GREEN INVESTMENT OPPORTUNITIES IN INDIA
About Impact Investors Council (IIC)
The Impact Investors Council (IIC) is India’s preeminent member-based, not-for-profit industry body set up to strengthen impact investing in the country. IIC’s key areas of activity and effort include advocacy and policy support, research, and publications in addition to a strong focus on impact measurement and management. IIC is supported by 60 investors and ecosystem partners.

About Climate Policy Initiative (CPI)
CPI is an analysis and advisory organization with deep expertise in finance and policy. CPI’s mission is to help governments, businesses, and financial institutions drive economic growth while addressing climate change. CPI’s vision is to build a sustainable, resilient, and inclusive global economy.

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The world faces a deficit in climate investments, and the gap has been increasing by the order of a trillion dollar every year. The India-led G20 Leaders’ Declaration stated that the developing world would need USD 5.9 trillion until 2030 to achieve their Nationally Determined Contributions (NDCs) out of which USD 4 trillion is required only for clean energy transition to meet the zero-emission goal. In addition, India is one of the major climate vulnerable countries in the world, and therefore India is committed to scale up climate investments through clean energy transition and shift to a low-carbon economy in Services, Industry and Agriculture.

The Global Landscape of Climate Finance Report 2021 Report published by Climate Policy Initiative (CPI) states the total climate investments at USD 850 – 950 billion against a requirement of USD 4.5 - 5 trillion annually; and in India the total climate investments for FY2019 and FY 2020 were of USD 44 billion annually while India need USD 160 billion as stated in its NDCs to meet the Paris Agreement goals.

The world cannot meet its climate goals without adequate investments in developing countries (including India) and therefore, there is a need to channelise global capital from developed to developing countries. Given India’s current scale of emissions and growth trajectory, it may not be possible for the world to meet its climate goals if climate investments are not materialised in India.

In the light of the above, India presents a huge green investment opportunity for global investors across critical sectors such as cleantech, clean energy, clean transportation, electrical vehicles, industrial decarbonisation, water, nature-based solutions etc. which could drive green growth in India.

While the high-level numbers on climate investments required in India are well acknowledged, this report is an attempt by Impact Investors Council (IIC) and Climate Policy Initiative (CPI), to delve deeper and identify climate-oriented sectors in both mitigation and adaptation which offer potential investment opportunities across green value chains in products, technologies, and services. With the right set of enabling policies and incentives, these critical climate investment sectors have the potential to scale up significantly.

This report endeavours to provide adequate investment information to global strategic and financial investors on the scale of green investment opportunities in India. We hope that this report will pave the path to direct global green capital to India.
MESSAGE FROM NEEV FUND

When it comes to tackling climate change, the world is rapidly moving from ambition to action, with India being on the forefront as a climate change leader.

Adaptation of processes used in sectors such as traditional agriculture, waste management, through technology & process improvements is the way forward to mitigate & adapt to climate change. Along with process adaptations, India’s increasing confidence in alternative green sources of energy such as green hydrogen can make the country a potential game changer in the race of achieving net-zero emissions.

Through increasing policy impetus, growing consumer awareness, technology innovations and international trends, we not only see the larger traditional players paving the way, but also exciting and promising emerging enterprises playing a significant role in this global energy transition.

The current climate conscious environment supports the cause of sustainable investing, and hence we see immense opportunity for private capital to play a catalysing role in not just climate mitigation but also adaptation centric efforts.

We believe this report will outline key insights for those looking to match the growing spirit of innovation with a befitting financial support.

Akshay Panth
Chief Investment Officer
Neev Fund
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Green Investment Opportunities in India

