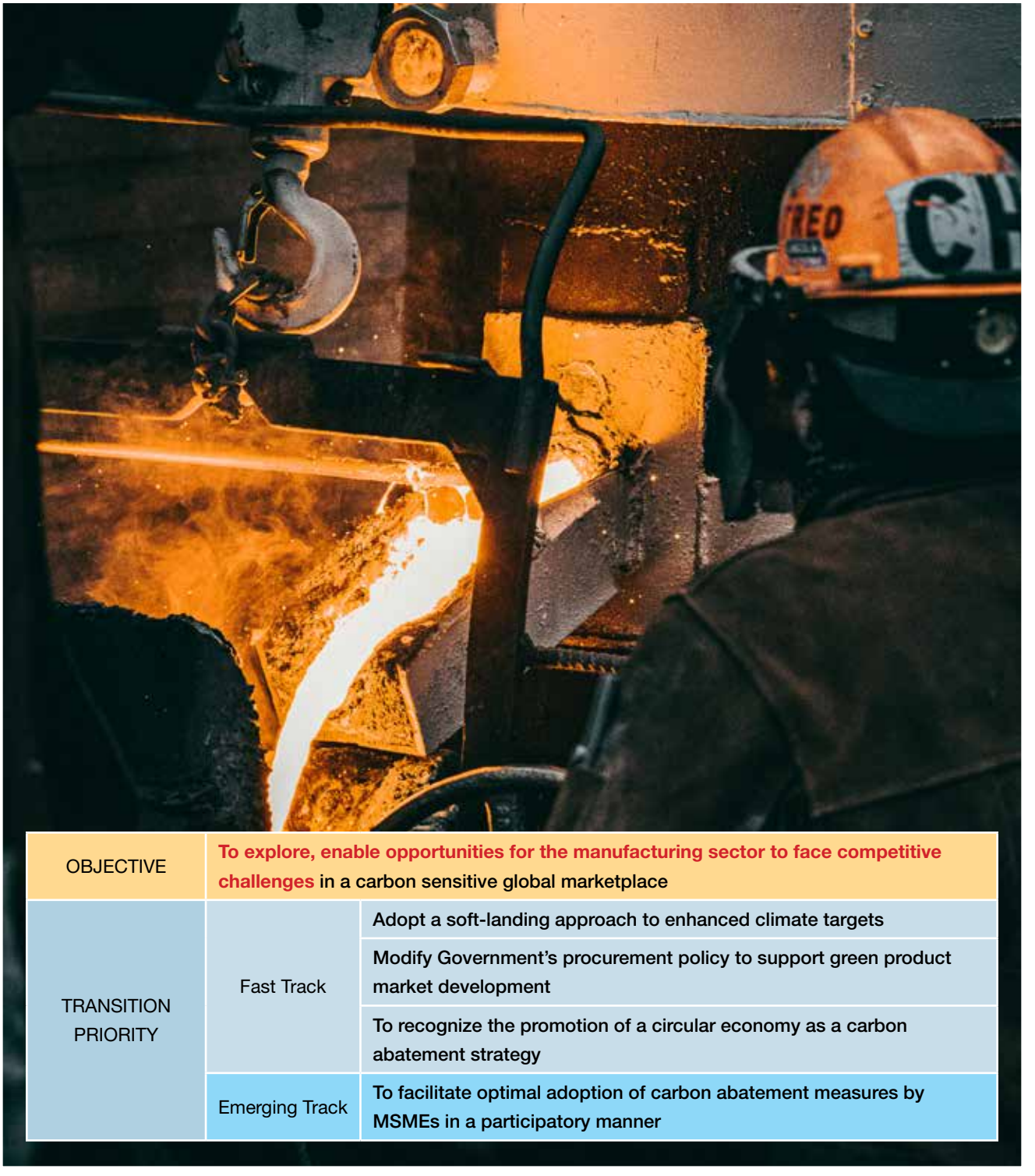
  Treat buildings as virtual energy firms that consume various forms of energy, from electricity to heating, and apply Scope 2 emission principles.

