



प्रशासनिक सुधार और लोक शिकायत विभाग
DEPARTMENT OF
ADMINISTRATIVE REFORMS &
PUBLIC GRIEVANCES

Early Vision Summary

Consolidation of the initial visions submitted by the 10 individual Cells that were part of the

Imagining India @ 2047 - Symposium at the IIT Madras Research Park



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1. Energy & Net Zero

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Envisioning the Energy scenario in India in 2047

India is a developing country with a per capita GDP of INR 150,000.00 (USD 2000.00). Currently, India is fuelled by primarily coal-based electricity generation, imported petroleum and natural gas. In 2018-19, ~ 1250 TWh of total electrical energy was generated, and nearly 11% of it came from renewable energy sources. Per capita electricity consumption in the country is roughly 1200 kWh, more than 50% of it comes from coal-based power plant, nuclear accounts for 3% while renewable and hydropower together produces 30% of electricity. With this background information, it is imperative to understand that use of fossil fuels which drives our GDP has resulted in significant release of anthropogenic CO₂. A recent study suggests that India could see an increase of surface temperature as high as 5°C by 2100 AD. While India's per capita CO₂ emission is less than half of the world average, rate of growth is the highest among all the countries. India is committed to achieve net zero CO₂ by 2070. One of the immediate target is to achieve 40% cumulative energy power installed capacity through non-fossil fuel sources. Further, creating a significantly large carbon sink by different approaches is essential, for financial resource, India introduced a coal cess in 2010, which continues till date. India has launched many special programs like "International Solar Alliance", "India Cooling Action Plan" etc. which were connected with "Skill India Mission" to train and re-skill the human resource necessary for this change.

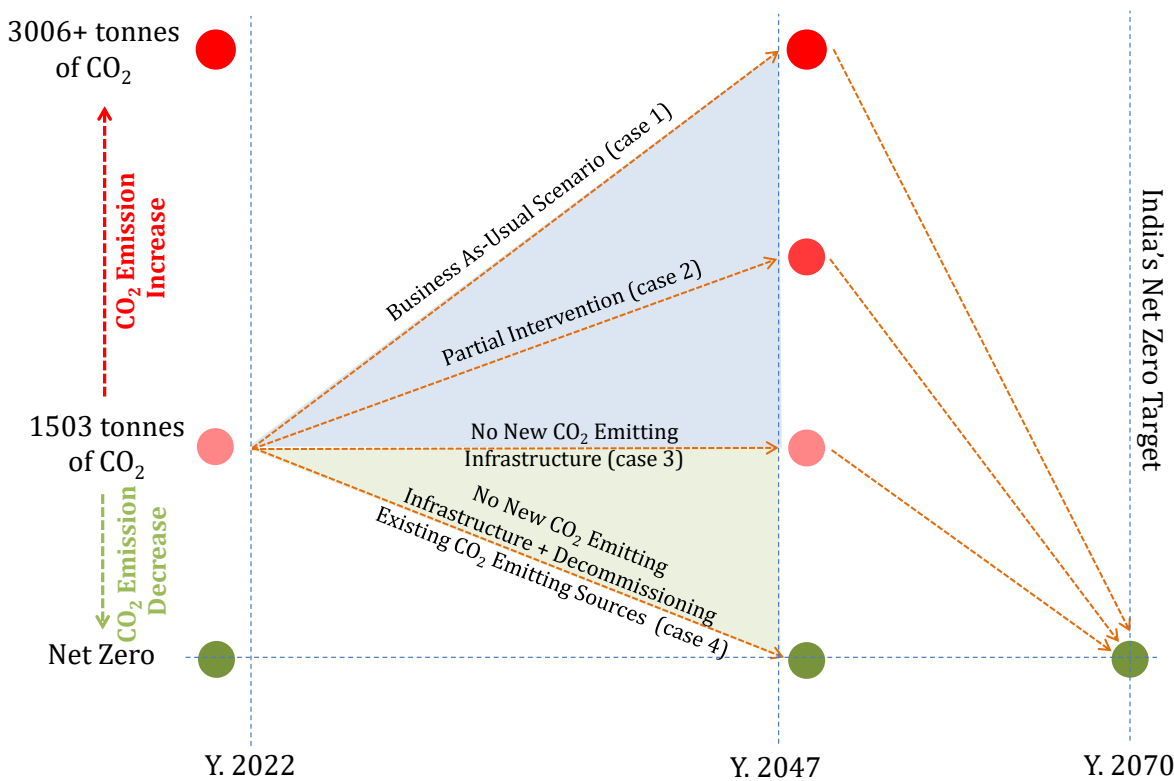
India's yearly CO₂ emission stands at 2.5 billion tons, which is increasing at the rate of roughly 5% per year. In India's total power production, contribution of coal is expected to decline over the next few decades, however, in absolute term coal utilization would increase as our energy demand grows every day. With recent push for renewable technologies, solar and wind have become lot more reliable and affordable so much so that most of the coal-based power plants are now running at a plant load factor of roughly 50%. Today, solar energy is the cheapest form of energy available in India when sun is shining, however, coal-based electricity is still the cheapest when sun does not shine and thus we need to decarbonize to fulfil our goal of net carbon zero. Implementing carbon capture, utilization and sequestration (CCUS) strategies are equally important as identifying a scalable and long-term renewable energy storage options. In this document we discuss a right blend of policies coupled with sound technological innovations which will take us to our target of net zero carbon.

Fossil fuels are primarily carbon which is mined from under the earth, energy is produced from the carbon, and CO₂ is released into the atmosphere. A sustainable approach would be to capture the CO₂ produced, and sequester it deep down the earth to close the loop. Since coal is going to be part of energy mix in foreseeable future, the short to medium term strategy would be to decarbonise existing electricity generation facilities. As of today, electricity and heat generation correspond to over 40% of global CO₂ emissions from fuel combustion alone, 70% of these emissions are coming from coal fired power plant. Cement, and steel industry contributes roughly 15% of total CO₂ emission. These three sectors are prime target for CCUS intervention.

CO₂ capture from point source requires capturing it from the effluent stream (flue gas) of industries where its concentration is fairly high and it would be more economical compared to capturing the CO₂ from atmosphere which has ppm levels of CO₂. Such CO₂ capture facilities from point source could be retrofitted

after FGD so that roughly 10% to 15% concentrated CO₂ stream could be separated from its associated non-GH gases, like N₂ and O₂. For complete decarbonisation, captured CO₂ has to be transported and sequestered deep down the earth either as solids, or in a manner which does not leak to atmosphere in geological time scale. Technology already exists; however, it is not clear who will pay the energy penalty (roughly 25% of total production) for making the process sustainable.

In 2020, roughly the total electrical energy production of the globe stood at 24,000 TWh. If one assumes 20% of this energy is to be stored, it amounts to 4800 TWh. Banking on battery storage alone, assuming an energy density of about 200 Wh/kg, 24x10⁶ MMT of batteries are required which is an astronomical figure especially when we are at a nascent stage on efficient complete battery recycling (although available for some batteries like lead-acid) technologies. Therefore, the right approach would be combining many other storage technologies such as Flywheels, pumped hydro, compressed air, flow batteries, capacitors, other battery technologies (**especially whose raw materials are available within India**), hydrogen, and organic energy storage devices. As detailed in annexure II, depending upon the applications, their duration, and frequency of use, suitable storage technologies can be chosen. However one has to perform Levelized Cost of Energy Storage (LCoES) analysis for each application with the available choice of energy storage technologies to identify the most suitable energy storage technology.



It is understood that energy transition towards “renewable” sources which do not emit carbon dioxide is key to achieve net zero emission. Considering the population and economic growth, if we go by ‘business-as-usual’ case, carbon emission will more than double by 2047. So the plans are proposed to reduce the slope of the trajectory. As of 2021-22, India’s per capita CO₂ emission is more than 1500 tonnes per year, and

based on economic and population growth, it is expected to double in next 20 years, in the business as-usual case scenario (case-1). Multiple levels of interventions shall be enforced in order to attain lesser CO₂ emission. If one plans to partially introduce non-carbon emitting sources while continue to use the carbon emitting infrastructure, existing and some new installations (case-2), this would still ensure significant increase in net CO₂ emission by 2047 as shown the figure given below. In the event of serious intervention where no new carbon emitting sources will be installed but the existing infrastructure exist to live out their lifetime (case 3), and all the additional new energy infrastructure is going to be from carbon neutral renewable source, the CO₂ emission is going to be at the same level as 2021-2022. In the last case, simultaneous installation of carbon free energy generation and decommissioning of existing conventional fossil fuel based energy infrastructure (case 4) would lead to net zero India by 2047. Since India plans to attain net zero by 2070, it is preferred to follow path suggested in case 3 or in case 4.

To achieve this target, one must focus on three different domains, where the first two requires technological innovations, and the last one requires intervention from policy makers.

- (i) The sources/sectors where complete replacement of fossil fuels by renewables are possible.
- (ii) The hard-to-abate sectors where the emission of carbon dioxide is inevitable, and which requires process modifications to attain net zero
- (iii) Policy dependent aspects, and implementation strategies which will facilitate points (i) and (ii)

In each of these categories, the action plan is segregated into short to long term goals depending on the feasibility of implementation *en masse*.

Sectors that can be replaced by 100 % renewables

There are number of carbon emitting sectors like thermal power plants, transport sectors, housing/commercial/public consumption domains, agriculture & food processing industries, and construction that can potentially be replaced by renewables and make them net-zero by 2047. However there exist technological and implementation challenges, where many of these existing infrastructures are at least expected to live out their lifetimes and even some new carbon emitting infrastructures may still be built. A step-by-step transition with short-, medium- and long-term goals are necessary to balance the energy security, economy and net-zero emission. The goals are aligned towards energy generation, storage and consumption. In the short-run, the well-established technologies related to solar panels, and offshore wind turbines shall be considered for energy generation from sun and wind respectively. The energy storage/consumption sector shall target using batteries, thermal storage which could be augmented through use of heat pumps. The medium-term goals, say in 5 to 10 years, the technologies that can be focussed are direct solar water splitting to generate hydrogen fuel, solar wall paint to effectively use walls for energy generation, and use fuel agnostic engines and turbines on energy consumption side.

Since we are expected to emit CO₂ from existing carbon emitting sources, it is wise to develop technologies to recycle carbon dioxide to value added fuels. The long-term goals can be aligned towards using nuclear power using microreactors, tidal power generators and possibly identifying geothermal sources. The aforementioned sectors can potentially be made into net-zero, however, the implementation should be based on technology maturity as identified by short- to long-term goals to ensure smooth transition.

Hard-to-abate sectors

There are some sectors including cement industries, where CO₂ emission is unavoidable. During the processing of raw materials for cement production, CO₂ is emitted as a by-product. These sectors require serious intervention of CO₂ capture, utilization and storage. The energy required to process the cement can be generated from green sources. Technology development on recycling CO₂ to value added products is essential to achieve net zero in hard-to-abate sectors.

Policy dependent aspects and implementation strategies.

Government must identify ways to subsidise the energy penalties and capital required for retrofitting the coal fired power plants. The pay back should be calculated based on significant employment generation in building the infrastructure, and sustaining Coal India, one of the largest producers of coal in world.

To enhance implementation and bring quick innovation, industries should be assigned a set target to reduce their CO₂ emission by CCUS routes. On the lines of vehicular emission norms like BS-6 (used in transportation sector to curb vehicular pollution), Bharat Stage -I strategy could be implemented in power sectors for control in CO₂ emission. Such regulations would ensure large number of demonstration units, and challenges one may face in running such units in long run. Bharat stage -II could be implemented based on the outcome after a period of say 5 years. A list of similar policy recommendations has been included to ensure net-zero carbon emission.

- a. Carbon auditing and carbon tax (power sectors should be obliged to reduce)
- b. Incentives/tax holidays for carbon zero technology
- c. One nation one grid
- d. R&D funds - National Innovation and Research Fund
- e. Access to emerging technologies Procure/transfer IPs
- f. Reimagining the Energy Distribution Company (DISCOM)
- g. Energy Pricing policy
- h. Removing cap on energy feed to grid (open access to grid)
- i. Building code to promote energy efficiency and renewable generation
- j. Financing and credit support, viability gap funding
- k. Evidence based energy optimization
- l. Expanding of PLI for ancillary and support technologies
- m. National Skill Qualification Framework – should produce skilled person power

It has been identified that viable technology and policy alone aren't sufficient to ensure implementation. Definite intervention on various aspects of implementation is required.

- a. Innovation Demonstration Fund: Many of the advanced technologies should be demonstrated at prototype level or scale-up version to test and analyse them at large scale. This will help transition the technologies that are being developed at small scale to installation *en masse*.
- b. Scaled commercialization support
- c. Data driven decision making
- d. Skill and workforce development.
- e. Out of the box thinking like enabling national and state highways to work as solar corridors
Improvement in transportation efficiency by creating dedicated inland waterways etc.



Concluding remarks

The technological innovation, policy intervention and viable implementation strategies will help transitioning India to net zero. The transition should enable economic development coupled with energy security. An umbrella approach is required towards identifying, evaluating and deploying solution. A multidisciplinary approach involving industries, academic and research institute and start-ups should be followed in defining policies, regulations, and standards for energy.

Annexure 1

Feedback and Questions from Audience

1. What will be the gross per capita CO₂ emissions, energy consumption, GDP of India by 2047? At what rate is it expected to grow and how will the increasing per capita consumption play a role in achieving net zero?

It is expected that even with the adaptation of best practices, per capita CO₂ emission in India would be slightly higher than the current value. Phasing out of old coal fired power stations, implementing carbon capture and sequestration based retrofitted technologies would ensure that the increased rate of CO₂ emission due to increased GDP is managed.

2. The current focus of net zero is on carbon emissions, how will various other Green House Gases (GHG), chemicals and emissions affect net zero? Is there a need to focus on some other component or element broadly while considering net zero?

Primary target is to reduce GHG emission, other than CO₂, focus is also on methane. For India, fugitive emissions of methane from coal mining would reduce with drop in coal demand and its exploitation. Further, implementation of coal bed methane recovery would be necessary to curb methane emission to large extent.

3. How are we planning to address the skillset requirement of various people involved in the Renewable Energy (RE) value chain?

This will be quite challenging and thus a long-term strategy would be essential. Educational institutions through suitable training courses along with industrial participation this could be achieved.

4. Nature and biological systems are the most energy efficient, how can we learn from nature to improve energy efficiency?

Plant uses sunlight with an overall efficiency of 1% to around 11% (photosynthesis). Man-made solar panels do better, however, one has to do a Life Cycle Analysis (LCA) to actually identify the overall efficiency. To decarbonize entire value chain of solar electricity, right from mining to silicon crystallization, and panel manufacturing to storage and transportation of generated energy, significant technological intervention would be necessary. Achieving this will not be easy!

5. What needs to be considered to focus on waste generated from RE eg: solar panel waste, wind turbine waste, etc.? How to handle this enormous increase in waste as the country moves towards net zero?

6. Regeneration, recycle and remanufacturing the entire chain has to be decarbonized. This will be a challenge as discussed in the question above.