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<th>Description</th>
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<tr>
<td>ACC</td>
<td>Advanced Cell Chemistry</td>
</tr>
<tr>
<td>ADB</td>
<td>Asian Development Bank</td>
</tr>
<tr>
<td>AI</td>
<td>Artificial Intelligence</td>
</tr>
<tr>
<td>BESS</td>
<td>Battery Energy Storage Systems</td>
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<tr>
<td>BMS</td>
<td>Battery Management Systems</td>
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<tr>
<td>CCfD</td>
<td>Carbon Contract for Differences</td>
</tr>
<tr>
<td>CEA</td>
<td>Central Electricity Authority of India</td>
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<tr>
<td>CO₂</td>
<td>Carbon dioxide</td>
</tr>
<tr>
<td>CSA</td>
<td>Climate Smart Agriculture</td>
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<tr>
<td>CSO</td>
<td>Civil Society Organisations</td>
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<td>CSR</td>
<td>Corporate Social Responsibility</td>
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<tr>
<td>CSS</td>
<td>Cross Subsidy Surcharge</td>
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<tr>
<td>CTF</td>
<td>Clean Technology Fund</td>
</tr>
<tr>
<td>DFI</td>
<td>Development Financial Institutions</td>
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<tr>
<td>ED</td>
<td>Electricity Duty</td>
</tr>
<tr>
<td>EIB</td>
<td>European Investment Bank</td>
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<tr>
<td>EPR</td>
<td>Extended Producer Responsibility</td>
</tr>
<tr>
<td>ESS</td>
<td>Energy Storage Systems</td>
</tr>
<tr>
<td>FCDO</td>
<td>Foreign, Commonwealth and Development Office</td>
</tr>
<tr>
<td>FMCG</td>
<td>Fast Moving Consumer Goods</td>
</tr>
<tr>
<td>FPO</td>
<td>Farmer Producer Organisation</td>
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<tr>
<td>G-H2</td>
<td>Green Hydrogen</td>
</tr>
<tr>
<td>GDP</td>
<td>Gross Domestic Product</td>
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<td>GESP</td>
<td>Global Energy Storage Programs</td>
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<tr>
<td>GHGs</td>
<td>Greenhouse Gasses</td>
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<td>GWh</td>
<td>Gigawatt-hour</td>
</tr>
<tr>
<td>Gol</td>
<td>Government of India</td>
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<td>H4D</td>
<td>Hydrogen for Development Partnership</td>
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<td>IDB</td>
<td>Inter-American Development Bank</td>
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<td>IFC</td>
<td>International Finance Corporation</td>
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<tr>
<td>IoT</td>
<td>Internet of Things</td>
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<tr>
<td>IREDA</td>
<td>Indian Renewable Energy Development Agency</td>
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<tr>
<td>ISTS</td>
<td>Inter-state transmission charges</td>
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<tr>
<td>KWh</td>
<td>Kilowatt-hour</td>
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<tr>
<td>LABs</td>
<td>Lead Acid Batteries</td>
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<td>LIBs</td>
<td>Lithium-ion Batteries</td>
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<tr>
<td>MeITY</td>
<td>Ministry of Electronics and Information Technology</td>
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<tr>
<td>MMT</td>
<td>Million Metric Tons</td>
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<td>MNRE</td>
<td>Ministry of New and Renewable Energy</td>
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<tr>
<td>MoEFCC</td>
<td>Ministry of Environment, Forest and Climate Change of India</td>
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<td>MoHUA</td>
<td>Ministry of Housing and Urban Affairs</td>
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<td>MoU</td>
<td>Memorandum of Understanding</td>
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<tr>
<td>MWh</td>
<td>Megawatt-hour</td>
</tr>
<tr>
<td>NAPCC</td>
<td>National Action Plan on Climate Change</td>
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<td>NDCs</td>
<td>Nationally Determined Contributions</td>
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<td>NGHM</td>
<td>The National Green Hydrogen Mission</td>
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<td>NGO</td>
<td>Non-governmental organization</td>
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<td>NMSA</td>
<td>National Mission for Sustainable Agriculture</td>
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<td>NZE</td>
<td>Net Zero Emissions</td>
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<td>PE</td>
<td>Private Equity</td>
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<td>PFC</td>
<td>Power Finance Corporation</td>
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<td>PLI</td>
<td>Product-linked Incentive Scheme</td>
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<td>PPP</td>
<td>Public Private Partnerships</td>
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<td>PRAS</td>
<td>Primary Reserve Ancillary Services</td>
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<td>PSL</td>
<td>Priority Sector Lending</td>
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<td>PSUs</td>
<td>Public Sector Undertakings</td>
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<td>PtX</td>
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<td>R&amp;D</td>
<td>Research &amp; Development</td>
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<td>RD&amp;D</td>
<td>Research, Development &amp; Demonstration</td>
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<tr>
<td>RE</td>
<td>Renewable Energy</td>
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<tr>
<td>REC</td>
<td>Rural Electrification Corporation</td>
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<td>RTC</td>
<td>Round-the-Clock Power</td>
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<tr>
<td>SAPCCs</td>
<td>State Action Plans on Climate Change</td>
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<tr>
<td>SDG</td>
<td>Sustainable Development Goals</td>
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<td>SECI</td>
<td>Solar Energy Corporation Of India</td>
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<td>SHGs</td>
<td>Self Help Groups</td>
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<td>SIGHT</td>
<td>Strategic Interventions for Green Hydrogen Transition</td>
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<td>SME</td>
<td>Small and medium-sized enterprises</td>
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<td>SOP</td>
<td>Standard Operating Procedure</td>
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<td>SSA</td>
<td>Stationary Storage Applications</td>
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<td>ToD</td>
<td>Time of day pricing</td>
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<tr>
<td>TPDDL</td>
<td>Tata Power Delhi Distribution Limited</td>
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<tr>
<td>ULB</td>
<td>Urban Local Bodies</td>
</tr>
<tr>
<td>VC</td>
<td>Venture Capital</td>
</tr>
<tr>
<td>VGF</td>
<td>Viability Gap Funding</td>
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</tbody>
</table>
INTRODUCTION
Introduction