DEMAND

Manufacturing Might

- India's manufacturing sector has maintained its share in India's economic output over the last decade, hovering around 15-17% of GDP. **It accounts for 44% of energy consumed in the country**, and hence, it is a key sector to engage from a carbon emission standpoint. However, the challenge to raise the share of the manufacturing sector in country's GDP—key to income and employment generation—remains.

- The Government is striving to enhance the share of manufacturing in GDP through various initiatives such as 'Make in India'. **India is emerging as an investment destination** for high technology, energy intensive sectors like silicon chip manufacture. It is projected that industrial production and domestic consumption will continue to rise leading to an increase in energy demand by around 2.5 times by 2047.



OBJECTIVE	**To explore, enable opportunities for the manufacturing sector to face competitive challenges in a carbon sensitive global marketplace**	
TRANSITION PRIORITY	Fast Track	Adopt a soft-landing approach to enhanced climate targets
		Modify Government's procurement policy to support green product market development
		To recognize the promotion of a circular economy as a carbon abatement strategy
	Emerging Track	To facilitate optimal adoption of carbon abatement measures by MSMEs in a participatory manner

- At the same time, the global competitiveness metric is evolving to capture embedded carbon in the manufacture of goods. Europe has launched the **Carbon Border Adjustment Mechanism (CBAM)**, which will levy a tax on embedded carbon from 2026 to maintain the competitiveness of European industry as it faces increasingly stringent carbon regulation. On the supply side, the developed world is resorting to strong fiscal and financial stimulus to promote clean-energy projects ranging from wind farms to factories that make batteries, solar components, and hydrogen. This supportive regime extends all the way to the consumer end through access to low-cost finance holding promise for greater improvements in performance and affordability of renewable energy for the world.

- In August 2023, the Union government in India ushered in the **Carbon Credit Trading Scheme (CCTS)** which seeks to enhance the transition efforts of the existing energy efficiency-centered Performance Achieve and Trade (PAT) scheme, with an increased scope that rewards cleaner fuel, feedstock switch, and will cover the energy intensive sectors in India. For these sectors, GHG emissions intensity benchmark and targets will be developed, which will be aligned with India's emissions trajectory as per climate goals. The trading of carbon credits will take place based on the performance against these sectoral trajectories. Further, it is envisaged that there will be a development of a voluntary mechanism concurrently, to encourage GHG reduction from non-obligated sectors. CCTS could function in parallel to the Perform Achieve Trade (PAT) scheme, where the latter retains focus on energy efficiency.

This chapter examines the energy implications of national and international policies for Indian industry that needs to remain competitive but also lower its carbon footprint. To take forward this exercise, we use the 4R circular economy principle—Reduce, Reuse, Recycle and Remove approach—to navigate the industry's energy use and carbon pathway. This brings to the fore the following questions:

Q1: What are the challenges for energy intensive industries—both technical and financial—and the enabling environment needed to catalyse adoption of a low carbon growth trajectory?

Q2: How efficiently will CCTS and PAT drive the energy transition narrative? After all, the price should be able to justify the investments made to reduce emissions?

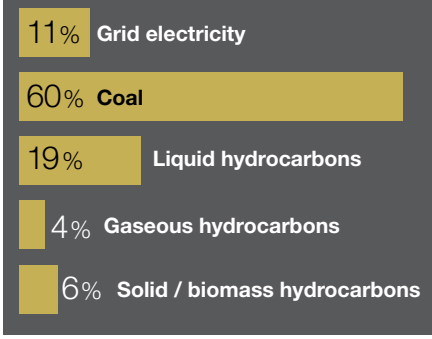
Q3: What improvements are required in the eco-system to nudge, foster, and promote skills, innovations, capacities at scale, towards enhancing sustainability?