Annexure 2

Sectors identified

POWER SECTOR

Area	Technologies identified/research needed	Timeframe
Power generation	Solar Panels	Short Term
Solar	Solar Concentrator	Short Term
	Solar thin films	Medium Term
	Solar wall paints	Medium Term
Wind	Micro wind turbines	Short Term
	Offshore wind turbines	Short Term
	Large capacity size turbines with increased efficiency	Ongoing
	Vertical axis commercial turbines	Short to Medium Term
Hydro	Small hydro turbines	Short Term
Tidal	Small ocean wave turbines	Long Term
Geothermal energy	Commercial and viable technology	Long Term
Nuclear energy	Thorium based reactors	Long Term
	Nuclear Fusion reactors	Long Term
Transmission & Distribution	Smart meters	Short Term
	Using Artificial Intelligence (AI) and Machine Learning (ML)	Short Term
	Micro Grid and Smart Grid	Short – Mid Term
Energy Storage	Battery storage/ Pumped Hydro storage/Gravity storage	Short Term
Green Hydrogen	Green Hydrogen production	Medium to Long Term
	Green Hydrogen Usage	

In the Power Sector following areas may be concentrated for short term

Application	Suitable Role / Technologies
Energy Arbitrage	Purchase at low price sell at high price (Battery storage)
Primary response	Correcting continuous and sudden frequency and voltage changes in the network (Flywheels / Battery storage/ Capacitor storage)
Secondary response	Correct imbalance between generation and load (Pumped hydro / compressed air / flow batteries)
Tertiary response	Replaces primary and secondary response during prolonged system stress (Battery storage / pumped hydro / hydrogen)

Application	Suitable Role / Technologies
Peaker replacement	Peaker power plants generate electricity when demand cannot be met by regular power plants (therefore runs infrequently, produce expensive power) (flywheels / supercapacitors/ short cycle life inexpensive batteries)
Black start	Restore power plant operations after network outage without external power supply
Seasonal storage	Compensate long-term supply disruption (hydrogen / ammonia powered fuel cells)

TRANSPORT SECTOR

Area	Technology identified/research needed	Timeframe
Road/Rail	Battery for EV (2W,3W,4W, buses)	Short Term
	Fuel cell for Heavy duty vehicles	Medium Term
	Flex fuel/Fuel agnostic engines /turbines	Medium Term
	Hydrogen as fuel for vehicles	Medium to Long Term
	Electrification of Railway engines	Short to Medium Term
	Battery swapping technology	Short to Medium Term
	Safe storage for Hydrogen fuel	Medium to Long Term
	Nuclear powered engine	Long Term
Water	Electrification of inland water ways	Short to Medium Term
Air	Short duration air travel electrification	Short to Medium Term
	Long Haul flights electrify	Long Term

Policy changes/interventions needed

- Promotion of charging infrastructure and battery swapping stations
- Alternative fuels promotion policy (ethanol, methanol, biofuels, hydrogen)
- Fuel cells promotion for trucks and Heavy vehicles instead of batteries
- Municipal Solid Waste (MSW) to fuel/oil conversion promotion

HOUSING/COMMERCIAL/PUBLIC CONSUMPTION

Areas	Technologies identified/research needed	Timeframe
HVAC	Heat pumps	Short Term
	Thermal Storage	Short Term
	Absorption chillers	Medium Storage
	Energy management system using IOT/AI	Short Term
Lighting	LED materials innovation	Short to Medium Term
Architecture	Smart windows	Medium Term
	Solar collectors in outside walls	Medium Term
	Building management system using IOT and AI	Short Term

Policy changes/interventions needed

- Setting standards or regulations for temperature control in household air conditioning based on size of AC
- Building code to promote energy efficiency
- Evidence based energy optimization

AGRICULTURE/FOOD PROCESSING

- Electrification of agricultural equipment's (short term)
- Solar pumps (short term)
- Using AI/IOT for improved efficiency (short term)
- Food processing (meat, dairy, animal husbandry)

CONSTRUCTION SECTOR

- Electrification of equipment's (short term)
- Innovation in building materials (medium to long term)

INDUSTRIES

- There are some hard to abate sectors like Steel, Cement, etc.
- Carbon Capture and Storage (CCS) technology pilots can need to capture CO₂ and send it through pipelines for storage. CO₂ sequestration can happen 100m-300m below seabed with minimal damage to ecosystem

Policy changes/interventions needed by 2047

- Climate policy and energy policy must be in sync
- Creation of R&D funds like National Innovation and Research Fund (NIRF) for emerging technologies
- Green premium: Commercializing green tech. products to people who are willing to pay extra money
- Reducing policy uncertainty by creating a body where states and centre can discuss commonly (like GST council)
- Creating common energy market and energy pricing policy
- Expanding Production Linked Incentive (PLI) for ancillary and support technologies, it will help in indigenising technologies
- Funding Carbon Capture and Storage (CCS) Technology pilots without expecting immediate ROI
- Access to emerging technologies by buying out/transferring IP's
- Financial and credit support through Viability Gap Funding (VGF)
- Focus on increasing share of clean energy rather than elimination of conventional sources of energy
- National Skill Qualification Framework (NSQF) must address clean energy-based skills and jobs
- Incentives/tax holidays for carbon neutral/zero technologies

Implementation framework for identified technologies and policies

- Creation of innovation demonstration fund for creating prototypes
- Setting up solar corridors in all 4 lane National Highways
 - Localized power generation
 - Reduced AC load in cars
 - Reduction in thickness of roads leading to reduction in quarry materials needed
 - Creation of proper drainage for rainwater that falls on solar panels
- Scaled commercialization of R&D and technologies towards Net-Zero
- Fast track single window clearance for projects
- Data driven decision making adoption
- Focusing on economic growth by keeping energy security in mind
- Training and development of skilled workforce

2.Education

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Introduction

Education plays a fundamental role in the development of an individual. Since independence, India has focused on improving access to education for students from all walks of life. Based on the available data, it is evident that we have by and large succeeded in providing access to primary education. While continuing these efforts, our country has reached a point where imparting inclusive, equitable, and skill-based education is needed to accelerate India's ascent at the global stage.

The scientific and technological advances are also pushing the need for skill-based training in cutting-edge multidisciplinary domains. Along with delivering content, the teaching-learning process must evolve to help the learner think critically and apply the knowledge gained to solve real-world problems. In addition, designing holistic education that nurtures well-rounded citizens with social and civic responsibility is critical.

In this document, we discuss the current state of education with more emphasis on areas of improvement and current challenges. NEP 2020 is taken as base. We have envisioned the future of education in 2047 and how to achieve these goals by applying innovation in the areas of learning configuration, educational offerings, and the actual learning experience.

Current Education Landscape and Change Required

Each child has a different learning style. Lack of methods to identify a child's learning style is a major concern. The system does not cater to all types of learners. The current focus on marks-based evaluation must be upgraded to skill-based evaluation. Work towards fast tracking the implementation of NEP 2020 to be done. Teacher selection process must be quality oriented and there is a need for greater stress on providing teachers the possibility to upgrade their skill via both technical and modern teaching methods that emphasizes skill based and value-based teaching methodologies. The process is decentralized across private schools.

A human brain takes minimum of three years to form maximum portion of the nerves. This growth defines how a kid be future. A health care team should monitor how to keep a check in this time period to minimize the grow a kid in least abusive environment. The fruit from this process will come after 16 years from the birth of a baby. We can nurture one batch of kids in next 25 years at least and many batches of kinds will be there in the process.

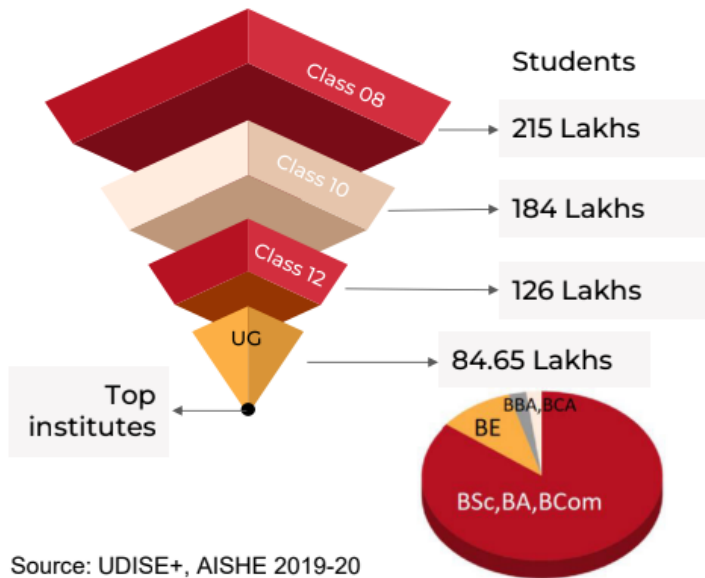
The basic education till class X-standard should bring morals/ethics and basic educations. Our goal should be to bring 100% learners to the schools. We should sort out how to bring our lesson/education to the poorest in the country as well. This education should kill the hidden demons and nature social morals in every individual. This will minimize criminal activities in the country in future.

We need good teachers who should motivate students. There should be a course where students can get a road map of their future which they would like to walk to reach their goals. A syllabus should be made on it (the future perspectives after class X).

Education should provide the means of living hood. We should have a plan how a student can get a job or can air for next level of education. A training program should be available from industry/company to enter into some jobs.

Higher Education

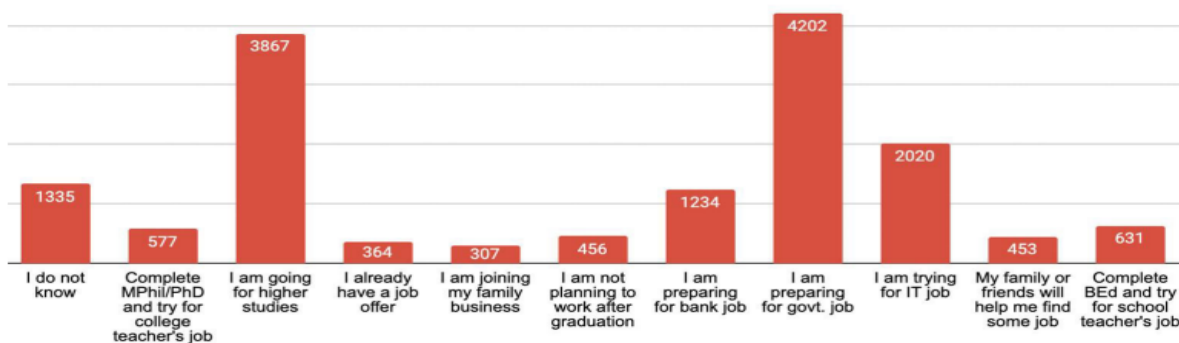
Few of the key challenges in higher education are – Extreme competition for top institutions, High costs of quality private institutions, Low employability, Low GER (Gross Enrolment Ratio).



Source: UDISE+, AISHE 2019-20

Survey of 11000+ arts/science students: Mar 2022

Plans after graduation



Digital Education

SWAYAM: Nearly 1000 courses every semester from 100+ organizations



25

lakh+
enrol and
learn for free



3.5

lakh+
write in-person
exams



2

lakh+
credit transfer
into degree
programs

UG DEGREES



Large scale:
IIT Madras BSc
in Programming and
Data Science
(12000+ in 1 year)



Smaller scale:
Few universities
through UGC's
online degree
regulations and
other means

Immediate Focus

Motivation & commitment must be the entry criteria; with Consistency, skill & ability being the exit criteria. The curriculum must be market driven, and it must be Centralized, Crowd-sourced, Certified, and Top-rated right from Kindergarten to PG. Technology will play the key role and digital divide to be brought to Zero which includes but not limited to High-speed Internet for all, Devices and On Demand Content, measuring outcomes of learning by students & quality of delivery by teachers / facilitators.

“**Digital University**” can formulate and confer multi-institutional degrees.

The curriculum must incorporate continuous learning on fostering 21st century skills including Cognitive aka Higher Order Thinking Skills, Emotional Skills & Social Skills among students and thrust to be given on learning UN Sustainable development goals from an early age.

Holistic & multidisciplinary approach must be practiced for which courses like value-based education, sports education, and all other vocational courses must be given due focus.

The National Education policy 2020 formulated by the brightest minds in the country to realize India’s future by 2047, is aimed at making education more holistic, flexible, multidisciplinary, suited to 21st century needs and bringing out the unique capabilities of each student. The emphasis of the NEP 2020 on 21st century skills is underscored by recent findings of the [world economic forum](#) on future of jobs 2020.

The effectiveness of the policy is contingent upon availability of resources such as curriculum content, teaching methodology, learning platform, assessments for education institutions to systematically implement the key facets of NEP 2020. Today’s NEP 2020 requires identification and implementation of robust solutions that deliver the objectives of the NEP successfully.

In response to the demands of future education, The Edtech industry is rapidly innovating 21st century learning solutions that have the potential to fast track NEP 2020 across India. The emerging solutions in digital and offline methods cover various domains such as cognitive, social, and emotional learning, multi-disciplinary learning for holistic development of students. Premier education institutions of the country such

as IIT Madras are incubating organizations focused on 21st century EdTech solutions for systemically assessing and developing core cognitive skills & emotional skills in a personalized manner for students. The solutions are successful in implementation and delivering improvement in overall learning abilities of students.

The recommendation is to evaluate proven solutions aligned to the overall NEP objectives and made available for schools to implement & Fast Track NEP 2020 for realizing the 2047 future for India.

Unique Student ID (Can be future linked to Aadhar) can be thought about for students tracking. In today's ecosystem, there is no effective tracking of Students from Kindergarten to Post Graduate Level (K-PG). Student tracking is decentralized at school level and there is no effective tracking of a student along with their academic & curricular & Co curricular talent / status. Providing a unique ID will help in not only tracking but also providing scholarships, preventing dropouts etc. Tracing the group of students who drop out due to economic and social pressures must be worked out including girl child education, special children, and those in the bottom of the pyramid. Treat problems in primary School and higher secondary school education separately - pedagogy and HR in higher education.

Effective Assessments & Personalized learning to be integrated as part of regular Curriculum. Building Skills right from School days is the long-term solution than to address the skill gap at Higher Education. As an example, an important skill that seems in need for further upgradation at school level is ability to create structured writing, and the ability to coherently express thoughts verbally by students. Such skills must be further stressed upon not only in language courses but across all subjects covered in school syllabus.

Syllabi to be worked with academicians and industrialists to cover skill-based learning. Alumni tracking mechanism to be strengthened.

Increased Flexibility in modes of instruction, student deliverables, assessment.

The deliverables can be accepted in any form such as voice over, animated story, written, powerpoint, etc.

Projects should be in a position that can be validated by AI driven algorithms.

From Grade 8, selection from an assortment of subjects to be made available to the students. University programs for Vocational short- & long-term Courses to be introduced at every university. Ministry of Education to work with Startups on pilots and come up with evidence of outcomes that can be scaled. At least 10% of all of CSR funding can be routed to Research Projects across all institutes of eminence and universities & colleges.

Unfortunately, most of the UG projects are "bought" in India. Independent Project Based Learning Portal to be deployed and made available to students with companies participating with Live projects which can be bid by students. Similarly, project day at school also gets an opportunity to pick projects from this.

Choice of Internships from Grade 9 onwards & Right for Internships from UG to be introduced from agriculture to aerospace. In this context there is far greater scope for providing short technical education



that would benefit a large spectrum of economically and socially disadvantaged students who drop out at the matriculation level. This would primarily expand the scope of ITI institutions and provide such short-term employment based technical education using our vast network of universities and technical institutions.

Further, those students who may not want to pursue UG due to financial situation, to be given an opportunity through a centralized system to pick up jobs and continue their degrees Online.

There are about 25000 Indian students traveling to foreign countries to study medicine. The Prime Minister recently thrust upon opening more medical colleges in India. To facilitate this, the teaching colleges must extend beds in hospitals within about 10 KM radius. This reduces the entry barrier due to higher investment costs. This will also help in achieving fulfilment of seats and additional seats shall also emerge which can be given to foreign nationals to pursue medical education in India.

Physical gadgets (with the help of CSR) with tracking tools will ensure last mile delivery and whether the purpose is served. Tracking and feedback mechanism for the participation of teachers in virtual/offline learning workshops.

Residential schools in rural areas with PPP (like Zoho, Tata Schools) will address the unemployment and livelihood challenges of the rural areas to a great extent.

A 24 hr helpline for students, educators and parents to cater to the demands of assistance in digital learning or conveying feedback.