India’s significant greenhouse gas emissions, high vulnerability to the impacts of climate change and fast-paced development require for rapid innovation systems and timely, adequate, and targeted financial resources to unlock and bring climate action into the mainstream. The same also has to scale up and accelerate sustainable development.

Limited climate related investments continue to be one of the biggest barriers to achieving India’s ambitious emissions reduction targets, with estimates indicating that India could face an investment shortfall of $3.5 trillion in achieving its net-zero target. Public finance will be largely insufficient, requiring the private sector to play a crucial role in closing the financing gap and accelerating green finance.

The business case for enabling low-carbon and resilient growth, while pursuing sustainable growth, continues to strengthen, creating an array of opportunities that are already being explored by various investors at different stages. The rationale behind such opportunities is backed by a series of high-level assessments around the green investment climate, and existing challenges and approaches to unlocking investments in green solutions and technologies at scale.

Recognising the immense potential that the green investment space holds for funders and enterprises in India, this report attempts to bring together global and national perspectives on green investment opportunities, as well as the knowledge and expertise of funders and sector experts to present an analysis of:

• Green investment opportunities, which have the potential to be replicated or/and scaled in the short-to-medium term and best suited financing mechanisms for each;
• Financing requirements for replicating or/and scaling these opportunities wherein funders can play a significant role.

The in-depth assessments of priority green sectors and deep dives of green technologies and solutions within these elucidate their:

• Contribution to climate action;
• Green investment landscape; and
• Actionable pathways for financing them at scale.

India’s investment requirement is significant for transitioning to a low carbon and resilient economy

$170 billion

Required per year to meet India’s Nationally Determined Contributions (NDCs) targets by 2030.
Source: Climate Policy Initiative, 2022

3.5 - 6% of GDP

Required in green investments until 2050 to decarbonise the Indian economy.
Source: McKinsey, 2022

Additionally, annual investments of about 2.5% of India’s GDP would be required until 2030 solely to address the infrastructure gap caused due to climate events.
Source: Reserve Bank of India, 2023

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• Green investment landscape; and
• Actionable pathways for financing them at scale.
Green Investment Opportunities in India

Green investment opportunities encompass multiple sectors, sub-sectors and technologies across the areas of climate change mitigation and adaptation, and sustainable development goals. This report refers to key green technologies and solutions listed by the International Energy Agency and United Nations Environment Programme. These include:

### Green Investment Sectors

<table>
<thead>
<tr>
<th>Sector</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Energy and Feedstock Transformation</strong></td>
<td>Generation, transmission, distribution and storage of energy and feedstock from renewable sources</td>
</tr>
<tr>
<td><strong>Transport</strong></td>
<td>Shift to low-carbon modes of transportation</td>
</tr>
<tr>
<td><strong>Waste and Circular Economy</strong></td>
<td>Efficient use and reuse of materials and waste to reduce demand and GHG emissions</td>
</tr>
<tr>
<td><strong>Land Use and Oceans</strong></td>
<td>Management of land use changes and oceanic temperatures to reduce GHG emissions into the atmosphere</td>
</tr>
<tr>
<td><strong>Water</strong></td>
<td>Conservation and sustainable management of water resources to ensure water security</td>
</tr>
<tr>
<td><strong>Health</strong></td>
<td>Improvement of food security, health infrastructure and services to adapt to the impacts of climate change</td>
</tr>
<tr>
<td><strong>Climate Change Forecasting and Monitoring</strong></td>
<td>Protection of people, infrastructure and ecosystems from climate hazards with planning and early warning systems and technologies</td>
</tr>
<tr>
<td><strong>Industry</strong></td>
<td>Technologies and processes for low-carbon and sustainable manufacturing of industrial materials and products</td>
</tr>
<tr>
<td><strong>CO₂ Management</strong></td>
<td>Reduction of CO₂ in the atmosphere using technologies and natural climate solutions</td>
</tr>
<tr>
<td><strong>Buildings</strong></td>
<td>Reduction of energy consumption in buildings by using technological and design efficiency measures</td>
</tr>
<tr>
<td><strong>Food, Agriculture and Livestock</strong></td>
<td>Initiatives to reduce emissions from agriculture and livestock and help the sector adapt to the impacts of climate change</td>
</tr>
<tr>
<td><strong>Marines, Fisheries and Coastal Zones</strong></td>
<td>Protection of marine and coastal ecosystems from the impacts of climate change</td>
</tr>
<tr>
<td><strong>Forestry</strong></td>
<td>Protection of and increase in forest cover for carbon sequestration, ecosystem protection and livelihood generation</td>
</tr>
</tbody>
</table>

Sources: [International Energy Agency](https://www.iea.org) & [United Nations Environment Programme](https://unep.org)

### Green finance and investments

While there is no singular definition of ‘green’ in the context of finance and investments, this paper understands green finance and investments as ‘finance and investments focused on climate action and environmental objectives necessary to support sustainability, and in particular, aspects such as biodiversity and resource conservation.’

Green financing focuses on increasing levels of financial flows from various sources such as banking, micro-credit, insurance and investment, from public, private and not-for-profit sectors to:

- Better manage climate and environmental, and associated social risks; and
- Adopt opportunities that ensure both a decent rate of return, and climate and environmental benefits.
Green sectors, sub-sectors, and technologies and solutions within these have been selected based on their relevance in the Indian investment ecosystem and their potential for scaling in the short-to-medium term.

Recognising the growing importance of climate adaptation and the opportunities arising from it, this study also attempts to emphasise the case for financing adaptation activities. This includes sectors such as healthcare, water, infrastructure resilience, and climate change forecasting and monitoring, which currently do not see private sector financing and engagement at scale, but have immense potential for business opportunities in the form of products, technologies and services.
GREEN INVESTMENT OPPORTUNITIES IN INDIA

APPROACH AND METHODOLOGY
### Overall Approach

#### Identify high-potential investment opportunities

- **Map landscape** of green sectors, sub-sectors and technologies / solutions
- **Select technologies / solutions** that have high investment potential for deep-dive analysis

**Selection criteria:** Climate impact, maturity and commercial readiness, investment activity, financial sustainability, enabling environment, scalability

#### Research

- **Detailed assessment** of selected investment opportunities
- **Consultations with stakeholders** to understand the current state and expected trajectory of the sector

**Assessment areas:** Value chain components, key players, policy environment, investment trends and potential, capital requirements, investment barriers

#### Analysis and recommendations

- **Analyse investment gaps and barriers** and identify opportunities for interventions by different types of stakeholders
- **Recommend specific actions** for policy-makers and investors to unlock green investments

**Recommendations for:** Policy-makers, regulators, investors and lenders

#### Validation

- **Validate assumptions, analysis and recommendations** with stakeholders

**Validated by:** Industry and independent subject experts
Identifying Investment Opportunities: Mapping Green Sub-sectors

All sub-sectors within the green investment sectors were analysed and then selected on the basis of two metrics: their importance for India’s net-zero emissions (NZE) target or climate impact, and their ‘investability’ (see below for definition of metrics). The accompanying graph maps these selected sub-sectors. Of these, four sub-sectors (in the green shaded cells) were then chosen for a deep-dive analysis: Battery Energy Storage Systems, Green Hydrogen, Waste Management & Material Circularity, and Climate Smart Agriculture. Each of these sub-sectors have:

1. High to very-high relevance for India’s NZE ambitions and sustainable development;
2. High investment potential, but are in early stages of development. They require strategic interventions to address investment barriers and scale up commercial investments.