CONTEXT

Resource Management:

- Between 1970 and 2015, India has increased its material consumption six-fold. This is expected to double by 2030. Usage of virgin material is still prevalent with "scrap management" being highly unorganized. On the other hand, rapid industrialization increasingly generated large quantities of wastes such as slag from steel and copper industry, red-mud from aluminium, dolo char from sponge iron etc. Circularity of resources - input material, output waste or scrap management—is an evolving paradigm in India.

Figure-7: **Profile of Energy Consumption by industry, 2022**



- There is vast scope for co-generation in energy intensive industries, particularly where both electricity and steam are required. While the captive generation of power is as high as equivalent to 19 per cent of the country's installed Utility capacity, only a small share is driven by renewables. Sugar mills are a good example of co-generation, and now even petroleum refineries and steel mills are tapping their flue gases for conversion to fuels for internal use. Carbon pricing may influence business decisions towards such investments.

- In India, heat applications such as boilers, ovens and furnaces, account for around two-thirds' of industrial energy demand. Waste heat re-use is a key energy efficiency measure. It has been widely adopted in the cement industry, where the cost of Waste Heat Recovery System generation is around a quarter of that of coal-fired captive units that power up cement plants.

- Steel, a major energy intensive industry, is the most conducive material for circular economy as it can be used, reused, and recycled infinitely. Using a tonne of scrap steel averts burning of 0.6 tonnes of coking coal. In 2019, government introduced the steel scrapping policy with aim to increase the number of collection and processing centres. Two years later, the government introduced the Vehicle Scrappage policy that made it mandatory to scrap diesel vehicles older than 10 years and petrol vehicles more than 15 years, thereby augmenting supplies into the scrap market.

Process Challenges:

- Carbon emitted in a manufacturing process depends on the feedstock, fuel and the technology deployed. In energy intensive industries, it is difficult to remove carbon beyond a certain limit, even after serious interventions are made in all three aspects. As a result, often total cleansing may require carbon to be scrubbed from the air.

- Two highly polluting industries, namely, iron and steel and cement, are examined here to unravel the challenges and options available.

    - **Steel production:** Iron and steel sector is the single largest consumer of energy and single largest contributor of GHG emissions within the Indian manufacturing sector. Traditionally, coal is used both as fuel (for high temperature heat) and as feed stock. This process occurs in a coal-fired Blast Furnace-Basic Oxygen Furnace (BF-BOF) and is prevalent in around 60-65 per cent of the country's steel factories

        Switching feedstock from coal to Petcoke which has a higher calorific value results only in a meagre reduction in carbon emission.

        Deeper carbon cleansing involves measures such as a fuel switch to natural gas as a reducing agent or/ and to replace the Blast Furnace with an Electric Arc Furnace (EAF) that operates on renewable electricity.

        Near complete decarbonization is possible when a fuel switch is made to Green hydrogen (which also acts as a reductant). The price of green hydrogen must come down by a fourth to make it commercially viable, which is not expected to happen in the short term.

        Technology for fuel-feedstock carbon cleansing is still at a pilot stage and is expected to be commercialized by 2030.

    - **Cement production:** The Indian cement industry is the second largest energy consuming industry after steel and is already quite energy and carbon efficient globally. The cement process has a potential to consume both hazardous and non hazardous waste as alternative raw material, serving a larger purpose

        Around 30-40 per cent of carbon is emitted while heating up the kiln to produce clinker, the active component that confers binding properties in cement, remaining is released in the chemical process inherent to the production of Clinker. While the former can be addressed by supplying heat from low carbon fuels such as natural gas, biomass and Municipal Solid Waste (MSW), supply of carbon as a feedstock for producing Clinker remains irreplaceable.

Indian cement industry's carbon intensity at 3.1 GJ/tonne of clinker is better than the world average of 3.5 GJ/tonne but still the Thermal Substitution Rate (ratio of fossil fuels to alternate fuels), is around 3-4% - while in developed nations it's in double digits - indicating a good scope for improvement.

While Clinker alternates, newer post combustion technologies hold the key, the process only minimizes carbon release. Hence, as of today, carbon capture and sequestration are the only available remedy to completely eliminate the clinker production-related emission.