3. Health Care & Assistive Technologies

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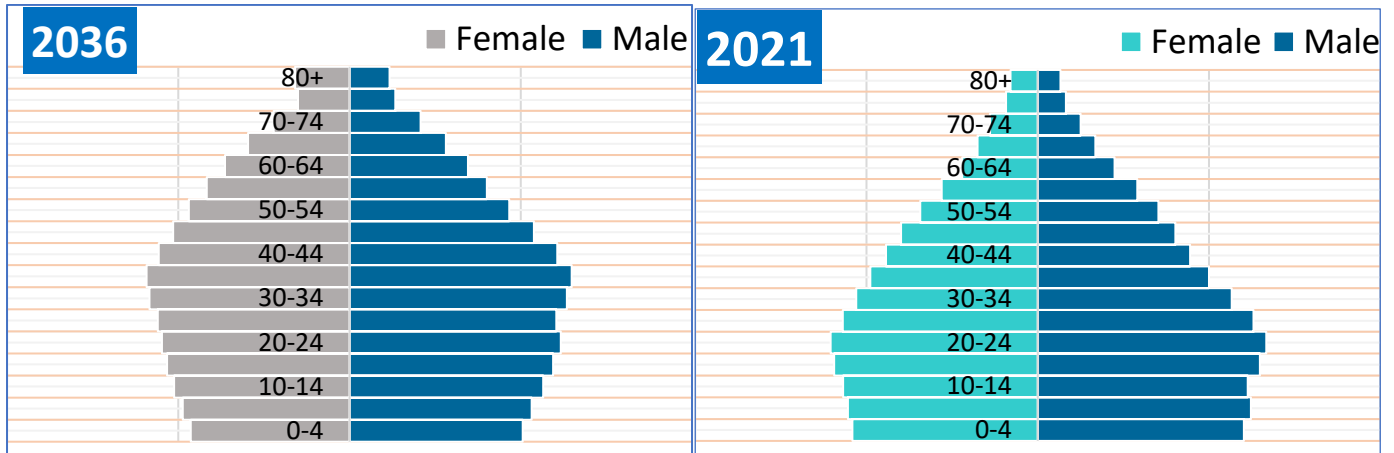
Vision for Indian Healthcare and Assistive Technologies @2047

To provide affordable, accessible, inclusive, high quality, responsive and sustainable healthcare for all.

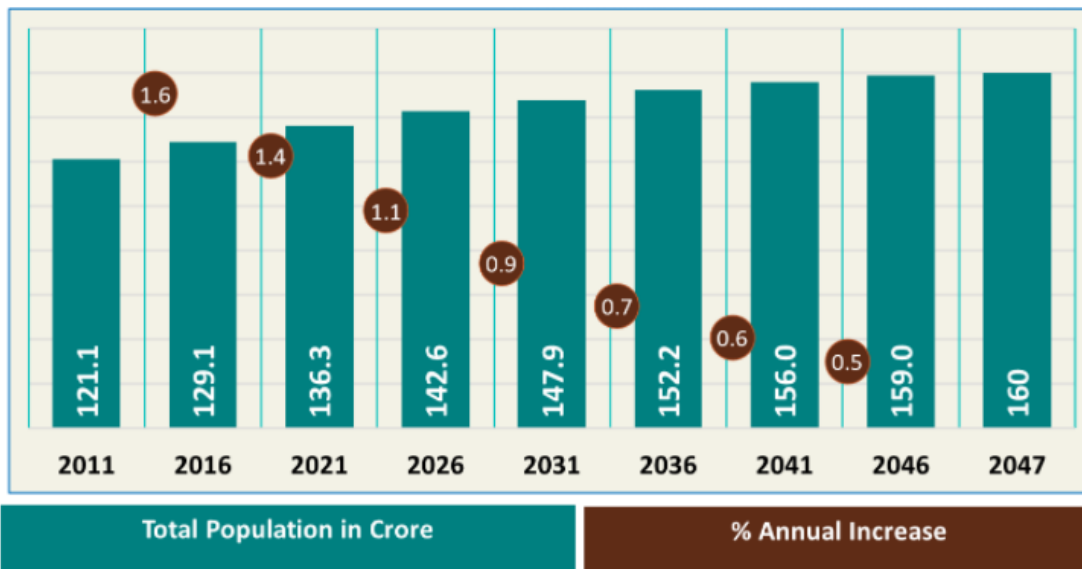
Background

It is important to work towards improving not only the lifespan of every India but also the healthspan (healthy period of life span) of every citizen in the country. And this cannot be achieved without enhancing the healthcare and assistive technologies ecosystem of our country.

Understanding the basics – Healthcare demographic Shift:

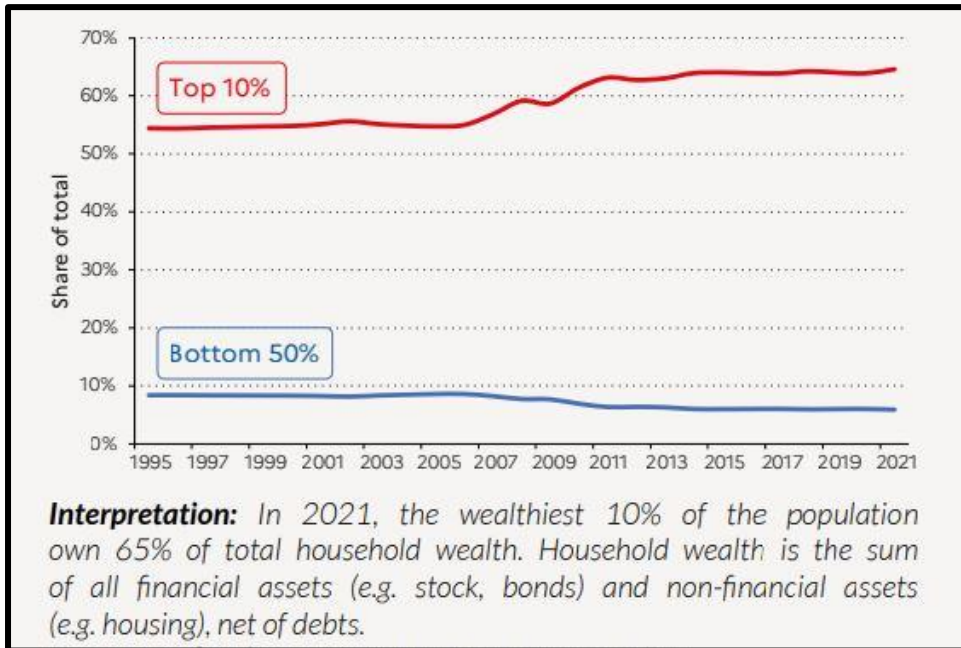


Source: 2011 to 2036- RGI Technical Group for Population Projection Report; July 2020



Source: 2011 to 2036- RGI Technical Group for Population Projection Report; 2041 and 2046- approx. estimated values To improve Indian healthcare, it is important to understand the basics. For instance, when we look at the age-wise population projection for India at 2040, we see that the significant population will still be the working-age

population. Though there is going to be an increasing population in the 60+ age group, it will not be an unprecedented increase.



Sources and series: [wir2022.wid.world/methodology](https://data.worldbank.org/wir2022.wid.world/methodology).

Socio-economic disparities will not only persist but increase. Hence there is a need for continued investment in health and reducing out-of-pocket & catastrophic health expenditures. [Current OOPE is 48.8%. Source: NHA 2017-18]

Focus area:

- This means our focus largely should be towards mitigating the expected lifestyle diseases and enhancing the holistic wellbeing of both the working-age population and the elderly population.
- Also, it is expected that most of the organized working groups may have access to healthcare insurance by 2047, but it is also important to focus on better health insurance for the large unorganized sector in India.

Understanding the Basics – Health Care Technology

India is envisioned to become a \$5 trillion economy by 2025-26. There will be advances in manufacturing and electronics with an increased focus on the indigenous manufacturing of medical devices. There will also be a focus in BioTech and Pharma sectors to bring increased self-reliance in the health sector.

Focus area:

- This means that our major focus should be making healthcare more **affordable** by reducing the out of pocket expenditure and by increasing the government expenditure on healthcare.

- India Medical Equipment market is provided with an enabling ecosystem to promote **self-reliance and self-sufficiency**.
- **Advanced Research:** We need to focus on technologies such as AI-enabled diagnostics and treatment planning, Brain-Computer Interface (BCI) for cognitive enhancement and remediation, Advanced stem cell research and research in autoimmune disorders
- **Digital Health:** We need to leverage Technology to connect Hospitals and Technology platforms to access Health. We need connected digital Hospitals for advanced care. We need to strengthen telemedicine portals and go beyond tele consultation to tele intervention and also provide end to end support for those seeking health care.

Understanding the Basics – Healthcare infrastructure:

Currently, the focus of Indian health care has been Universal Primary Health Care and we have largely achieved our goals of taking primary health care to the last mile.

Focus area:

Our future goals for 2047 should be on the following areas,

- Increased access to specialist care in the last mile (probably through telemedicine and other advanced technology)
- Technology-based wellness resource centres for Information, wellness and prevention activities with wider access to diagnostic technology and Medical devices
- Resources to addresses changing disease burden- NCDs and geriatric problems
- Access to a large number of free essential drugs
- Tech based diagnostics – move from hum and spoke to lab on a chip model.
- Virtual hospitals

Understanding the Basics – Healthcare Human Resources, Education and Training:

As of now, India has large scale awareness programs and IEC materials are available at every sub-centre level.

Focus area:

Experiential Learning:

- We have to provide and maintain health and technology experience centres (eg. Body Worlds- Amsterdam) with the availability of medical technology/medical devices demos

Workforce training:

- Reassess existing curriculums and work on bridge courses.
- Focus on structured training and accreditation for all health and allied professionals
- Focus on Inter-disciplinary learning between medical schools and technology schools
- Focus on integrated traditional and allopathic providers in nursing and physiotherapy especially for geriatric and palliative care.
- Trainings using Augmented Reality- virtual medical schools

Task shifting:

- We need to have rational redistribution of tasks among healthcare professionals. Specific tasks should be moved, where appropriate, from highly qualified health workers to health workers with shorter training and fewer qualifications in order to make more efficient use of the available human resources for health.

Technology to fill the gaps

Understanding the basics – Perception changes:

- The big picture thinking is that through this effort we should move away from the perception that a hospital or health centre is only for either the sick or Highly-qualified one by making it open to participation from a wider segment of the local community.
- This will not only have a huge economic impact on that local neighbourhood but also make it attractive for getting a “sense of belonging”
- See health not only as a right but as duty as well.
- Creating Wellness Bank: India should set up the wellness bank scheme which can be operated from Womb to Tomb where every citizen of India can acquire wellness points for every healthy activity undertaken. The wellness bank scheme can be promoted by incentives and other attractive benefits. These wellness bank can be accumulated to get back rewards when the citizen has some unexpected healthcare needs.

Understanding the Basics – Traditional Medicine:

According to WHO, Traditional and complementary medicine (T&CM) is important and often an underestimated health resource with many applications, especially in the prevention and management of lifestyle-related chronic diseases, and in meeting the health needs of aging populations.

India is already well known for its traditional medicine practices. So, our focus for the future should be global. In view of that, following should be the focus areas:

- India should house multiple Centres of excellence in Traditional Medicine Practice. This can be tagged with “wellness retreat centres” for patients from other countries too.
- Focus on being the global leader in Traditional Medicine, Wellness through Yoga, Naturopathy and other Ayush intervention

- Focus on development of sports medicine (herbal/nature-based)
- Focus on reversal and prevention of Diabetes and Cardiac disease
- Adoption of international standards like ISO/TC for the Indian System of Medicines will facilitate greater acceptability of ISMs. India should lead the development of standards both in ISO and WHO on the ISM sector
- Improve, standardize, and formalize Ayush educational courses to ensure uniform skill levels & employability across industry
- Standardization of Ayush Research & Medicine Systems
- Cross-collaborations in education, research, and training with countries of strategic potential to ensure the integration of best practices and technology in the sector.
- Focused research on herbal vaccines: Establishment of Centres of Alternative Medicine within schools of biotechnology research and fundamental sciences to promote interdisciplinary research for standardisation of Indigenous system of medicine in India for low cost sustainable development of herbal drugs, thereby promoting globalisation of Indian traditional medicine.

Assistive Tech / Disability Health Care:

In this sector, we lack behind many countries. We need to make India Inclusive and we can do it by working on some of the following aspects

Focus area:

Our Focus areas should be on creating the following,

- Single unified platform for assistive tech information and tech product details
- Integrated Centre of Excellence for Assistive tech with a focus on all stakeholders
- Insurance and Medical Plans for disability health and for availing assistive technologies
- Become a global leader of Assistive Tech products and services
- Provide Rehabilitation services at the community level
- Provide Palliative care at the community level Provide Community referral points for persons with disabilities to connect for services related to health, Livelihood, disaster services, Caregiver services, Paramedical services for health disabilities and rare diseases

Medical Products:

- Medical Products comprise of drugs, diagnostic devices and medical devices.
- For quality healthcare services, it is imperative to have medical products with high quality, safety and efficacy
- Invention of novel medical products of not only good quality but affordable in terms of price is the responsibility of industry and entrepreneurs
- Investments in medical products are largely driven by private sector.

- Government support to entrepreneurs need to be widely present especially for innovative products, acquisition of good technologies, innovation of new medical products and healthcare solutions
- Govt. of India has various industry promotion schemes which aim at nudging the industry towards production of medical products where India is dependent on other countries and the products are critical to our requirements, supporting clusters of pharmaceutical producers to manufacture in an environmentally friendly manner, incentivisation of novel products etc.
- Government supported affordable medicines should be widely accessible.
- Regulations of medical products need to be balanced and harmonised with other countries to have wider access to medical products.
- A funding ecosystem for innovators and ideas that is based on a “high risk – high reward” mindset to promote drug discovery. A potential rethink of CSR funding to allow for patentable. Expansion in CSR policies to facilitate involvement and financial assistance by companies to encourage high-risk high-reward biotechnological research in academic and research institutes needing sufficiently long timelines
- Joint programmes organised at regular intervals between government bodies, technology incubators, academic institutes and industries to promote young scientists, students and budding entrepreneurs to undertake high-risk research projects without significant financial stakes/liabilities early in their career..

The Bigger Picture for Indian Healthcare at 2047

In 2047, India should aspire to

- Become the Global destination for wellness and medical value travel.
- Become the Global leaders in training high-quality healthcare professionals
- Become the Integrated hub for ideation, innovation and implementation
- Create a transparent, resilient and accountable health system
- Work for Globalization of Indian Traditional Medicine
- Envision creating “Health City” or “Wellbeing Campus” or “Techno- Health Parks” or “Healthcare Campus” or “Healthcare Eco-system park” or “Healthcare satellites” (At least 1 per state by 2047)

4. Water

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Vision

‘Water for ecosystem’ through complete sustainability in all spheres of human activity, accommodating for climate change and offering water resilience.

Background

India is home to ~18% of the world population, but has only 4% of the world’s water resources. Therefore sustainable management of water is a necessity for the country. Moving forward in a manner that ensures equity would require ensuring simultaneous considerations related to: (i) a community based approach to water management, (ii) ensuring deterrence for excessive water usage, (iii) clear implementation of the polluter pay principle and incentivization for effluent treatment, (iv) regulation of ground water management (considering replenishment as a priority), and (v) a fundamental, paradigmatic shift away from treating water as a mere *‘economic good’*. A view on water as an *‘ecological essential’* is the paradigm we suggest. To understand how this view builds upon policy work carried out thus far, the following background is given.

National Water Policy: Formulated in 1987, it played an important role placing central importance on an information system driven approach to resource planning and recycling. Safety of water storage structures and impact of human activities were clearly at a central theme. Ground water, equity and regulation of water for commercial use did not occupy the very core of this document.

Jal Shakti Abhiyaan: Formulated in 2019, it marked the shift in thinking towards an integrated approach. Here activities involving water resource management, river development and rejuvenation, drinking water and sanitation were all seen as part of an integrated whole. A community based water conservation approach was promoted. Catching rain where it falls became the key activity that was promoted.

Jal Jeevan Mission: This program involves community participation for recharge and reuse of greywater, rain water harvesting, water conservation. Spreading information and communications concerning water management too became a mandate under the mission. A visible outcome of such activities would be the viability of ensuring taps with water in every house. Work towards this goal is ongoing.

As part of Water Vision 2047, we propose to promote water not as a mere economic good, but as an *ecological essential*. This is a reasonable step forward, given what is known from studies on sustainability. We hence recommend a *“Water for ecosystem - Vasudeva Kutumbakam”*, wherein water resource management, recycling, river and water corridor development and replenishment, community based engagement for water conservation and resource sharing would all follow this paradigm, to ensure ‘ecological justice’ and ‘social justice’ simultaneously [1].