Legend: Green Investment Sectors
- Energy and Feedstock Transformation
- Food, Agriculture and Livestock
- Transport
- Land Use and Oceans
- Industry
- Waste and Circular Economy
- Buildings
- CO₂ Management

Note: Of the 13 sectors introduced before, five sectors under climate adaptation have been excluded from this analysis due to low-investability (low financial sustainability/ high dependence on public finance). The sector ‘Food, Agriculture and Livestock’ has overlapping mitigation and adaptation benefits. Here we use the term, ‘Climate Smart Agriculture’, to collectively refer to investable opportunities in this space.

Definition of Metrics:

Importance for NZE / Climate Impact: Measure of the impact of the sub-sector on India’s GHG emissions.

Investability: A compound measure of the sub-sector’s maturity (technological and commercial readiness levels), enabling environment (supporting policies and regulations) and level of investment activity in recent years.
Green Investment Opportunities in India

Each of the chosen sub-sectors has several technologies and solutions which present suitable investment opportunities for a wide range of investors. Again, based on climate impact and investability, key technologies and solutions were identified and selected for deep-dive analysis. The figure below shows these opportunity spaces and the sub-sector and sector to which they belong.

<table>
<thead>
<tr>
<th>Sector</th>
<th>Sub-sector</th>
<th>Opportunities – Technology/Solution</th>
</tr>
</thead>
<tbody>
<tr>
<td>Energy and Feedstock</td>
<td>Transformation</td>
<td>Battery Energy Storage Systems: Li-ion batteries, application in EVs, stationary storage and grid management</td>
</tr>
<tr>
<td>Waste and Circular Economy</td>
<td>Management &amp; Material Circularity</td>
<td>Green Hydrogen: Electrolysers, hydrogen production, hydrogen transport and storage</td>
</tr>
<tr>
<td>Food, Agriculture and Livestock</td>
<td></td>
<td>Waste: Plastic and packaging material, construction material, batteries, municipal and agricultural waste</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Climate Smart Agriculture: Low-carbon fertilisers, cold storage, robotics, soil and crop health monitoring, etc.</td>
</tr>
</tbody>
</table>
Green Hydrogen

Green Hydrogen: Unlocking its Pivotal Role in India’s Decarbonisation Journey

India is at a crucial juncture, striving to harmonise economic growth with sustainability. Industries like oil refineries, fertilisers, steel, and shipping, which are substantial users of grey hydrogen, are now presented with a significant opportunity to transition towards green hydrogen, thereby reducing their carbon emissions. The adoption of green hydrogen is slated to enable India to cumulatively abate 3.6 gigatonnes of CO₂ emissions by 2050.

Green hydrogen (G-H2), produced by using clean energy has been seeing policy impetus as well as active interest from the real and financial sector with investments expected to reach ~$97 billion by 2030 with oil refineries, fertilisers and gas blending driving demand in the short-term. Despite this promising story, the pressing challenge of making G-H2 economically viable for application sectors remains.

The Cost Conundrum: An Opportunity Waiting

Reducing the current cost of G-H2, which is above $4/kg, to approximately $2/kg is imperative for achieving economic viability for end-users. There is an opportunity to mobilise increased investments in the sector to foster innovation and build economies of scale in green hydrogen production. This cost reduction trajectory can be led by increased investments in two key cost components:

- Renewable energy production
- Electrolyser manufacturing

Building the Value Chain

As India aspires to become a global hub for G-H2 production, we witness a spur of activities across the value chain with:

- Startups and SMEs developing electrolyser technologies and G-H2 production facilities
- Large corporate announcing large-scale, integrated G-H2 projects

Strategic partnerships are abound as enterprises are collaborating to work across different business models.
**Business Model Variables**

<table>
<thead>
<tr>
<th></th>
<th>RE</th>
<th>G-H2 Production</th>
<th>Transportation</th>
<th>Storage</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>On-site generation</strong></td>
<td>• Centralised production (hubs, valleys)</td>
<td>• Pipelines (high volume)</td>
<td>• Salt caverns, rock caverns, Depleted oil and gas fields (large volume, long term)</td>
<td></td>
</tr>
<tr>
<td><strong>Off-site generation with transmission</strong></td>
<td>• Decentralised production (on-site)</td>
<td>• Trucks (short distances)</td>
<td>• Tanks (small volume, short/long distance transport)</td>
<td></td>
</tr>
</tbody>
</table>

Given the evolving nature of the sector and requirement for large capacities, technical and financial assistance are critical for building a sustainable value chain and aligning with policy directives.