Swithing fuels:

- A process plant industry typically needs three ingredients - heat, feedstock, and electricity - to operate the machines. While technology for Renewables is mature and well adopted, the electricity markets are still undergoing reforms to ensure efficient supply and delivery, while fossil energy continues to remain subsidised. In the case of heat and feedstock, both technology and adoption are still evolving. In the fossil world, for example, coking coal or Petcoke doubles up to perform the two roles. Carbon-free replacements for these functions, on a sector-specific adoption mode basis, are hydrogen and ammonia. In the steel sector, as we noted above, Green Hydrogen is being used in a small way. Fertilisers and refining sectors are turning to Green Hydrogen instead of Grey Hydrogen derived from natural gas, depending upon availability and viability.

- While governments are recognizing the need to fuel switch programs, offering low or no risk guarantee to investors, etc.

Carbon Markets:

- In India, the Perform Achieve Trade (PAT) scheme is the existing regulatory instrument and is limited to capturing energy efficiency gains. It has achieved partial success, importantly that of inducing behavioral change in industries to adopt efficiency measures and, consequently, bringing down the energy intensity of operations and thereby reducing carbon emissions. However, critics have highlighted several areas for strengthening the performance of this system including enhanced transparency on energy and emissions disclosures by industry and more attractive floor prices and more stringent targets for efficiency improvements.

- The recently legislated Carbon Credit Trading Scheme (CCTS), which is currently being developed and expected to be operational in 2024-25, moves beyond the PAT scheme:

- It will recognise a wide array of technology options, fuel switch and process modification, albeit not all related to energy. This will enable greater traction on technology-led financing in pursuit of a lower carbon imprint.

- It allows for a wider participation of buyers, has provisions to register entities who wish to buy credits to offset their carbon footprint. This hopes to allow for a better price discovery for carbon credits.

- It seeks to create a globally acceptable carbon market that will be tradable in other nations and thereby offset levies like CBAM in Europe; the verification will

be rigorous, and agencies entrusted for this exercise will have to clear a high bar set by the Union government.

Innovation and Capacity Building:

- Data collected under PAT scheme is not available in public domain. Government may make this data public to promote innovative practises.
- Technology specific centers of excellence and capacity building cum exchange programs—either state sponsored or supported—drives innovations in the west. MSME needs such knowledge and capacity support more than the large industries.
- Behavioral nudging instruments can potentially drive least-cost sustainable practices in industries. Programs like the "star rating program" have been tried in states like Odisha, Maharashtra, Gujarat, and has a potential to scale up in industries.

Recommendations

1. RESOURCE EFFICIENCY

A Resource Efficiency Policy is needed for its implementation. The administrative overlap of this subject also needs to be clarified.

- Union government has a scrap policy only for the steel sector, one that incentivizes the business of scrap collection and processing. And a framework for non-ferrous metals scrap recycling exists in India, this needs to be drawn into a policy.
- State governments must evolve a policy that incentivizes the use of recycled cement and concrete materials in new buildings and construction.
- Product labelling must disclose carbon content.

The Union government may also draw up a Heat strategy that mandates renewable solutions in a phased manner. A cost-effective clean energy approach to meeting the industry's heating needs would be possible through use of biomass

2. TECHNOLOGY PROMOTION

India's manufacturing sector majorly comprises small and medium enterprises. This sector has seen little innovation, which would be the key to sustainability. Imposition of a carbon price would make them more vulnerable than the large industries who are able to innovate better. The Government has been mindful of this special requirement and needs to do more.