Current Water Challenges

Challenges in the Agriculture Sector

Water is a critical input for agriculture production and plays an important role in food security. Irrigated agriculture represents 20% of the cultivated land and contributes 40% of the total food produced worldwide. Population is expected to increase to over 10 billion by 2047, and whether urban or rural; this population will need food to meet its basic needs. Combined with increased consumption of calories and more complex

foods, which accompanies income growth in the developing world, it is estimated that the agriculture production will need to expand by approximately 70% by 2047 [2].

The **key challenges** faced by this sector are as follows:

- a) In addition, the future demands on water by all sectors will require as much as 25 to 40 % of water to be relocated from lower to high productivity and employment activities. This would be more so the case for water-stressed regions. In most cases such relocation is expected to come from agriculture due to the high share of water use. Currently, agriculture accounts (on an average) for 70% of all freshwater withdrawals globally. An even higher share of “consumptive water use” due to evapotranspiration of crops occurs, which ought to be accounted for while doing water resource management as well.
- b) The ability to improve water management in agriculture is typically constrained by inadequate policies, major institutional under-performance, and financing limitations. Critical public and private institutions (encompassing agricultural and water ministries, basin authorities, irrigation agencies, water users’ and farmer organizations) generally lack the enabling environment and necessary capacities to effectively carry out their functions.
- c) Moreover, most governments and water users fail to invest adequately in the maintenance of irrigation and drainage (I&D) systems. While inadequate management and operation may play a part in the poor performance of I&D systems, it is especially the failure to sufficiently maintain systems that results in their declining performance and the subsequent need for rehabilitation. This failure to provide adequate funds for maintenance of I&D systems has resulted in the **“build-neglect-rehabilitate-neglect”** cycle commonly observed in the sector.
- d) Given the existing constraints above, the agricultural water management sector is currently in the process of repositioning itself towards modern and sustainable service provision. It proposes a singular and comprehensive water approach on building resilient water services and sustaining water resources, while also managing risks related to broader social and economic water-related impacts. This includes transforming governance and service provision as well as supporting watershed management and greening the sector and can be achieved by providing improved incentives for innovation, reforms, and accountability.
- e) In addition to the above, the following factors too present challenges in the agricultural sector:
 - Poor quality assurance associated with water supply, due to various contaminating sources (geogenic, anthropogenic)
 - Pollution due to farm discharge containing agro-chemicals, organic matter, drug residues, etc (UNEP 2016)
 - Lack of sufficient water harvesting.
 - Poor water literacy among farmers

We recognize that resolving the challenges of the future requires a thorough reconsideration of how water is managed in the agricultural sector, and how it can be repositioned in the broader context of overall water resources management and water security. Moreover, *irrigation and drainage schemes*, whether large or small, represent prominent spatially dispersed public works in rural spaces. Thereby, they represent a *logical vehicle for mobilizing employment opportunities* into communities.

Challenges in Industry Sector

Industrial sector is one of the major consumers of the available water resources in India and according to the Central Pollution Control Board (CPCB) of India, about 500 billion cubic meter water out of the total available fresh water is used in industries annually. Out of this, about 10 billion cubic meters of water is used by processing industries and 30 billion cubic meters is used for refrigeration purposes. Thus, this part of water used for industries comes to about 6 per cent of total available water in the country. On the other hand, according to the World Bank, the demand for water for industrial use and power generation is increasing at the rate of 42 per cent per annum.

By the year 2025 it would become 228 billion cubic meters as compared to only 67 billion cubic meters in 1999. Thus, water used in industries is about 13 percent of total available fresh water at present. It is clear from different estimates that demand for water in industries has been continuously increasing.

- a) In India both the surface and ground water is under huge stress due to the irresponsible use by the industries. One of the reasons for this is the substantial increase in the number of grossly polluting industries (GPI) between 2011 and 2018. There has been a 136 per cent increase in the number of grossly polluting industries over the period. GPIs are industries that discharge more than 1,00,000 liters of wastewater and/or hazardous chemicals into the rivers, and include pulp and paper mills, distilleries, sugar mills, textile units, tanneries, thermal power plants, the food, dairy and beverage industries, chemical units, slaughterhouses, etc.
- b) In India, the awareness related to over exploitation of water resources has been very low. India has always been projected as a country with abundant water resources which is no longer the case. This lack of awareness over the exploitation of water resulted in inhibition of the industries to implement processes for wastewater treatment, recycle and reuse. From a recent survey by the Observer Research foundation 2021 it was found that only ~29% of wastewater was treated.
- c) Though India has developed regulations of ground water but lack of strict implementation of the regulation resulted in the over exploitation by Industries. In this current scenario, experts state that industrialization in the country is moving towards the crisis of groundwater overuse, exploitation, and contamination. According to the CAG report 2021, among units granted license by the Bureau of Indian Standards (BIS) in 15 states of India, 78 percent were extracting groundwater without NOC.
- d) Water tanks and pipelines are the one of the major infrastructure assets in the water sector due to its utilization in storing and transportation of water respectively. But due to lack of annual maintenance of these assets results in losses and contamination due to leakages. According to the Niti Aayog report of 2018, 70% of water in pipelines is contaminated.

Challenges in the Domestic Sector

Domestic usage is one the critical usage of water, 10% of water usage is consumed for domestic purposes in India. Possibly the most substantial everyday use of water for most people is household water use. Domestic use involves water used every day in the home, including water for ordinary household uses, such as

drinking, cooking meals, bathing, washing clothes and dishes, flushing toilets, and irrigating lawns and gardens.

- a. In India, ground water is one the main sources of water for domestic usage. In fact currently, the over exploitation of ground water and the changes in climate together have an adverse effect on the availability and accessibility of water to common citizens. India has a rural population of 63.4 million, a good fraction of whom live without access to clean water. This is the largest such population facing such distress when compared to any other country, according to Wild Water, ***State of the World's Water 2017***. This is a news report by WaterAid, a global advocacy group on water and sanitation.
- b. The problem of water pollution presents serious concerns. The UN World Water Development Report too clearly identifies this as an increasingly serious concern. Pollution of water is correlated with population density and economic growth. At present 12% of the world population drinks water from unimproved and unsafe sources.
- c. More than 30% of the world population, or 2.4 billion people, lives without any form of sanitation. Lack of sanitation contributes to water pollution. ~90% of sewage in developing countries, including India, is discharged into the water untreated. Every year 730 million tons of sewage and other effluents are discharged into the water. Industry discharges 300 to 400 megatons of waste into the water every year.
- d. The list of contaminants of concern is increasing, as novel or varied contaminants are used. Often these novel contaminants are detected at concentrations much higher than expected or tolerated. Novel contaminants include pharmaceuticals, hormones, industrial chemicals, personal care products, flame retardants, detergents, perfluorinated compounds, caffeine, fragrances, cyanotoxins, nanomaterials and cleaning agents. Exposure to pollutants will increase dramatically in low-income and lower-middle income countries. Pollution will be driven by higher population and economic growth in these countries, and the lack of wastewater treatment.
- e. In India, the awareness related to over exploitation of water resources has been very low. India has always been projected as a country with abundant water resources, which is not really the case when one considers the fact that it has only 4% of world's fresh water sources, while it houses 18% of world population. In fact, currently the per capita availability of water in India has dwindled from 1,800 cubic meters per year in 2001 to an estimated 1,100 in 2050. Water used for sanitation purposes is rarely recycled in India's urban areas. Wastewater recycling infrastructure in India's urban spaces is neither properly financed nor designed, resulting in limited options for people to recycle wastewater. Only 30 per cent of India's wastewater is recycled. The apathy with regard to treatment of wastewater in India is visible from how its sewage systems have been designed.
- f. Governments, communities and businesses are required to meet a range of water quality goals. Monitoring data is used to determine whether or not pollution regulations are being complied with. Regularly monitoring water quality is a crucial part of identifying any existing problems, or any issues that could emerge in the future. This requires a comprehensive sensor and data collection network, and there is a lacuna here.
- g. Reverse Osmosis or RO is a method of removing contaminants from the source water by applying pressure. Through this process all the sediment, heavy metals, hard minerals, nutrients, viruses, and bacteria (both the good and bad) are no longer present. The near universal use of RO however is

questionable and likely to be an over-engineered solution, which too threatens the possibility of achieving sustainability.

Aspirations

It is important to aspire for strong goals to combat the current water usage coupled with climate change.

Agriculture

Agriculture, including animal farming needs to be addressed as early as possible since it utilizes the major portion of Groundwater. Upon training, farmers must employ efficient water management practices and implement: **Recycle, Reuse and Replenish** as much as possible. Groundwater replenishment with progressive movement towards 90% rain water harvesting can be an aspiration.

The farmers must be educated about the ill effects of pesticide and fertilizers and their impact on groundwater and crops. Continuous monitoring of the impact of available fertilizers on water and quicker ban on the high impact ones by the government could benefit society.

Farmers ought to be enlightened with alternative water sources for crop management and be introduced to the advantages of modern agriculture systems such as Drip irrigation, Aquaponics and Hydroponics. Government would do well to implement policies to perform research on water efficient crops, and issue advisories and regulations for the same. Smart agriculture and water infrastructure would be a way forward.

It is important for the government to create policies so farmers would embrace a biodiversity friendly practice. Government must also introduce policies that aim to replenish the loss of biodiversity that happened due to poor/no water, due to poor long term management of water and soil.

Industry

Industries are the next biggest consumers of Groundwater. They must be strictly accountable for the amount of water to be used and monitored frequently. The employees and workers must be educated to minimize the water usage and perform recycling. The effluent water system from the industries must be checked for quality before the release and must be recycled if needed.

Biotechnological and Biochemical research can enable development of kits for the identification of contaminants in a short time frame, at point of use or point of discharge. Also, continuous monitoring and maintenance in the inter and intra water transport is needed to minimize any leakage in the system. Efforts must be taken to research, develop and implement **intelligent water infrastructure** providing sustainable solutions. All through the integrity of the water infrastructure (asset integrity approach) will need to be monitored to prevent water losses. Government must bring standards to each of these and will also need to take measures to penalize offenders. A near complete implementation of 'polluter' and 'defaulter' pays principle can help deter inappropriate water management [3].

Domestic

Aspirations of water management are plentiful in the domestic sector. 24 hours of potable water supply in all homes must be a reality. Different methods to generate potable water must be developed and implemented (i.e. going '**Beyond RO**'). This will need targeted efforts - both technological as well as smart/e-

governance. Feedback mechanisms will need to be in place so that quick actions and remedies are provided, to nudge the entire country towards this goal.

RO water sustainability must be addressed with continuously improving technologies. The society must be aware of Rain water harvesting and it must be harvested in every building. Schools and universities too can play a role as change agents. Awareness of water usage and reuse must be taught among consumers and rewards must be introduced by the government.

It is important to include biodegradable components in domestic products such as detergents and educate the consumers about its positive impact on groundwater. Clearly research and development would be needed to develop such biodegradable soaps and detergents. At a community level, sustainable septage sludge management must be introduced. This too is an area wherein further research and development, and infrastructure development will need to be taken into consideration.

By 2035 (if not sooner), the concept of “**Water Footprint**” must be introduced to all the products (from cars to crops) so that the consumer can make an informed decision based on water footprint. By 2047, we must have a clear map associated with the ingredients that go into ‘**water for the ecosystem**’, so that simultaneously social and ecological justice is achieved, in the spirit of ‘**Vasudeva Kutumbakam**’. In addition, water resilience would need to be ensured so that both society and ecology withstand a variety of water-related risks.

Grand Vision

By 2024 - Water for all by Jal Jeevan Mission

The National Jal Jeevan Mission is envisioned to provide safe and adequate drinking water through individual household tap connections by 2024 to all households in rural India. The programme also envisages efficient gray water management, water conservation, and rain water harvesting. Enormous efforts are undertaken to motivate and foster community participation towards water conservation and management through extensive Information, Education and Communication. Active participation of community stakeholders through *Pani Samitis* is a mainstay of grassroots implementation of the scheme. The need and steps required to be taken to preserve traditional water bodies is an inbuilt part of the scheme. So far, 9,20,11,492 rural household tap connections have been made functional which is about 47.63 % of the total rural households of the country. Jal Jeevan Mission aims to ensure Water for all by 2024 [4, 5].

By 2030 - Quality water assurance for all

The ‘Invisible water crisis’ identifies water quality as being predominantly invisible and hard to detect. This presents hidden dangers. Hence deployment of technologies to ensure safer and cost effective quality assurance remedies along with prevention of pollution is a must. This shall be brought to force using people’s participation - citizen science , technology innovation and incentivising the sustainable and environment friendly methods in all domains of water usage. We will have to achieve this using a multi-pronged approach with special focus on technological (both low tech and high tech) interventions.

By 2035

The World Water Council identifies a sustainable water future as ‘**a world where all people have access to**

safe water to meet their needs including agricultural needs with management plans that maintain the integrity of freshwater ecosystems'. Hence for sustainable use: ~90% rainfall harvesting coupled with water resource management, ought to be considered. This ought to also factor in ecological footprints associated with every intervention. This would in turn require an '*ecological metabolism*' approach, thereby generating and using information and data on water flows across ecosystems. Eventually this would set us towards achieving water sustainability, via community management, enabled through participatory approach and smart infrastructure. The goal should be enabling renewable fresh water resources across India by 2035.

By 2040

- a) Near complete rejuvenation of rivers in India should be our goal. Given that by 2035, there would be sufficient data on water flows and ecological footprints, it is possible to envisage a near complete rejuvenation of Indian rivers, thereby setting India even further on the path of sustainability. This also means that by then our agricultural, domestic and industrial sectors would be duly reorganized to ensure the protection and rejuvenation of fresh water sources. Water recycling and conservation methods, along with waste water management would have to be near universal by then.
- b) Valorization of septage would mean that the nutrients that otherwise remain untapped, could be used to nudge agricultural sustainability, and also stimulate the economy. Best of septage management would need to be implemented. It is recognized that research and development towards this would need to be a continuous and consistent effort. As part of septage management, dewatering followed by water treatment would be necessary to ensure that water is sent back into the ecosystem where it belongs.
- c) Considerations and infrastructure for near complete water resilience would be clearly mapped out.

By 2047

Water security will be signaled by India, and the country will emerge as a model for water management for the world. Sustainable water ecosystems and preservation of biodiversity will be evidently present, and scientific documentation of the path from today up until 2047 will add value to the sustainability of the planet. 'Water for ecosystem' will be shown to be not just a slogan, but a practically achievable target. Hence the key principles of '*Vasudeva Kutumbakam*' and '*Loka Samastha sukhino bhavanthu*' will continue to guide the nation, even past 2047. The nation would also be able to prove itself to be water resilient.

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Introduction

Imagining India@2047 through innovation is a visioning exercise aimed at a 'Future-ready India'. To commemorate the 100th year of independence, the Central government has started work on a vision plan for a 'future-ready India' which covers various key areas including Energy and Net Zero, Rural Development & Agriculture, Water, Commerce, Infrastructure, Education, Healthcare, Transportation and mobility, Urbanization and housing, Fintech and Inclusion, Defense, and Information Security.

Infrastructure & Communication

A well-functioning infrastructure is one of the important prerequisites of a developed country. As India aspires to become a developed country, developing new infrastructure and improving the efficiency of the existing infrastructure should form a key part of this transition. Good infrastructure is a force multiplier, and it enables economic growth in myriad ways. Besides facilitating the smooth functioning of industries and various enterprises, good infrastructure improves the per capita income of citizens. The communications sector is another important/ crucial sector in a country's developing economy, underlying the operations of all government organizations, institutions, medical facilities, research, security, defense, transport, public safety organizations, and businesses. The infrastructure and communication networks are a key part for developing tourism in the country. Moreover, the communications sector provides an "enabling function" across all critical infrastructure sectors.

Any upgradation of existing infrastructure and/or addition of new infrastructure will have multiple challenges: 1) Financial aspects, 2) Environmental impact, and 3) Material and energy impact. To address the financial aspects, we suggest an increase in union budget and FDI (subject to constraints placed by national interest in different sectors) for infrastructure, public-private partnerships, monetization of land and the surrounding infrastructure, and levying user fee. To minimize the environmental impact, a system that is 70% green, i.e., usage of ecologically friendly materials and renewable energy sources can be considered. All aspects ranging from material selection, design, development, and maintenance of infrastructure should be resilient to climate change and not adversely affect it. Also, care must be taken to be inclusive and develop or modify infrastructure to be disable friendly.