**Policy's Impetus**

Recent initiatives like The National Green Hydrogen Mission, G-H2 Standards, and incentives to drive electrolyser manufacturing and G-H2 production, have outlined the government’s clear priority to build scale for the G-H2 sector with a target of achieving 5 MMT/annum G-H2 production capacity by 2030⁶. This momentum calls for a complementary set of demand-side incentives that can bolster local demand for G-H2 which will be critical towards the segment’s growth.

**A Case for ‘Green’ Finance**

India’s journey towards clean energy and industrial transition positions the green hydrogen segment to draw capital that can support innovation, build supporting infrastructure and invest in project capacities that together hold the potential to build a sustainable domestic value chain.

**Recommendations for Policy and Finance**

- Introduction of demand-side offtake mandates
- Concessional capital towards electrolyser manufacturing and G-H2 production facilities
- Patient capital for startups and SMEs across the value chain
- Investments in storage, transport, and hub infrastructure
- Technical assistance for project development and implementation
- Risk mitigation and de-risking mechanisms for crowding-in commercial capital
Battery Energy Storage Systems

Supporting India’s Renewable Energy Goals

India’s transition to the adoption of clean energy for both industry and transport requires sustainable and scalable solutions for storing energy. Battery energy storage systems (BESS) emerges as a vital solution in this space.

Within the realm of BESS, various battery chemistries play distinctive roles with lithium-ion batteries (LIBs) racing past lead acid batteries (LABs) because of superior performance.

LIBs: Powering India’s Energy Transition

With high energy density, extended lifespan, low maintenance requirements and rapidly declining costs, LIBs find applications in several areas - stationary storage, electric vehicles (EVs) and grid management services.

Across a scale of conservative to accelerated cases, the annual demand for batteries is expected to be ~106 GWh - 260 GWh by 2030, respectively. The India Battery Market, in the accelerated scenario, could surpass $15 billion, and in the conservative scenario, could amount to $6 billion.

This surging demand necessitates building a self sustainable value chain right from cell manufacturing to deploying battery technologies for applications.

Even as lithium-ion battery storage technologies gain traction, there is scope for research and development (R&D) in alternative advanced chemistry batteries.
Policy Boost

- The National Framework for Energy Storage Systems launched
- PLI scheme of $2.4 billion - National Program on Advanced Cell Chemistry (ACC) Battery Storage for promotion of domestic cell manufacturing
- Viability Gap Funding Scheme extending funding support for development of BESS projects
- The Faster Adoption and Manufacturing of Electric Vehicles (FAME) schemes incentivise adoption and manufacturing of EVs

These policies outline the pathway for commercial investments to support scale and innovation across the value chain.

Collaboration and Capital

The high capital requirements, innovative technologies and multiple applications across sectors, warrant the need for public and private sector players to invest in and build technical and financial capacity across the value chain.

Given the perceived complexity of technologies and deployment towards large-scale projects, there is an opportunity to develop strategic alliances and collaborations, facilitate knowledge-sharing and mobilise low cost capital towards enterprises.

A single BESS asset holds the promise of multiple value streams as the market for energy storage systems continues to grow. With technology advancements and increased policy support, the sector is poised to receive domestic and international capital, which can unleash the full potential of BESS.

Recommendations for Policy and Finance

- Policies to include BESS in energy systems planning and clarification on remuneration schemes for multiple services
- Facilitating knowledge building, technical advisory & strategic collaborations
- Low cost consumer finance for EVs
- Patient capital to support innovative cell chemistries
- Low-cost financing for developers for stationary storage projects
- Risk mitigation and de-risking mechanisms for crowding-in commercial capital
- Investment towards battery recycling solutions
Climate Smart Agriculture

Climate Change and Agriculture: Close Interplay

Agriculture is both, a sector most impacted by climate change, as well as an important source of greenhouse gas (GHG) emissions. In light of this, the adoption of climate smart agriculture (CSA) practices becomes not just a choice but a compelling imperative.

While climate-resilient practices are essential, farmers are more likely to embrace them when they have the financial means to access and adopt the solutions and can see their tangible benefits, such as enhanced income and reduced farm losses.

This presents an opportunity for philanthropic capital and development finance to enable the on-ground deployment of CSA solutions through capacity building of enterprises and farmers.