- Set up R&D technology hubs in designated centres of excellence.
- Such technical institutes may also address the skill gap in the ecosystem

3. CARBON MARKETS

To ensure that CCTS becomes an important driver for manufacturing Industries to achieve low carbon growth, the government may consider the following:

- Develop a publicly available national data repository for designing and monitoring large-scale programs like CCTS. While scope 1&2 emissions would be accounted, should capture scope 3 emissions as a first step.
- With evolving technologies, the credibility of the carbon regime hinges on the ability to assess the carbon intensity of the projects and in turn, the competency of the Measurement, Reporting and Verification (MRV) agencies. Hence, the MRV agencies also hold the key to unlocking access to carbon finance. Government should enable upskilling of local agencies as most MRV agencies are foreign, expensive, firms. Low-cost access is essential to widen and deepen the carbon markets, especially in the MSME industry segment.
- The targets set to earn the carbon credits must be achievable yet challenging. As efficiency gains are achieved, the bar needs to be raised. This line of sight must be provided to industry as it will give them the confidence to invest in low carbon technologies that have longer gestation periods for payback.

4. EARLY ADOPTION BARRIERS

The carbon market is still a work-in-progress and secondly,

MSME Sector

CONTEXT

- Access to capital and emerging, appropriate technology are a crucial aspect in effecting carbon transition. In India, as much as 36 per cent of manufacturing output is from Micro, Small and Medium Enterprises (MSME). The definitions are based on the upper limit of their revenues, with 'Medium' industries registering under Rs 50 crore.
- The sector contributes about 45 per cent of the total manufacturing output and about 40 per cent of the country's exports. For this sector, to go about their non-carbon challenges, government extends support in different manners from credit support to technology assistance to skill development to marketing.

RECOMMENDATIONS

- In their efforts to reduce carbon emissions, this segment of industry needs to be extended support to access capital and technology choices.
- The Union government may develop a scheme to promote Energy Service Companies to offer services in this sphere.

the extent of supply-end policy cover might not prove to be adequate to cover costs involved in adopting a low carbon pathway. In this regard, the government could consider:

- **Formulating a procurement Green policy** for end-products like cement and steel to stimulate demand. An Eco Label scheme may further this agenda.

CONCLUSION

Key Cross-Cutting Recommendations

In India's post-'91 liberalisation era, the broad governance outlook has been that of facilitating a receding role for the State while enabling efficient market behaviour and consumer protection, set against the challenges posed by the political economy. As a result, for example, there is broad-based evidence of sectoral deregulation, albeit to varying degrees of effectiveness.

In recent times, the exponential increase in global climate related anxieties has deepened the expectations that good governance, in all countries and at all levels, will empower humanity to overcome this challenge quickly and effectively. India is responding responsibly to this call, receiving global recognition of its many policy and programme initiatives to transit towards a low-

carbon pathway. However, to both meet its substantial 2030 goals as well as its Net-Zero GHG commitments by 2070, India will need an aggressive step-up in its efforts. An outcome-oriented, integrated approach to energy policies, with the objective of ensuring that all cogs of the wheel are driving the system in the same desired direction—a non-trivial task in a complex, inter-connected socio-economic environment—would greatly facilitate this goal achievement.

While India had become increasingly self-sufficient in meeting its needs for technology and capital in order to pursue a rapid path to industrialisation, the imperatives of the carbon reduction narrative today raise barriers on both counts. Access to capital has a new dimension to it—access to inexpensive and adequate carbon funds to reduce the cost of transition and to do so at pace. This translates to fast-tracking the capacity of existing institutions, as well as revisiting the role of the State, to enable low carbon transition optimally and inclusively.

The different chapters of this publication have made many recommendations to strengthen ongoing transition-related reform programmes of the Government with a reflection also on longer term directions that the country needs to take. Many of these signals on policy interventions for a longer-term impact seem to have common threads running through them, leading to the attempt in this chapter to stitch together cross-cutting interventions that would both serve the emerging needs of specific sectors as well as bring about greater efficiencies. Pulling out these threads to form key recommendations will, hopefully, put a spotlight on deepening reforms for transition in addition to strengthening the ongoing reforms.