Our Vision

Transport Infrastructure

To build an integrated multi modal transportation system where different modes of transport are efficiently inter-linked with each other. This translates into seamless movement of people and freight over various existing modes of transport such as roads, railways, ports, coastal shipping, inland water, civil aviation as well as futuristic travel methods. The proposed system should be accessible, universal, and affordable for everyone, and enable India to achieve net zero emissions. In the following paragraphs, we present our vision and outline ways to achieve the vision for the development of transportation infrastructure.

Road Infrastructure:

- All habitations across India should be connected and interlinked with multi-lane roads.
- India should achieve the highest road density per person. Roads should be designed and laid out keeping in view to accommodate futuristic vehicles and installation of smart technologies. Implementation of automatic Smart systems run by machines, algorithms etc to achieve zero fatalities on roads.

Way forward: Creating a single standard for every road. In other words, while the roads cannot be of the same thickness all over the country, one would want the roads in an urban area to be of similar quality regardless of which urban area we are discussing. Similarly, one would want all rural areas to have similar quality and construction of roads. As a simple example, as of now the speed bumps are not standardized even on a single stretch of road. If one is talking about futuristic vehicles and driverless vehicles these would require at least speed bump height to be standardized at the minimum.

Enabling sensor in the roads for continuous monitoring of roads could be one way to monitor road conditions. Development should not be limited to one main NH like the golden rectangle or NH8 (North South). Simultaneously parallel highways (Greenfield or otherwise) should be developed may be at 50 or 100 km gaps for inclusive and overarching development, along with perpendicular connecting roads, like a grid. This can be considered as an alternative to widening of the same highway. Rationalization of tolls must be done to avoid exploitation of the passengers. Multimodal connectivity should be planned along with highways. More Importance should be given to over bridges and underpasses, to bypass chokepoints in existing roads, instead of simply widening. Ensuring maintenance of roads is as important as building it. Incorporating long term maintenance into the construction contract should be done. Dedicated patrol vehicles should be there in each segments along with trauma care centers to manage any emergencies. Medians should be used to place solar panels, Highways to be provided with adequate EV charging infrastructure to accommodate the increasing traffic.

Railway Infrastructure:

We require a mix of both slow passenger trains and high-speed trains connecting the country. In 25 years, having some trains which make it possible to go from Kanyakumari to Kashmir in 6 hours, provided one has the infrastructure to support it. The traffic control and scheduling in the railways should be such that one has minimal delay. Like metropolitan cities, to avoid traffic in roads, tier 2 cities should have metro trains. So many underdeveloped regions with heavy prospects can be brought up with rail connectivity. Greenfield connectivity to unconnected regions. Bullet trains connecting all major cities. Metro rail in all cities with population more than 10 lakhs.

Way forward: Using green corridor for cargo movement to achieve energy efficiency and to decrease environmental impact. Developing high-speed transportation such as hyperloop and bullet trains on selected high traffic routes so that they are economically feasible. High speed rail corridors with Ro-Ro facility for passenger and freight vehicles. Ensure metro reaches airports in all cities. Inland water navigation may be

linked ensuring Multimodal connectivity for urban transportation. Build rail network and allow private players to operate with a regulatory mechanism. Just like a national highway or civil aviation sector, introduce universal smart cards for transportation and incentivize its usage. It will give a much better and accurate data regarding the pattern of travel. Also, it will improve income generation.

Port & Coastal Infrastructure:

Renewable power generators for operation of ports can be one way to reduce the carbonization. Instead of depending upon road or other ways of transport, we should well utilize our resources like inland waterways and coastal route for transportation. Generating energy using the tides, offshore wind energy, offshore solar, Ocean thermal energy conversion (OTEC) or any other marine renewables need to be considered to self-sustain the coastal infrastructure. The cost of implementing these structures is expensive in the ocean, hence it can be integrated along with the other infrastructure.

Way forward: Facilitate trading with a single window concept which allows international or cross border trader to submit documents to a single agency, rather than to deal with multiple agencies to obtain their permits for the export or import process. Every major port across the world today is facing vessel congestion, delays in container clearance and no-shows by truck drivers, leading to clogging right through the global supply chain. And here is exactly where port automation comes into the picture: cloud-based platforms like Port Community System will have a major role to play in addressing the crisis. Enabling centralized monitoring system for critical assets. Proper planning and implementation of the coastal, inland waterways for cargo transport, tourisms, needs to be undertaken. The design standards for the port, harbor and coastal infrastructures for the Indian Coastline needs to be implemented uniformly. Using digital twins to provide utilities actionable insights that help them predict performance and identify failure before it happened. Climate change poses a major risk, apart from the sea level rise, the increasing cyclone intensity and storm surges may pose the major threat to the coastal infrastructures, such as frequent damage to sea walls, jetties, fishing harbors and important buildings such as nuclear power plants along the coast. The coastal community needs to be educated on these risks. Seamless integration of the real time monitoring and dissemination to the coastal communities must be undertaken.

Aviation Infrastructure:

All tier-2 cities should have air connectivity. Large cities should have multiple airports to reduce congestion and improve efficiency. While the integration of unmanned aircraft systems (also known as drones) into the national airspace is already underway, systems and infrastructure should be developed and put in place for the safe integration of drones and air-taxis into the airspace. Develop indigenous civilian aircraft that meets the Indian market requirements. Set up numerous maintenances, repair, and overhaul (MRO) facilities and improve India's market share from the currently abysmal value of 1%.

Way forward: Besides constructing new greenfield airports, efforts should be made to repurpose existing airstrips and unused civilian/defense airports in the country to enable short-haul flight operations. There are a sizeable number of already developed airports that remains non-functional; thorough market study needs to be conducted and airlines should be incentivized to serve the airports that have sufficient demand. For

the safe integration of drones into the national airspace, a commercial drone corridor should be established for legal operation of drones. While it is encouraging that the government through the drone rules, 2021 is trying to strike a balance between regulating the use of drones and encouraging its adoption, it is also essential that we take a comprehensive look at the multifarious ways in which drones could be used to endanger the safety and privacy of the members of the public and other critical infrastructure. For instance, it is currently not possible to authenticate a drone and determine whether it poses a threat, it is necessary to have the infrastructure and systems in place to enable the following: detecting any drone flying within an altitude of 400 ft AGL, authenticating the detected drone, and if the authentication fails or the drone's path does not conform with the geofence constraints, taking control of the drone. While there are established civilian aircraft manufacturers such as Boeing, Airbus, Bombardier, etc., it is crucial that India has its own civilian aircraft design and manufacturing ecosystem. There is a lot of technical knowledge available within the country from successful fighter aircraft development programs and they should be leveraged. The government should significantly increase funding and initiate mission-mode development of civilian aircraft development in India.

Manufacturing Infrastructure:

Creating at least 100 unicorns, building a manufacturing ecosystem that is self-sustainable. Establishing industrial corridors to offer effective interaction between industry and infrastructure.

Way forward: Upgrade all industrial infrastructure to Industry 5.0 standards which envisions close cooperation between humans and machines that requires ultra-reliable and low latency communications (URLLC). Repurpose existing manufacturing infrastructure (Public Sector) policy and implementations to create a matured manufacturing eco-system. Since manufacturing involves capital investment and resources, one requires support from the government in terms of ease of import/export especially when one is looking at small scale manufacturing industries. As an example, for start-ups in this domain, one could consider relaxing/postponing levying the duties on import of equipment required for starting the manufacturing process. While the tax holiday currently present is important, it is only beneficial once one starts manufacturing and then starts selling. However, for manufacturing startups, the first few initial years when one is erecting/commissioning the plant, buying the equipment required for manufacturing and testing are highly capital and resource intensive. Hence it is critical to support them at this stage. Note this is quite different from a services startup/industry where equipment cost is not the key drain on resources. Furthermore, one requires the time between the initial filing of a critical patent and the eventual grant to be substantially reduced.

Energy Infrastructure

Focus should be on Renewables. Especially solar as it has become very much affordable. Build large solar plants with mass participation in empty remote lands and allow the benefit for each one's contribution in their own energy bill somewhere else. Allow wheeling for huge apartments, townships etc. Decentralize solar plants to Village levels. Incentivize EVs on tax but make solar plants mandatory for each EV purchase. Say 1kw/10 lakh price for EVs. Incentivize EV charging infrastructure on highways, attached to petrol pumps, hotels etc. Promote competition in the EV sector by attracting more startups with incentives and low-cost

loans. Promote research in these areas. Phase out nuclear plants and Thermal power stations and use the infrastructure for renewables.

Way forward: Exploring innovative technologies to reduce transmission and distribution losses. To have a local self-government institution to explore renewable energy. Make solar plants mandatory for all buildings, say 1kw for every 1000 sq ft. Provide low interest long term loans for solar plants in the lines of housing loans, so that EMI will be more or less equal to the current energy bill. In Association with LSGs, create solar plants in all villages, with capacity calculated in proportion to its population. (1kw /household). Similar plans may be used for windmills as well 1 or 2 windmills in each village wherever feasible.

Communication

- Build wired network all over the country. Nation should have many hi-tech startups in ICT. Optimize spectrum planning and management to increase efficiency. Integrate with other infrastructure.
- Real broadband connectivity: 1 Gbps average per household and 100 Mbps minimum internet speed across the nation.
- Broadband quality: Networks (wired and wireless) should be available 99.99% of the time with predefined QoS. Fiber to most of the households in India including rural. Fiber does not always mean optical connectivity. Currently there are wireless technologies that can provide fiber like connectivity.
- Broadband everywhere: superior quality broadband should be available at every nook and corner of the country. This means that ICT infrastructure should be scaled massively for rural connectivity.
- Indigenous infrastructure connectivity: 90% of the Network infrastructure should be designed and manufactured in the country.
- Indigenous Cell Phones: 40% of the product design and part design should be from India.
- Local standards for global adoption: India should play a significant role in global standards and should have (Indian companies and organizations) 15-20% IPR in any wireless global standard.
- Efficient usage of spectrum: A dynamic and efficient usage of spectrum.



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6. Transport & Mobility

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“Clean, convenient and congestion-free transportation of people and goods.”

Mobility is vital to the efficient movement of people and goods that underpins our economy. It has been at the heart of civilization and has contributed to the 20th-century economic growth. The societal change brought by the surge in mobility levels over the past century has transformed access to jobs, opening up new markets and driving the changing nature of land use. This along with the cross-continental maritime circuits have unlocked massive economic value and have enabled modern trade, as we know it.

To set the vision and aspirations for 2047, it is hence important to understand and outline the current status of the Indian transport and mobility scene, in order to delineate a realistic transport scheme for the future.



Current scenario of Transport & Mobility in India.

In the last few decades, rapid urbanization and fossil fuel dependency have propelled externalities that are no longer sustainable. The goal is now not just to move from one place to another, but move in a manner that is safe for the individual and the environment, utilizing the cleanest and greenest sources of energy, and with equitable access to all members of the populace, all while avoiding traffic congestion.

A recent WHO study has fourteen Indian cities featuring in the top fifteen most polluted cities in the world[1]. Additionally, major Indian cities are also now consistently ranked amongst the world's most congested cities[2]. The average speed for vehicles in some metros are reported as low as 17 km/h[3]. These high levels of congestion have huge costs in the form of reduced productivity and fuel waste.

<150 km

Emergence of Satellite Cities

Highspeed mass transit connectivity

Flying cars?

150-500 km

Network of high-speed rail and expressways

1-2 hour travel time; zero accidents; zero emissions

Flying taxis? Hyperloop?

>500 km

Multimodal airport hubs providing seamless travel

Leisure, social, and spiritual travel will grow significantly

Sensors driven security check eliminates bottlenecks and delays

<5 km

Smart Cluster – All activities within 5km

Non-motorized travel dominates

Jetpacks? Hoverboards?
E-scooters?

5-50 km

Dense Metro + Bus Network, Universal Free, Access, Seamless transfers and payment

Personal Vehicle Use – Dynamic Congestion Pricing

Personal autonomous taxis?
Flying taxis? Driverless bus?

Overall

Completely powered by renewable energy

Zero accidents; no pollution; Minimal congestion

Affordable, accessible, equitable, comfortable, diverse options

Intracity

Autonomous delivery robots at the doorstep

Underground tunnels connecting dark warehouses

Reverse logistics ensuring ~100% recycling

Intercity

Seamless multimodal systems

Autonomous truck platoons

Net zero emissions!

Disruptors

3D printing – make and ship it local, Customized goods

Urban farms – fresh produce in your street garden!

Universal market access, green highly automated supply chain

Next steps:

Rural Transportation Scenario - Now and in 2047

Vision 2047 - Roadmap to get there

- *Energy Requirements*
- *Material Requirements*
- *Technology Innovations*
- *Roles of Stakeholders*
 - *Academia*
 - *Entrepreneurs & Industry*
 - *Government*

What does the Commoner Want?

A survey of citizens in the age group of 15-45 to better understand what they want in terms of mobility in 2047.

What do the Experts think?

A process of voting and debate among experts to understand which of the future technologies are more likely to see the light of day.

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7. Urbanization & Housing

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Introduction

Urban India is home to 482 million people as per world bank data constituting about 35% of Indian population as of 2020. From 1960, the urban population has grown at a CAGR of 2.97% and it is projected to grow at a much faster rate in the next 25 years.

Urban India is a complex system which is evolving continuously over time and has diversified communities living with different culture, tradition and language. Indian urban cities are social, cultural and economic centres with unique features developed through their language, culture, geography and history.

Most Indian cities are witnessing higher rate of migration from rural India for a better life. This uncontrolled migration is leading to congestion, environmental degradation, economic inequality, unemployment, lack of urban facilities like housing, healthcare, educational campuses, public places, with enormous stress on urban infrastructure and governance.

Urban Housing

As the population in the cities grows, pressure on the ecosystem increases. India's urban housing shortage has risen to 54% to 29 million in 2018 from 18.78 million in 2012 and this is going to climb up at a higher rate. The per capita floor area of congested households has declined from 111 sqft in 2012 to 83 sqft in 2018 indicating the congestion in the urban area. The estimate for homeless households and non-slum households living in physically inadequate houses and slum households is 47.3 million or 41% of the urban households. The uncontrolled increase in the land cost and the construction materials makes it unviable to own a residential property. Construction industry relies on natural resources for manufacturing cement, steel, stone aggregates, bricks etc. This has an impact on depletion of natural resources and pollution. Construction industry generates huge amount of construction waste from demolition of aging buildings and reconstruction of buildings with higher built-up area. According to Building Material Promotion Council (BMPTC), India generates an estimated 150 million tonnes of construction and demolition (C&D) waste every year. But the official recycling capacity is a meagre 6,500 tonnes per day (TPD) - just about 1 per cent of the produce.

Most of residential development in the cities and suburban areas deviate from city planning parameters and are developed without any basic urban infrastructure. The developers target the rich and the upper middle class, and for most of the lower middle class and below poverty line people, housing is unaffordable. In the emerging urban scenario, affordable and eco-friendly housing with basic amenities for all class of people is the need of the hour.

Urban Facilities and Public Places

Public places connect people and communities and perform as an interactive space. It is the centre for community activities and cultural development. Based on zoning and urban design norms, public spaces have evolved into different categories to serve as places for social connections, religious activities, hubs for economic opportunities and places for recreation. Urban facilities such as affordable hospitals, libraries,

cultural centres, recreation centres, stadium, sports complex, parks, playgrounds, public toilets, markets, green spaces, parking facilities, public wi-fi, public bus shelters, taxi / rickshaw stands, etc determine the quality of urban life. Today's city development focuses on developing housing and commercial building, with disproportionate development of urban facilities.