As technological innovations come up, there is a case for impact investors to develop a sector focussed investment strategy.

Driving Climate Mitigation & Adaptation

- Climate resilient seeds & Low CO₂ fertilisers
- Soil & crop health monitoring
- Robotic agriculture
- Food processing & harvesting technologies
- Cold storage

These high impact solutions stand to benefit by increasing investments that build their scale and ability to ease on-ground adoption.

In 2022, over 60% of investments went to downstream agtech firms, highlighting an untapped opportunity for investors to bring capital to on-farm and closer-to-farm CSA solutions.

CSA solutions also hold the potential to equip investors and lenders with the much-needed farm level data insights, driving home their multidimensional impact as well as ability to build economical gains across the value chain.

Mobilising Capital for India’s Priority Sector

Providing timely support through concessional capital in the form of grants, equity, or debt can eventually lead to transformation of many emerging enterprises, which are building innovative solutions, into attractive investment opportunities.

Deploying patient capital, leveraging blended finance structures and adopting a holistic approach to build capacity for solution providers as well as users could pave the way for a climate focussed and financially viable investment approach for India’s priority sector.

Recommendations for policy and finance

- Building capacity & awareness programmes for farmers
- Deploying patient capital to CSA focussed enterprises
- Enabling affordable and accessible finance for farmers
- Developing and enabling access to agricultural insurance products
- Enhancing credit and risk mitigation structures to commercial lenders
Managing Waste: India’s Surmounting Challenge

India’s increasing population and its diverse forms of waste make the waste management process carried out by local municipal authorities very complex. The unorganised and informal nature of waste collection and segregation warrant the emergence of innovative solutions and enterprises that process waste.

Therein lies an opportunity to invest in a sector converging between climate action and social impact.

Municipal waste generated annually

Growing Demand for Waste Management Solutions

Given the underlying waste generating industries such as Electric Vehicles (EVs), consumer electronics, packaging and construction continue to grow, the Indian market for a circular economy practices is pegged at growing to $45 billion by 2030.

Despite this promising outlook, investments in waste management solutions are yet to gain traction. As per IIC’s analysis, startup enterprises in this sector attracted only $159 million in equity investments between 2020 and 2022. This highlights a substantial untapped opportunity to invest in innovation and scale that can bring efficiency to the waste management process across diverse streams. Within this ambit, one space, viz, battery recycling, stands out for its increasing relevance and demand potential in India’s clean energy transition.

Battery Recycling: A Special Mention

An increasing demand for Lithium (Li) batteries across various applications such as EVs, grid storage, and electronic devices drives demand for battery recycling solutions. The growing demand for lithium raw materials and battery recycling makes a compelling case for low-cost early-stage capital to support the development and scale up of such solutions.

Total CO₂ emissions from battery cell production

<table>
<thead>
<tr>
<th></th>
<th>Virgin raw materials</th>
<th>Recycled raw materials</th>
</tr>
</thead>
<tbody>
<tr>
<td>Raw Material</td>
<td>74</td>
<td>53</td>
</tr>
<tr>
<td>Active material production</td>
<td>29</td>
<td>8</td>
</tr>
<tr>
<td>Cell production</td>
<td>22</td>
<td>22</td>
</tr>
<tr>
<td></td>
<td>23</td>
<td>23</td>
</tr>
</tbody>
</table>

Source: Battery recycling takes the driver’s seat - McKinsey
An Increasing Policy Priority

National policies such as the EPR and Battery Management Rules encourage waste management practices by waste producers giving impetus to an increasing demand for such solutions. As local municipal authorities recognise the imperative to manage waste sustainably, there is a case for supporting private enterprises who build value linkages.

A Case for Development & Commercial Finance

The sector holds high potential for low cost concessional capital to build technical and technological capacity across the value chain and foster ecosystem collaborations as well as crowd-in commercial capital.

The high demand outlook, growing application industries and technological innovations create a fertile space for more impact investments to build capacity of early and growth-stage enterprises.

These comprehensive approaches, deployed at scale, are pivotal for nurturing the waste management ecosystem, ensuring its sustainability and long-term impact.