But first, a recap of key cross-cutting challenges and implicitly the opportunities for more efficiently addressing the same:

- To set sub-sectoral goals—for both driving in low-carbon energy and phasing down fossil energy—to provide a clear line of sight on energy goals to be achieved.
- The need to continuously evaluate suitability of current and emerging clean energy technology options from a social, environmental and security perspective.
- To raise adequate and timely finances for supporting the energy transition, design incentives for outcomes.
- To mitigate the scale and impact of stranded assets.

KEY RECOMMENDATIONS

To address the above challenges, it is critically important to strengthen and modernise the bedrock of any economic system – its institutional framework. Additionally, it is important to keep a sharp focus on those areas that could derail the energy transition process. Highlighted below are a select set of recommendations to address these areas through government intervention.

1. Establish a high-level committee to Review Energy and Related Energy Subsidies.

India's energy sector is riddled with subsidies and cross-subsidies that interfere with the efficient functioning of the sector and often preclude or retard private sector participation. Several of these are legacy subsidies designed to address specific challenges at given points in time. However, they have come to stay. On the other side, policy makers are now designing more incentives to align the energy system to achieve both our climate and sustainable development goals. There is, thus, an urgent need to review and revise the overall incentive framework for the energy sector with a clear delineation of objectives—social, economic, and environmental—and transparency and accountability measures defined. As a result, it must arrive at the economic cost of electricity from different sources including the grid stabilisation cost, the cost of dedicated evacuation systems and other ancillary services.

This committee, comprising representatives from all the related ministries, Niti Aayog, industry bodies, think tanks and civil society organisations should be chaired by the Ministry of Finance. Given the concurrent nature of parts of the energy system, it would be useful to have a few representatives of State governments as well. Several knowledge institutions have already attempted to capture the scale, application, and efficiency of energy subsidies, providing a firm base to take off from.

The Committee should be tasked to deliver its comprehensive recommendations with a time frame of, say, two years.

2. Strengthen the Energy Regulatory Framework

The electricity regulatory commissions in India have been functioning for nearly three decades now, following electricity sector reforms, and have accumulated a deep, evolving understanding of the sector and its operations. The Petroleum and Natural Gas Regulatory Board was formed a decade later.

> “India’s energy sector is riddled with subsidies and cross-subsidies that interfere with the efficient functioning of the sector and often preclude or retard private sector participation. Several of these are legacy subsidies designed to address specific challenges at that time.”

With rising private participation in the downstream gas business and the policy thrust to sharply raise share of gas in the country’s primary energy basket, PNGRB’s role is becoming crucial in the emerging energy map.

However, going forward, with a rapid electrification of the economy and a declining role for the fossil energy sectors—both of which require a greater alignment of regulatory decisions with transition policies—it would possibly be more efficient for the country to gradually move towards a single energy regulator set-up that is also tasked with regulating fossil, Renewables, liquid, and gas sectors. This encompasses the new energy molecules, namely, hydrogen and ammonia, in both their liquid and gaseous form.

A single energy regulator would be better able to support the policy coherence needs of the economy and would enhance confidence in the market players. Of course, this would need to be accompanied by the requisite skill enhancement and structural alignment. The government could consider preparing a document on an annual basis that captures the role of regulations in supporting the energy transition goals, including modernising the sector, along with the challenges faced. This would prove to be valuable in pushing forward the transition reforms.

3. **Establish a high-level committee on Harnessing Competitive Efficiencies through Market Development**

The quest to reduce carbon emission imposes a financial burden on every participant in the economy. A key approach to mitigate this lies in harnessing competitive efficiencies through market development. In this backdrop, the panel may examine the following three aspects and suggest recommendations:

Across several sectors, largely involving delivery of public goods and services and mass consumption products like electricity, as we have observed in the preceding chapters, there is need for the government to establish PSMs to usher in effective private participation. These arrangements need to be developed with linkages to larger sectoral reforms and cross-sectoral efficiencies.