Urban Water & Sanitation

Large quantities of food, water, and fuel need to be moved into the cities and huge quantities of garbage and sewage have to be moved out. Aquifers, wetlands, farmlands, forests, lakes, rivers are all essential for cities' survival as much as transport networks. In many Indian cities, water comes from overextended or contaminated aquifers through aging water supply lines with severe leakage losses and contamination enroute

In most Indian cities, very few locations have underground sewerage network. At many places the domestic sewage is connected to the open drains or the stormwater drains contaminating waterbodies like lakes, ponds and rivers nearby. As per Central Pollution Control Board data, the estimated sewage generation from Class I cities and Class II towns (as per 2001 census) is 29129 MLD, which is expected to be 33212 MLD at present assuming 30% decadal growth in urban population. Against this, there exist STPs with 6190 MLD capacity while further 1743 MLD capacity is being added. Thus, the existing treatment capacity is just 18.6 % of present sewage generation with a further 5.2 % capacity addition. However, the actual capacity utilization of STPs is only 72.2% and as such only 13.5 % of the sewage is treated. This clearly indicates a dismal position of sewage treatment, which is the main cause of pollution of rivers and lakes. To improve the water quality of rivers and lakes, there is an urgent need to increase sewage treatment capacity and its optimum utilization.

Urban Solid waste

As per the "task force on waste to energy" under the planning commission 2014 report, urban India will generate 4,50,132 tonnes per day (TPD) of waste by 2031, and 11,95,000 TPD by 2050. The municipal solid waste disposal and treatment yards are under tremendous distress due to overloading and most of the waste is disposed on the open ground or incinerated leading to land, water and air pollution.

Urban Transportation

Indian cities are slow due to uncongested mobility and not due to mobility delays. An index of uncongested mobility explains more than 50% of the variance in overall mobility across cities in India. This is due to the multipurpose nature of urban transport, where roads are multipurpose public goods, used by various classes of motorised and non-motorised vehicles, as well as a wide variety of other users such as street-sellers, children playing and animals. A better understanding of the factors behind congestion will improve the policy measures to improve urban mobility in India, and strengthen the interactions between transportation networks, market integration and globalisation that will drive future economic growth and job creation. Transportation remains the largest sector of lending by the World Bank and regional lending institutions, representing more than 20% of their net commitments. Demand for infrastructure investments will continue to increase in the future. Since the costs of congestion, transportation infrastructure and global warming will only increase in the future, transportation policy should be based on careful analysis of high-quality data, and not on the claims of advocacy groups.

Urban Risks and Disasters

Urban areas are prone to emissions of hazardous gases, epidemic and pandemic breakout due to contamination of land, water and air, Heat Island effects, and natural disasters such as earthquakes, fires, cyclones and floods, the latter particularly due to the quality and condition of the built environment aggravated by unplanned human interventions and development. As occurrence of natural disasters cannot be controlled, risk mitigation is only possible through reducing the vulnerabilities of the built environment through proper planning and robust regulatory mechanisms for building and infrastructure development.

India's CO₂ emission has grown to 1.8 metric tons per capita from 0.268 metric tons per capita due to uncontrolled urbanisation.

The PM 2.5 concentration in urban India is 10.4 times above the WHO annual air quality guideline value. Our air quality index shows that we all don't breathe clean air which has different causes and consequences.

Most Indian cities do not include investment for climate measures. Most cities lack an urban vision and holistic planning, and continue to construct energy-guzzling infrastructure, build roads without transit and pedestrian considerations, create development leading to long commutes, dispose waste without utilizing it as a power source, and ignore distributed generation and renewable energy options. When such oversights are made, we constrain ourselves to a future of wasted energy and high GHG emissions for decades to come. These opportunities are missed are mostly due to lack of awareness, technical know-how and support.

Climate change will directly impact urban India by submerging coastal cities, flooding, drought, air-borne and water-borne diseases. For every one-meter rise in sea levels, the World Bank estimates a loss of 2% in national GDP due to shortage of fresh water, damage to agriculture and fisheries, disruption of tourism, reduced energy security, and other consequences. Storms, floods, cyclones, coastal flooding that are expected to be more frequent put infrastructure at great risk. This includes transportation (roads, railways, bridges, ports and airports) and communication networks, water supply, sewage, gas pipelines, drainage, flood and coastal defence systems, power and telecommunication infrastructures, industrial units, plants. As far as buildings are concerned, informal and traditional housing are the most vulnerable to storms and floods.

Urban Governance & Administration

The Urban Local Bodies (ULBs) faces challenges due to lack of standard administrative framework and regulations across India. Most of the city level functions are managed by the fragmented state departments. ULBs lack autonomy in city management, and this has led to poor service delivery. Governance in the urban local bodies needs to become more efficient, effective, responsive, citizen friendly, transparent and accountable. Absence of these features contributes to "governance deficit" to varying degrees in the urban local bodies. Key problems in urban governance include weak legal and institutional framework within which the ULBs operate and their poor capacity including lack of a professional and sensitised cadre, to perform their development and regulatory functions.

Municipal revenue through taxation is very low and must depend on state or central government funds. Lack of sufficient funds deters the maintenance of existing infrastructure and development of new urban infrastructure.

Key areas of Urban challenges:

1. Urban Housing and Public Spaces
2. Urban Facilities: Healthcare, education, hospitality, commercial and retail establishments, logistic warehouses, sports training centres, recreation and entertainment
3. Urban Infrastructure
 - a. Multimodal transportation infrastructure (road, rail, metro, airports, seaports etc.,)
 - b. Water supply and wastewater management system
 - c. Air quality management
 - d. Solid waste and e-waste management
 - e. Energy infrastructure
 - f. Data and telecommunication (digital) Infrastructure
 - g. Security and surveillance
4. Urban Planning, Governance and Administration
 - a. Integration of urban bodies and policy changes
 - b. Urban planning through co-production (people, policy makers, technocrats)
 - c. Proactive decision making
 - d. Public connection and information flow
5. Urban Economy and Finance
 - a. Economic equality
 - b. Control on inflation and increase in raw material cost
 - c. Housing an infrastructure funding
6. Urban Laws and Judiciary System
7. Urban Risks and Disaster Management

The cell after careful study proposes two focus areas:

1. Urban transformation of old cities and towns
2. Creation of new model urban cities and towns

The proposed transformation of old Indian urban areas and creation of new urban areas needs to contribute to climate neutrality, circular economy and bio-diversity objectives, while ensuring cleaner and healthier environment, providing better social and economic opportunities and well-being.

Most Indian cities have been inhabited over centuries and their streets, buildings and neighbourhoods reflect their heritage. The existing infrastructure partly determines how fast we can replace the existing buildings or retrofit the existing buildings or create new transport options. Achieving sustainability in these cases requires careful considerations.

Vision Statement

The Urbanisation and Housing cell based on the team discussions held on 7th March to 9th March 2022, proposes the following vision statement:

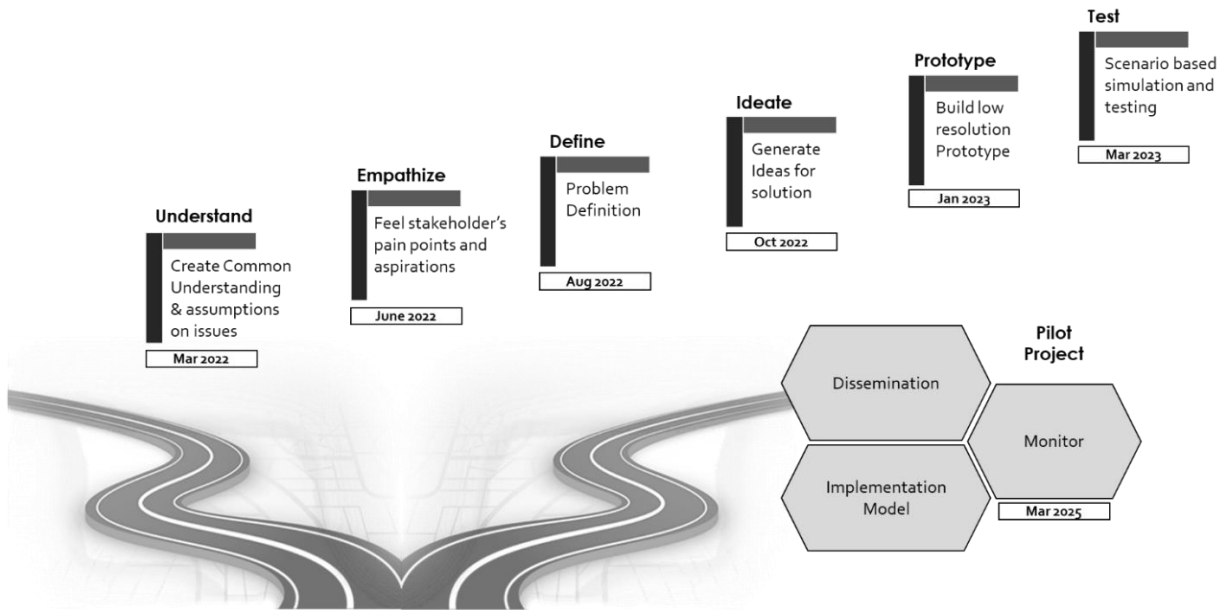
“To live in a Sustainable, Inclusive, Resilient and Secure urban ecosystem that will provide holistic well-being”

The urbanisation and housing cell proposes to bring all stakeholders together (including the user – the public, community circles and NGO's) and proposes to develop:

1. A people centric Integrated framework for urban planners, urban Local bodies, technical departments and policy makers to transform /design their sustainable cities based on the following eight development goals:
 - a. Blue-Green City
 - b. Healthy City
 - c. Resilient City
 - d. Low Carbon and Net Zero city
 - e. Zero-Waste City
 - f. Inclusive city
 - g. Circular city
 - h. Smart city

2. Robust urban planning, zoning, design, finance and project delivery strategies for the urban housing and infrastructure development, operation and maintenance which will include construction materials, technologies, methodologies and project management:
 - a. Blue-Green infrastructure to tackle climate change and its effects
 - b. Integrated, energy efficient smart transport Infrastructure supporting active mobility systems such as walking, cycling, e-vehicles, smart parking lots, smart tolls including charging stations
 - c. Retrofit existing buildings to smart sustainable buildings
 - d. Low-cost smart, sustainable building infrastructure for housing, healthcare, education, etc.
 - e. Smart warehousing and logistics infrastructure to support e-commerce
 - f. Floodwater drainage and water storage (rainwater collection system) and smart water supply system with zero losses and zero-ground water use (Recover and Reduce)
 - g. Wastewater treatment for zero discharge (Recycle and Reuse)
 - h. Zero solid-waste management
 - i. Net-zero buildings
 - j. Infrastructure to produce low-cost renewable energies
 - k. Infrastructure for data and telecommunication
 - l. Security and surveillance infrastructure
 - m. Smart systems for public access, governance and administration

Action Plan for the Urbanisation and Housing Cell



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8.Rural Development & Agriculture

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Background

Historically village ecosystems in India were a hub for innovations related to arts, crafts, metallurgy etc. Today rural India forms 65% of the total population, depending mainly on agriculture for livelihood. For higher disposal income, the rural population moves to the urban agglomeration. Given the ecological carrying capacity of urban locations, additional people make their life challenging. The demographic distribution of migrants is skewed towards largely on youth migrants from the rural areas, leaving the elderly back at home. While reducing migration significantly over the next 25 years is challenging, designing techno-economic policies to create alternative livelihood opportunities in rural areas would be appropriate. A reverse migration or return migration would improve quality of life and economic outcomes, rejuvenating the rural landscape. With the heterogeneous nature of the settlement, uniform urbanization may not be appropriate in the Indian setup. Hence, providing urban amenities in rural areas would be the preferred goal for sustainable development.

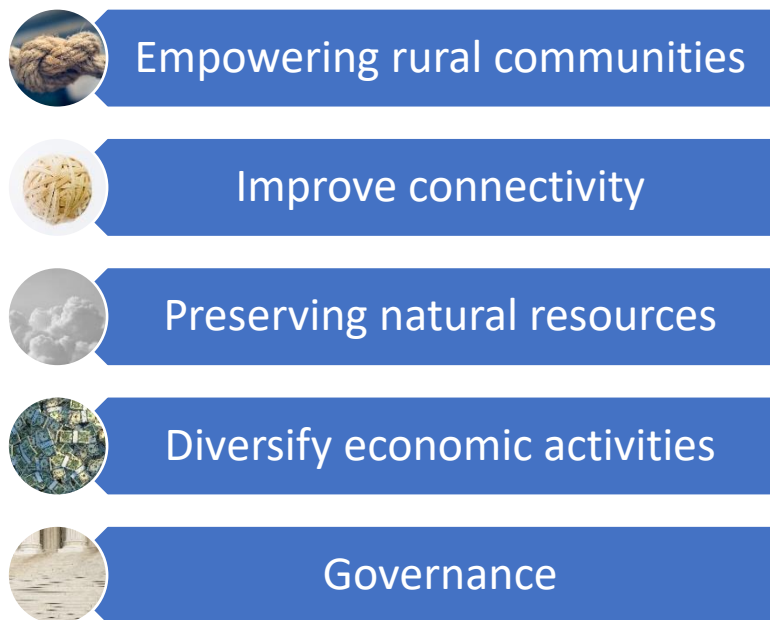


Fig. 1. Five areas of action at macro level

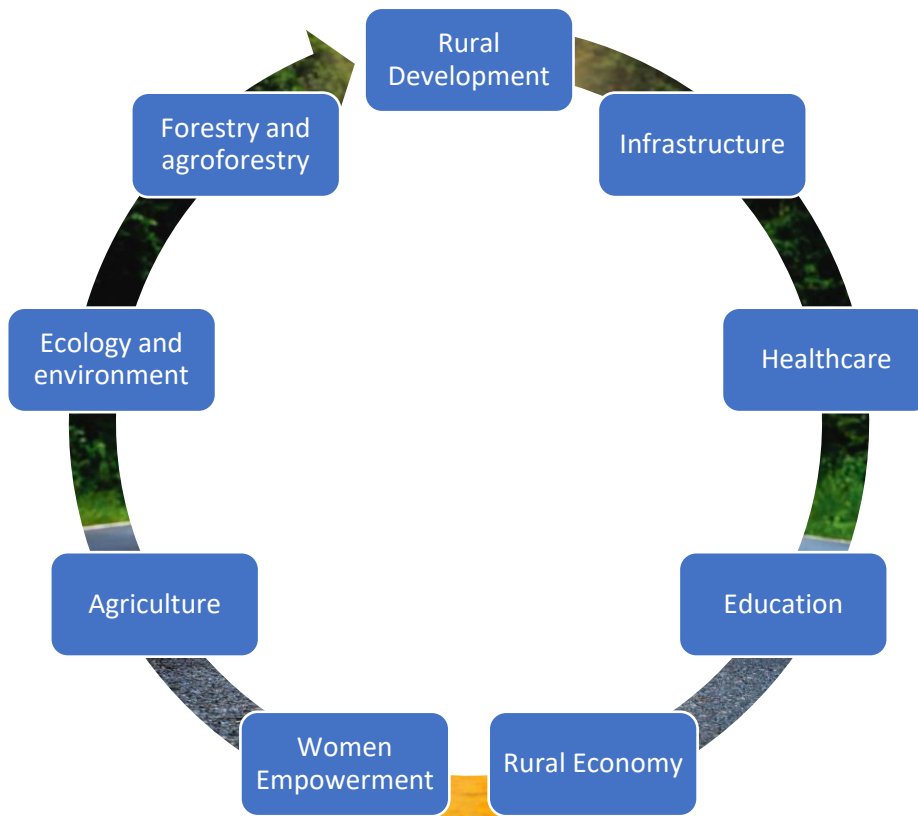
The per capita NVA for 2011-12 at current basic prices (the base year 2011-12) is Rs 1,01,313 for the urban areas and Rs 40,772 for the rural areas. Vision 2047 has a clear focus on reducing this inequality of NVA between the rural and the urban areas. **We identify five areas of action at the macro level**

Village Panchayat (local self-governance) is a significant step in implementing government policies for effective outcomes. Increasing the effectiveness of local self-governance is directly related to rural leadership politically and socially. Strong rural leadership will make better entrepreneurs, innovators, and

business outcomes. This approach is leading to a bottom-up techno-policy intervention for effective governance.

This report presents the current status of rural India and identifies areas of intervention for a better rural economy in India. Identified themes for techno-economic interventions are

Fig. 2. Proposed Themes for Techno-Economic Interventions



Thematic Area – Rural Infrastructure

Thematic Area	Issues	Vision 2047	Anticipated Innovation
Power	Currently high investment costs, fewer returns (PPP models can be used here to finance, and more innovative construction technologies must be adapted)	Energy technologies suitable for rural development and agriculture, 100 % RE	<p>One of the significant farm inputs is fuel about (10-20%), petrol diesel must be replaced with biofuels and other sustainable high-energy-density fuels (Dimethyl ether)</p> <p>Microgrid technologies (RE generation and storage to reduce transmission loss); Policy changes to address Discom issues</p>
Water	Access to safe drinking water – quality & quantity	Localized rainwater storage, building storage structures, replenishment of water tables to 100% –Net zero in drinking water	Technology mapping rainwater inflow and outflow- Rainwater audit,
Mobility	Limited access to accessible and affordable transport	Every facility should be available within 30 minutes of commute (at par with urban facilities); Paved road connectivity to each hamlet	Electric Vehicles for Public transport; App-based, affordable transportation for rural areas,

Thematic Area	Issues	Vision 2047	Anticipated Innovation
Healthcare	Limited access to affordable and quality healthcare	Universal coverage of annual health check-ups enabling preventive healthcare; Affordable health care in every village in a Hybrid model/ cluster approach	Integrated health infrastructure development through AI/ Telemedicine; Micro-specialisation on health expertise at local levels/ telemedicine
Education	Limited access to quality education (skilled teachers)	80% enrolment in higher education; 100% literacy in every state; Hybrid model of physical and digital learning centres enabling access to accessible and affordable education.	<p>Digital educational infrastructure – cluster-based approach; Skill training through education clusters (related to MSMEs)</p> <p>Rural Students:</p> <ul style="list-style-type: none"> • 100 % literacy for all states. • 90 % digital literacy for all states • Skill-based & Entrepreneurial Learning Curriculum from Standard VIII for all schools <p>Rural Teachers:</p> <ul style="list-style-type: none"> • National Recognition Network for Rural School Teachers

Thematic Area	Issues	Vision 2047	Anticipated Innovation
			<ul style="list-style-type: none"> • Research at School Level • Design robust Career/Professional Growth Ladder Mechanism <p>Rural Schools:</p> <ul style="list-style-type: none"> • Infrastructure: ALL Schools have TOILETS for girls & boys • Technical: Every School should host and run (through structured curriculum) A TECH LAB <p>'Connecting Premier/Higher Educations Institutes to Rural Schools'</p>

Thematic Area – Rural Economy

Thematic Area	Issues	Vision 2047	Anticipated Innovation
Migration	Migration of youth from villages to cities (income induced migration; climate-induced migration)	No forced migration; reverse migration; Doubling rural income every ten years	<p>Creating acceptable employment for the rural economy</p> <ul style="list-style-type: none"> • Vibrant agriculture and allied sectors • Employment through the diversified non-agriculture channels (Rural artisan, Tourism) • Reverse migration strategies, e.g., service sector development (IT&ITES), manufacturing (MSME based on geography) • Promoting Rural entrepreneurship
Access to Finance	Lack of access to formal financial services to rural households	Boosting digital payment; Choice to Farmer/ rural entrepreneur; 100% financial inclusion	<p>Digital financial services (voice-enabled processing technologies in vernacular language); Policy change with options to Farmer in Insurance, Crop loan</p> <p>Gig Economy</p>

Thematic Area	Issues	Vision 2047	Anticipated Innovation
Knowledge Gap	Lack of knowledge	Uniform Virtual assistant (in PPP mode) for every household to address information requirements (government schemes, health-related)	Through AR/VR with Traditional and Technological Know-how
Rural Governance	Limited participation from village institutions	100% participation from the gram sabha; Unified Geotagging of Asset	E-voting on specific issues raised and Virtual meetings of gram sabha at panchayat level
Women Empowerment	In addition to being a moral and social issue, gender inequality is also a serious economic challenge, highlighted in a McKinsey study. Closing gender gaps would add \$28 trillion to GDP by 2025. The Enrich program provides support for a woman's ambition to transform herself.	STRENGTHEN (Awareness and Aspirations), ENSURE (Sustainable Livelihoods), ENRICH (Communities and Local Partners), BUILD (Change Agents).	Action Plan: <ul style="list-style-type: none"> • Women's Workshops Tailored to their Needs (A journey that builds participants' awareness, self-confidence, and skills across key areas of knowledge and helps them envision their path in empowering themselves) • Community Outreach and Mobilization Educational support to enable participants to share their skills and expertise within the community Support to transform community aspirations into practicable actions and solutions • The provision of livelihood skills and assets allows local resources and markets to be utilized. The transfer of assets as "in-kind" seed capital.

Thematic Area	Issues	Vision 2047	Anticipated Innovation
			<p>Support to Social Enterprises throughout the entire value chain.</p> <ul style="list-style-type: none"> Financial, marketing, and mentoring services Provide participants with the opportunity to access available financial services, market links and mentoring opportunities that will help them become self-reliant, resilient entrepreneurs and change agents.
Agriculture	<p>A healthy and dynamic agricultural sector is an essential foundation of rural development, generating strong linkages to other economic sectors.</p> <p>Agricultural technologies and adaptability; Degrading of Soil quality; groundwater availability; Fertilizer and pesticide demand management system</p> <p>Lack of access to Agri Credit</p> <p>Limited labour</p>	<p>Net Zero of Rural economy, Reducing landholding size</p> <p>Sustainable soil-based, climate-smart agriculture</p> <p>100% Agri credit during the Agri cycle and post-harvesting; 100% insurance cover for Agri cycle with choice</p> <p>100% mechanization replacing hard labour</p> <p>Demand-based production</p>	<p>Village wise index (Power, Agri, Water, Environment): A policy framework</p> <p>Integrated technology-based information system enabling action-based incentives for improving soil health and production; Policy framework for Agri rating; Linkage of ULPIN, Soil Health card, Agri input/ Knowhows and Market date</p> <p>Leveraging existing schemes such as NREGA, etc., to provide a comprehensive package of guaranteed financial services. Promoting more Fintech companies in the Agri space</p>

Thematic Area	Issues	Vision 2047	Anticipated Innovation
	<p>Market imperfection and information asymmetry</p> <p>Knowledge gap in Farming</p> <p>Inadequate agriculture infrastructure</p> <p>Limited Value addition (2% of production being processed)</p> <p>No commercially viable and usable technology so far</p>	<p>Each block to have a scientific and safe storage facility; Capacity for 90% of produce to be stored</p> <p>Value addition utilizing better processing/wider variety</p> <p>Commercially viable and usable technology development with complete automation at 95% system efficiency (no semi-automation, no something-is-better-than-nothing technologies)</p>	<p>Production of Affordable agricultural equipment and machinery; App-based custom hiring of relevant equipment; App-based Arji Labour market</p> <p>An integrated technology-based information system that maps country production data to provide inputs on crops to be cultivated/practices to be followed.</p> <p>Direct access to remote markets by enabling roads and social commerce.</p> <p>Capacity building for FPOs to ensure that they take the lead role in marketing the produce</p> <p>Open market enabling Farmers/FPOs to sell their products to any buyer in any part of the country, leveraging technology.</p> <p>Uniform Virtual assistant (in PPP mode) for every farmer to address information requirements (government schemes, health-related)</p>

Thematic Area	Issues	Vision 2047	Anticipated Innovation
			<p>Through AR/VR with Traditional and Technological Knowhows</p> <p>Enabling IoT monitored storage facility</p> <p>Small to large scale agro-processing units from village to block levels</p> <p>Broad area scanner development to get live crop blueprint: Design, develop and test of "Detection and estimation of crop and soil parameters wireframe/blueprint for every one hour", with a maximum of 1000 sample points in an acre (to have 95% system efficiency, two or ten sample point in an acre will not give even 5% of system efficiency)</p> <p>No active Region Sensing Technology: Non-active, Non-destructive based sensing technology must be encouraged to avoid practical implementation difficulties, corrosion and erosion and damage by rats and farm labours</p> <p>No direct Chemical Injection technology: Ecology friendly crop production</p>

Thematic Area	Issues	Vision 2047	Anticipated Innovation
			<p>environment creation, to make natural nitrogen fixation process through microorganism in the soil than artificial direct chemical injection through Water</p> <p>Biofuel Energy: Development of technology that locally gives energy supply to the tractor, sensors, water pumping and other farm activity that need a power supply (avoid grid supply to farmland)</p>
Forestry and agroforestry	Forest produce is mostly underutilized. However, it has huge demand all over India due to poor connectivity, and forest land is being converted to agricultural land at a very rapid pace.	Forest produce must be well processed and marketed, and forest dwellers must be empowered to meet the market demands	Forest produce must be given a fair price, stored, transported, and distributed efficiently. Agroforestry with more high yielding varieties must be given the push in a big way to meet the nation's timber without putting extra pressure on the forests' ecosystems.
Marine Potential	India has a 1000km coastline, and most of the coasts are surrounded by villages that depend on fishing for livelihood. Being one of the most perishable products, 30-40 per cent of marine output is discarded due to limited access to proper storage and logistics; less than 10 per cent of marine	<p>Maritime produce should be stored and distributed in a scientific and safe method, and</p> <p>Usage of marine potential should be maximized to 50 per cent, and the fishing community should be de-risked with access to improved resources.</p>	Access to affordable Cold chain logistics, better insurance, finance facilities to coastal villages. Fishers should be equipped with the best technologies like GPS, weather information, maritime, communication systems and reliable vessels.

Thematic Area	Issues	Vision 2047	Anticipated Innovation
	<p>potential is being harnessed by India now.</p> <p>Fishers utilize age-old fishing techniques risking their lives at sea. Access to technology, education and financial capital is one of the lowest among rural India in these many coastal villages.</p>		
Ecology and environment	Topsoil is one of the fastest depleting resources along with the organic content in the soil; with this rate of depletion 90% of cropland will be decertified by 2050.	Indian organic content in soil is less than 0.5% and 50% loss in existing biodiversity, and many organisms are highly endangered with losing the biodiversity of villages.	GeoTagging, preserving, promoting the native crops, animals, flora & fauna varieties and encouraging villagers to preserve and incentivize the propagation

9.Fintech & Inclusion

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Introduction

Financial services sector in India has undergone a transformation over last few years and has positioned the country to start taking rapid strides towards inclusion of all sections of population. This document lays out a vision towards which the country can grow and transform finance into a fundamental human capacity. It will require concerted efforts from various stakeholders and along various areas encompassing technology, education, policymaking and regulations.

Objectives

The objective put forth in this document are attainable in the next 10-15 years as basic building blocks already exist to work towards them. After that the focus would be on enhancing customization, improving user experience and technological capabilities. The objectives are enlisted below:

- a) **Access to multiple financial products** – For all sections of the population, access to a range of financial services at individual level is important. This will include a bank account with complete transparency on charges, credit to cover emergency situations and life insurance as minimum. Further, savings products that allow individuals to offset inflation and generate interest through a balanced portfolio of investments, credit products with inflation-linked interest rates based on credit score of the individuals, and households and additional insurance products for risk management based on requirements of the individuals.
- b) **Ubiquitous financial services** – The above range of financial products need to be easily accessible to all individuals. This not only includes geographical proximity, but also reliability of access, availability round the clock and convenience. This can be enabled through availability and adoption of various technologies.
 - a. Access to smartphones with data connection across all areas
 - b. Availability of cash-in/out points within a kilometer distance
 - c. Usage of assisted technologies as needed for different sections of the population like elderly, individuals with special needs. This could be through a Business Correspondent or other banking partners as well.
- c) **Digital Payment access** – Universal adoption of digital mode of transactions over next 10 years can play a key role in bolster efforts towards financial inclusion. Using above-mentioned technologies every household should be enabled to make digital payments and can use it for regular bill and expenses payments. Enabling each individual to make P2P payments will allow integration into the financial system.
- d) **Access to high quality services** –
 - a. To overcome information asymmetry in financial services, provider will be responsible for the solutions offered to a customer. All key risks and exclusions will need to be disclosed upfront in simple points, and no fine print will be included.
 - b. Pricing of every product will be transparent and there will be no charges levied without customer consent.

- c. Digitization of all immovable objects, like property and wealth records, along with integrated systems will allow for quick verification of assets and thereby fast access to credit for individuals and enterprises.
 - d. Strong grievance redressal mechanism will be needed to instill confidence in the financial system for the user.
 - e. A small percentage of transaction amount could be used to secure a financial insurance that will further increase confidence of the user during digital transactions.
- e) **Awareness, Digital Literacy & Financial Literacy** – Regulators can develop a set of guidelines so that any product sold has certain “packaging instructions” to make it more customer friendly and easier to “consume”. This puts the onus on the Financial Institution to make products easier to understand, rather than putting the onus on the customer to be financially “literate”. Targeted initiatives will be implemented to enable individuals to understand different financial products as well as technology used to access them, where specialist advice is available, whom to approach for grievance redressal etc. These initiatives will also allow the individuals to understand credit scores, and why it’s important to have a good score to be access credit. This may be done through various channels like short videos, public services messaging on Whatsapp, radio messages, and further, including a basic financial literacy course in schools. Training content will be developed in all vernacular languages and initiatives will target both urban and rural areas to ensure coverage of all areas.
- The training could happen in schools (students), village level training at Panchayat houses (rural population) through State Institutes of Rural Development (SIRDs), SHG level (women) or organization level training (working population). NGOs could be partners for these initiatives to maximize outreach eg. Parinaam through the ‘Diksha Financial Literacy Programme’.

Target groups for Financial Services

For enhancing financial inclusion, focus will have to be on low-income households, women, rural population, vulnerable customer groups and excluded communities. Frameworks that allow for financial service design and delivery to these user-groups will have to be created along following lines:

- a) Occupation oriented – farmers, daily-wage workers, small merchants, MSMEs. Agribusiness has a different income generating cycle concentrated around the harvesting season (and hence a different repayment cycle) than a daily wage laborer that has uneven income flows, but all year around.
- b) Location oriented – urban, rural, remote, insurgency-affected areas. Geographic and cultural context to be taken into account when identifying periods of increased annual expenditures, climate driven events etc.
- c) Household oriented – elderly, women, people with special needs. Household with a single earning member and low-income household would require more flexibility in repayment than a multi-earner, land owning household

There may be significant overlap between these categories, i.e. an individual can fall into more than one of these categories, and therefore product-design will have to be customized based on individual’s situation.

Facilitators

Proactive and coordinated efforts from various facilitators will be required as follows to attain the vision in 10-years:

- a) Government – Providing open architecture and space for experimentation. This will allow entrepreneurs to develop innovative solutions for different stakeholders. Support with grants and subsidies for cash-in cash-out infrastructure will improve access, especially for individuals in rural areas. Welfare schemes may have to be designed to support the economically weaker section (bottom 15%) of the society.
- b) Businesses – engage with the government and academia to bring solution templates to market, agile pivots during pilot testing of solutions, mirror market feedback to academia & government
- c) Academia – Developing innovative technologies leveraging newest research that can enhance innovation in products, access, personalization capabilities etc.

Unified Data Platform

A unified data platform with required linkages with following features will enable access to all financial product:

- a) **Single Digital ID** – A strong personal data vault will be created using a single digital ID. This purpose could be served by enhancing an existing ID like Aadhaar. This will be used to smoothen the KYC process for access to financial services, eg. single KYC used for financial products, credit scores linked to the digital ID. Currently verification of KYC has become one of the rate limiting steps for the financial institution in providing faster high quality service. Hence, the onus of periodic verification of the KYC for single digital ID will be with the customer at any one of the multiple government agencies such as e-seva or postoffices among others so that the financial institution can focus on the quality of the product being delivered.
- b) **Portability** – A single KYC will be used not only across all products with the same financial institution but also all providers across the industry. Further, ability to carry their bank account number with all payment mandates, loan EMIs, savings SIPs, monthly bill etc. to any provider. Some insurance policies are already portable to different providers.
- c) **Efficiency** - Near instantaneous update of information related to transactions, payment defaults etc. with syncing of data across multiple database will not only ease access for users but also provider required information to providers to design better solution and also check on fraudulent activities.