The government has been providing incentives for developing markets for low-carbon alternatives, for example, EV promotion through production-linked subsidies. There is need to develop a larger integrated approach to providing incentives to industry and consumers. Given finite government resources set against the sectoral hurdles in adopting low carbon trajectories, this will help arrive at a priority and scope of intervention. For example, it will help allocation of incentives set against the larger trade-off of delayed adoption, extent of carbon abatement.

Developing an efficient carbon market to usher in carbon finance from the developed world is an important objective in the larger narrative. This involves policy measures to enforce carbon tagging across the value chain. tax transparency in input products used by industry. Another key aspect is the evolution of the CCTS and the emission norms in a manner that industry engages with the market to seek out not just the ‘low hanging fruits’ but also steeper interventions in the pursuit to reduce carbon emissions. Another challenge lies in access to these markets. Fulfilling compliance norms and costs involved therein should not pose a barrier to engagement.

The panel must also examine the aspect of external policy in bringing global arbitrages to improve domestic competitiveness, be it access to fuel, technology, or capital. With more countries adopting an Emission Trading System and carbon-based trade

> “A single energy regulator would be better able to support the policy coherence needs of the economy and would enhance confidence in the market players. Of course, this would need to be accompanied by the requisite skill enhancement and structural alignment.”

taxes, Free Trade Agreements need to be reviewed. Given the compulsions and constraints of a developing country, emissions, competitiveness, and market access need to be viewed in a unified manner.

The aspect of developing the circular economy and measures to promote it have been dwelt upon across the various chapters, for example re-use of concrete from buildings. A road map needs to be developed to promote it across all limbs of the economy and in a comprehensive manner.

4. Develop a Strategic Sustainability Indicator Framework (SSIF)

Energy transitions through the Indian economy are likely to touch all aspects of life, as we know it, and all living beings. Currently, in the rush of finding economically viable measures/technologies for the low-carbon transition, there is little time to focus on the unintended consequences and/or fall-outs of the transition process. This is particularly true for evaluating the winners and losers in the transition process. The design, development and implementation of a Strategic Sustainability Impact Framework could go a long way in mitigating the negative consequences of adopted transition pathways on people and nature. The SSIF would be the tool for measuring and reporting on the impacts of energy transition initiatives on the three pillars of sustainable development, namely, environmental, social, and economic.

5. Set up an Energy Transition Authority (ETA)

Cross-cutting issues are dealt with frequently by the Government through a range of mechanisms—at a political level, the Empowered Group of Ministers (EGoM), or a ‘short’ Cabinet provided a platform for focussed and decisive decision-making ability. At the bureaucratic level, panels enlisting the heads of departments (Committee of Secretaries) played a substantive part in the evolution of policies.

In the case of energy transition, however, there is an urgent need to provide policy coherence across all the energy sub-sectors and over time, for example, assess the ‘runway’ for coal and hydrocarbons use in view of the emerging technologies for mitigating carbon like carbon capture and storage (CCS) and its onward conversion to chemicals. As much as that, assess and optimally promote feedstock and energy supply and shift across sectors. For example, the use and scope of transition fuels like natural gas, ‘grey’ and ‘black’ hydrogen set against the ‘visibility’ of ‘Green’ hydrogen’s economic viability and adoption.

This will result in efficiently and optimally allocating carbon budgets to the energy sub-sectors and continuously reviewing them. To undertake this exercise, the government must evaluate and understand emerging dynamic energy transition pathways over several decades, analyse effectiveness and impact of various policy and programme measures and ensure that the transition is inclusive and just. This requires a more permanent and empowered entity to be established with the requisite staff skills and tools to facilitate effective functioning—an Energy Transition Authority (ETA) reporting directly to the PMO.

The ETA should be supported by a highly skilled, competitively procured and technically equipped Secretariat demonstrating a deep understanding of the energy sector—both from the supply and demand dimensions, strong capabilities in state-of-art quantitative and technical analysis and impact evaluation capabilities. The Head of the Secretariat should be an internationally renowned, independent expert in the energy field.

Notes

Notes

Energy Policies for India's Conversion to a Net-Zero Economy (EPIC)

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