Data Privacy

Each household should have access to personalized suite of financial services which is based on individual's data. To design and mass customize relevant and personalized solutions at scale, following points on individuals' data and its usage will be considered:

- a) **Data ownership and monetization** – Users will own their personal data and can decide which data they want to share with the providers. Data can also be used as currency, eg. low/no premium given for sharing data with an insurance company.
- b) **Anonymization of data** – Any data set shared with a service provider will be anonymized to protect privacy of individuals
- c) **Ethics, privacy and security** – No algorithmic or community-based red lining will be allowed by service providers to allow access irrespective of factors like community, caste, region etc. An underlying commitment to these points will be essential.
- d) **Standards** – To allow smooth sharing of data, standards will need to be evolved for the industry, covering details on who can access data, what data is allowed to be shared, how data can be shared.

Technology & Innovation

Technology will play a key role in providing financial access to all individuals. A solutions approach will need to be developed for financial services, providing a personalized suite of products linked to individual's situation and life goals, with a safety net built-in in case of exigencies. As new technology evolves, like voice-based services using vernacular languages, virtual reality, artificial intelligence, blockchain, it will be incorporated at various steps of the value chain – from designing of personalized products to improving access and enhancing financial and digital literacy.

Evaluations

Periodic evaluation (eg. every two years) of the measures to be taken in order to understand effectiveness and efficiency of the steps taken, challenges being faced may be done. It will involve identifying the challenge or process efficiency requirement, key players who can help resolve and solutions possible. This will also allow incorporation of innovation, both in policy-making as well as from entrepreneurs, in the financial system.

Conclusion

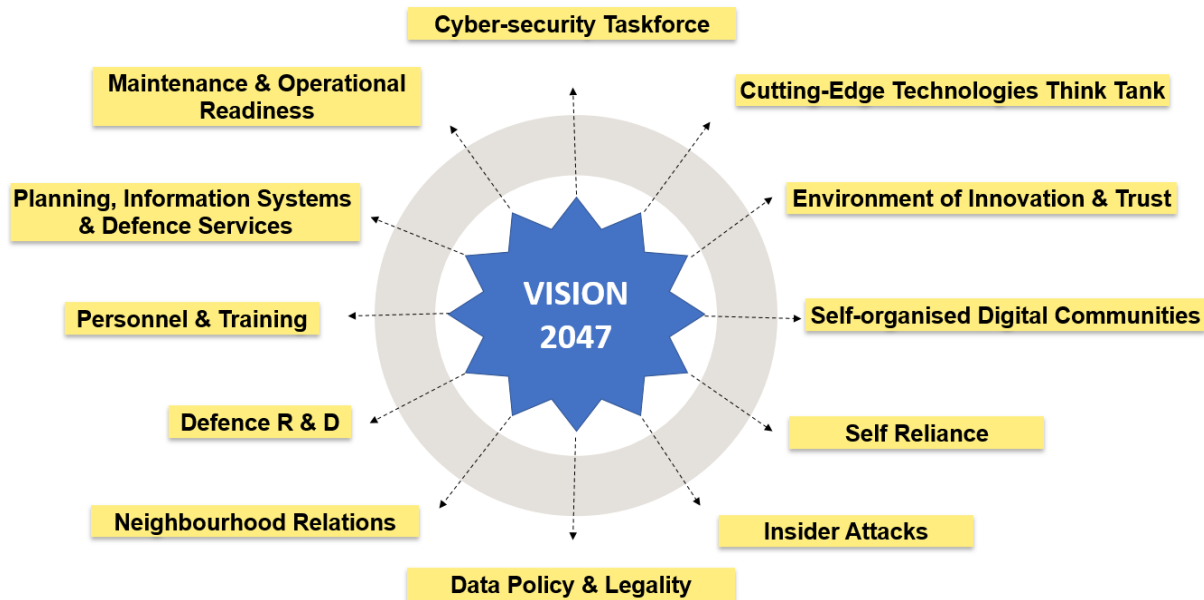
Financial products, training, and income will all be equally important for people to engage in Financial Ecosystem. So, integrating all necessary activities is highly essential and a collaborative approach will need to be adopted. A greater collaboration among value chain players with NGOs (for financial & digital literacy) and Product/Solution companies (accessibility and product innovation). A synergistic approach among value chain players like (Stellapps), Cooperatives (like Amul), literacy providers & Product/Solutions providers proposed here gains momentum, then we could facilitate the large-scale financial inclusion & subsequent financial planning in next 5 years. As we drive this model with value chain players, continual engagement with people can be fast and yet cost-effective.

10. Information Security & Defence

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Introduction

This concept note addresses the critical pillars of Information Security & Defence for India @ 2047



Information Security

Introduction

Information security is a crucial area of defence – as more and more data and control has moved online, the nation remains vulnerable to attacks. This area is important enough to justify shorter turnaround times and clearer policies on modernisation, preparedness and disaster management. In our judgement, the current preparedness of the nation in this realm is inadequate. Information Security should be an important factor in our policy making across all sectors in the country. Transparent, data driven decisions with minimum ad hoc controls would be the hallmark of governance in India @ 2047. Moreover, we will need to ensure that the massive data that will be generated remains in-country, secure and protected - when in transit and when persisted in end-user devices or data storage systems. R&D related to all aspects of Information Security enabling development of indigenous technology will bolster and strengthen our sovereignty from external dependency and threats.

We envision that by 2047 or even before, India will be a digitally transformed knowledge economy with 'Digital' and 'E-Governance' being the primary delivery mechanisms by which the Government services our citizens. Transactions across most sectors are envisioned to be digital in nature. Information Security will be of critical importance for the country to protect and secure its citizens, organisations, institutions and Governments (Central and State) from local, domestic and global threats. We also need our citizens to be aware of their digital rights and harbour the trust, confidentiality, privacy, security of our Information Systems.

Cyber-security task force

This area entails creation of high-ranking positions, analogous to the structure of the armed forces, an organised and dedicated task force at the national, state and domestic levels with a rigorous training program for officers. *This space of warfare must be treated with as much importance as traditional spaces like land, air and sea.* There is also a parallel with disaster management – preparation and response to cyber-attacks can benefit by learning from natural disaster management. There must be round the year training programs at all levels, simulations of attacks and responses (similar to flight simulators), and usage of other modern techniques to develop a highly competent security task force.

Globally cutting edge think tanks looking at futuristic attacks:

Within the domain of cyber-attacks, there are emerging threat paradigms that we must prepare the nation for, otherwise it could cripple the activity of organisations, institutions or even the whole country by stealth or surprise. A key threat is posed by emerging domains such as quantum technology in which certain countries are taking large strides. A quantum computer is a fundamentally different paradigm of computing as compared to a classical computer and can allow for extremely high (exponential) speedups in attacking security. Most modern-day cryptography relies on the hardness of certain mathematical problems which can be solved/broken by a sufficiently powerful quantum computer. To avert this scenario, we need to be up to date with the technologies of quantum computing or must prepare ourselves to deploy secure systems via post quantum cryptography. The awareness and readiness of the nation to this threat is still rudimentary and needs attention.

As a general strategy, we must have thinktanks involving experts who are abreast of the state-of-the-art technologies in security and cryptography. It is crucial that the government think tanks maintain a healthy and active relationship with academia for maximum gain. In the absence of a strong collaboration with academic experts, such organisations run the risk of getting outpaced by rapidly advancing technologies. Experts from these think tanks must, for instance, routinely undergo as well as conduct training programs, participate in research conferences in the field, and also host internships of top students in the country.

Environment of Innovation and Trust

To capture the expertise and enthusiasm of talented entrepreneurs of the country, the government must define meaningful innovation challenges, with adequate rewards and reasonable criteria especially at initial stages of competitions. The goal is to foster an environment where risk-taking and bold thinking is encouraged. Rewards for these competitions must be designed in collaboration with all the stakeholders, so that they are genuinely attractive and encourage participation. Development should be planned as multi-stage, where early stages are focused primarily on trying out innovative new ideas and demonstrating proof of concept. Just as cooperation between entrepreneurs and government is required, there also needs to be a formal bridge between academia and government so that the government can stay abreast with the latest developments in science.

Self-organised digital communities

Aside from building a dedicated task force, it is crucial to educate citizens on digital hygiene practices, using local languages and creative approaches such as games, street plays and such. Citizens must be made aware of their data privacy rights and there needs to be serious accountability for data leakage, which is publicised as well as strictly enforced. It may be worthwhile to build some strategies for imparting this type of education into the NEP.

One can envisage an environment in which digitally native citizens exist in an atmosphere of fraternity and cooperation in a global network of self-organised communities, analogous to the federal structure of many nation states. These citizens are able to switch seamlessly between their physical and digital avatars. In both these realms, they execute their duties to the country as well as enjoy the rights protected by the nation state. A scenario is envisaged where a myriad of personalised apps emerge operating in a framework with a common interface that is enabled by self-organised community standards. Citizens will be disposed to generating enormous amounts of personal data and sharing it with third party applications. Some of these applications can also be controlled by other nation states, in exchange for information and infrastructure services. This will pose serious challenges to monitoring and safeguarding national security where personal data of each citizen can be mined. A need for government-enabled regulation for standards is required, which act as guidelines to such digital communities to set their security configurations.

Self-Reliance

The country needs to develop expertise in developing security solutions, such as encryption boxes, security hardware etc within the nation. Importing such goods is not only extremely expensive but is also very risky – the government should try to nurture companies that can take the lead in such efforts. It is observed that Indian entrepreneurs are very capable and are already designing far more complex things than encryption boxes. The government needs to actively craft its policy to tap into this national resource and secure itself from insidious attacks. Another aspect of self-reliance is that sensitive data should remain within the country or at least within the control of the country, to the extent possible – this is a big challenge in the age of globalisation and cloud storage.

Insider Attacks

A very crucial attack paradigm in information security are the so-called “insider” attacks, where an insider who has privileged access compromises security. Such insiders may be part of the government and citizens need to be made aware of these threats and the measures that are deployed to protect them. There are tools and techniques that can mitigate such behaviour or at least assist in tracing such malicious users, which must be understood and deployed. It is crucial that the design and deployment of such systems considers all aspects of privacy/security compromise of the end user as part of its threat model. While technology can aid in identifying security compromises, it should also be backed up by sound law and policy enforcement to thwart security breaches.

Data Policy and Legality Aspects

An immediate-term need is to evolve a meaningful data usage policy and update this frequently. Similarly, we must study and understand the legal implications of different kinds of security breaches and develop a sound legal framework to address these.

Defence

India @ 2047 should be self-reliant in defence with effective deterrence against all types of man-made threats such as conventional, nuclear, cyber, chemical, and biological warfare, and also protect ourselves from natural disasters. India in 2047 would exercise its influence not just through conventional techniques, but also through our “soft power” to rally other nations around the world to jointly work towards mutual advancement and human development. We should emerge as a shining reliable beacon for the world at large and South-Asia specifically and embody an aspirational role in our neighbourhood. In the world of depleting natural resources and competing aspirations, the notional present-day material security is inadequate in providing an assurance of basic ‘security’ whether it is territorial or human related. Through dedicated investment in state-of-the-art technologies, inclusive policies, and smart strategies, we envision a holistic sense of security not only for our nation, but humanity at large.

Neighbourhood Relations

While India needs to continually foster and champion Global Peace, our national security is defined and closely tied to our relations with our neighbours. To warrant a strong defence, India must aspire not only to be self-sufficient in our technological needs, but also have an influence that will promote co-prosperity with our neighbours, which in turn will help both parties achieve their aspirations. Looking towards other parts of the globe, US concentrates economic activity in NAFTA, EU conducts majority of its trade within its combined borders, and China's economic activity is concentrated within the East Asian neighbourhood. In contrast, India's local economic and political footprint has reduced, and consequently we cannot be secure if the status quo were to be maintained. Hence, major effort is required in framing policies and establishing interdependence (economic and defence) in our neighbourhood to ensure our security and economic growth.

Defence R&D

India is currently heavily reliant on imports for conventional defence hardware and weapon systems. This dependency is not only a drain on foreign exchange but also makes it difficult for us in framing our geo-political strategies. There is an urgent need to design and make these systems in-country. While there have been several initiatives in this front, the need is a coordinated effort and execution of what is most relevant. We recommend an empowered task force with a charter to collaborate with stakeholders (Defence R&D, Academia, Industry and Startups); identify, prioritise and indigenise a substantial part of our imports within the next 5 years. This task will involve reverse engineering as well as inventing new technologies, for which startups and academia need to be adequately incentivized to take up such engagements. Additionally, we will also develop a knowledge base of the know-how and the know-why.

Startups Collaboration

With the breath-taking speed at which innovations emerge and technology-obsolence being a fact of life, what we indigenise over the next 5 years will need to be improved upon or replaced. It is imperative that continuous innovation is the key to our defence technology to be modern and relevant. Startups will need to play a key role in the modernization initiatives. Coordinated Fundamental and Translational research involving academia and the industry is needed to keep the innovation pipeline flowing with new ideas and prototypes that the startups and the industry could take forward to commercialization.

Academia - Government - Industry crossovers

There's a lot more that needs to be done in the context of academia and government interaction. A "revolving door" policy which allows subject or domain experts to contribute formally to the policy ecosystem is the need of the hour. The United States, UK all benefit from such cross-fertilization of ideas. This interface is needed in India and the mindset has to change in bringing this change over the next 25 years.

Intellectual Property Focus

Indigenous manufacturing has been the focus of DPP 2020. However, it should not lead to market protectionism or cost prohibitive wheel re-invention activities. It should focus on comparative advantages, foster an innovation ecosystem and allow national champions to emerge in key areas (instead of resources being spread thinly). Examples of Japanese companies like Honda, Toyota, Mitsubishi all were the result of Government handholding and yet they emerged as world-leading companies. Issues like MOD termination rights in public interest, issues related to sellers IP getting acquired by govt for unlimited use, leasing, strategic entrepreneurship are some of the points which need to be addressed

Space Capabilities

In the context of space policy, we need to think of wars of the future where the first targets would be assets in space as communication technology becomes the key to winning war. India has recently established a defence space agency as a Tri-service command to better evaluate threats and maximise the effectiveness of Indian operations in space, land, sea and air domains. India needs to enhance the capability of this agency in the coming 25 years. This may include establishing a Space Command (the US did this recently) in addition to the existing tri-services.

Modernizing Systems

India has expended a great deal of energy and resources to set up a vast defence economy and state-of-the-art weapon systems. However, the performance of the defence led domestic economic activity has been largely suboptimal. The shortcomings are related to difficulties faced in conversion of 'hard' and 'soft' innovation capacities to fruition. Lack of strong support from higher political leadership, meagre research and development (R&D) and procurement budgets, inefficiency of the main R&D and manufacturing players, poor management of human resources and a weak acquisition system, among others, leave India's defence innovation in a poor state. We need to transform this over the next 25 years so we are the home for hi-tech defence technologies.

Personnel and Training

In the digital age and especially in the realm of defence intelligence and ops, the demands on human oversight units for identifying trends and analysing the reports from automated learning algorithms is envisaged to be high. An entire personnel unit of highly efficient data miners is required to manage and orchestrate the ops. They need to be enabled with training in emerging technologies. Online / field training for such realms is to be imbibed for awareness.

Planning, Information systems and defence services

For operational tasks, such as defence material procurement, logistics & Supply chain, various services such as medical services / engineering / projects / finance, a smart, seamless and realtime planning & coordination engine is envisaged. This will strengthen the ability to act and adapt to updates from the field (as and when such data is sourced), therefore enabling data-driven decision making while at the same time implementing the best practices from civilian domains that have proven successes for such services

Maintenance and operational readiness

An engineering driven, sensor-enabled and functionally smart maintenance system is envisaged. The system is expected to be capable in performing predictive maintenance, automated rapid prototyping of parts of low volume requirements, placement of orders for spare parts, ensure operational readiness and enable financial management, Such a system will be enabled by developments in sensor technology, data science and AR/VR to consistently monitor / track the health and operational usage of critical systems, provide the maintenance technicians with realtime visibility into the system parameters and suggest optimal operating parameters for peak performance, with an objective to improve preparedness.

Conclusion

India @ 2047 is envisioned to be a confident and vibrant nation. Our confidence and vibrance would be built both on conventional sources of strength (material and otherwise) as well as co-optive ways using soft-power that can actually allow India to set the agenda and standards on multiple issues, thereby attenuating the likelihood of conventional conflicts and zero-sum competition. Our concept note is the first stage in laying out the kind of institutions, ideas, and policies we hope could lay the foundation towards that goal.