Recommendations for policy and finance

- Building capacity programmes for the unorganised waste picker workforce
- Preparing technical and project level guidance for implementing waste management projects
- Facilitating strategic collaborations and partnerships
- Deploying early-stage capital to foster R&D efforts and build technological innovations
- Enhancing credit and de-risking mechanisms to commercial lenders
Having explored the four sectors in brief, we can comprehend their pivotal roles in achieving decarbonisation, facilitating clean energy transition, and transforming India’s priority industries. These emerging sectors are still in their nascent stages, offering not only significant investment opportunities, but also demanding support from both the public and private sectors to achieve scale. Within the scope of our report, each of these emerging sectors, albeit at varying stages of maturity, shares a common need for specific interventions. This section outlines the areas where essential interventions are imperative to drive progress in India’s sustainable development journey.

A Glimpse of Sectoral Needs

In the following sections, we will delve deeper into each sector for a comprehensive understanding of their investment potential and their contribution to reducing climate impact.

Nourish the Entire Value Chain
- Invest in supply-side interventions & build economies of scale
- Enable demand creation across application areas

Enable Technical Assistance
- Earmark funds for technical assistance in addition to direct financial investments
- Ensure efficiency of operations and effectiveness of impact

Explore Blended Finance Structures
- Explore blending of different forms of capital to support emerging solutions with high potential for long-term growth.

Nurture Innovation
- Invest in early and growth-stage enterprises for building commercially viable businesses
- Provide patient capital, commensurate with the developing stage of the sector

Strengthen the ecosystem
- Build cross-linkages for technical and financial synergies between ecosystem players including civil society and government organisations
- Foster public and private partnerships for innovation and commercialisation of green technologies and solutions

Align with Policy
- Develop an investment strategy to complement policy and regulatory enablers
Green Investment Opportunities

SUB-SECTOR DEEP DIVES
Energy and Industry Transformation:

GREEN HYdrogen

THE KEY TO DECARBONISATION

- Replacement for carbon-intensive grey hydrogen
- High potential to abate CO₂: 3.6 GT by 2050
- Scope for application: Fertilisers, refining and steel among others
Green Hydrogen finds application in industrial uses such as refineries and as feedstock to produce ammonia and methanol. Green hydrogen (G-H2), a low-carbon alternative, can play a critical role in enabling deep decarbonisation of many sectors such as steel, fertilisers, refining, and maritime shipping, which are a major contributor of CO2 emissions.

Decoding the G-H2 Sector

- Hydrogen is an existing fuel/feedstock for several critical industrial sectors. G-H2 made from renewable sources accounts for less than 1% of global production but holds great potential for scale given its pivotal role in decarbonising the economy and is the second most important decarbonisation lever after electrification and renewable energy (RE).

- Market demand is currently in nascent stages but significant interest from public sector undertakings (PSUs), early-stage startups and SMEs, as well as large corporates, active across the G-H2 value chain, hold promise to provide value to several end-use sectors, especially with increasing policy impetus to scaling up G-H2.

- Key imperatives to build the supply chain for G-H2 would entail greater investment towards renewable energy production, electrolyser manufacturing and G-H2 production.
Green Investment Opportunities in India

**G-H2 costs 2-3 times more than Grey Hydrogen**

- Lower power consumption reduced cost
- Lower capital cost
- Waiver of grid charges
- Higher operating efficiency
- 62% cost reduction over next 5 years via technology improvements, policy incentives and economies of scale

Key cost components: electricity, electrolysers, and storage & transport. The cost structure is*:

- **Electrolyser plants**: $475–750/KWh
- **Electricity cost**: $40–60/MWh
- **Operational expenses**: 3–5% of capex
- **Storage and transportation**: $1–2/kg
- **Capacity utilisation**: 18–32%.

Overall, depending on the electrolyser technology, cost of RE supply and the mode of hydrogen storage and transport, the total cost of delivered G-H2 ranges at $4-9/kg. It is expected to reach ~$2/kg by 2030.

*Refer Annexure: G-H2 production cost components

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**Demand to grow more than fourfold by 2050, representing 10% of global demand**

<table>
<thead>
<tr>
<th>Demand Areas</th>
<th>Estimated Annual Consumption of G-H2 (by 2030)</th>
<th>G-H2 Investment Potential ($)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oil refining</td>
<td>1.8 MMT</td>
<td>32.5 billion</td>
</tr>
<tr>
<td>Gas blending</td>
<td>0.54 MMT</td>
<td>9.7 billion</td>
</tr>
<tr>
<td>Fertiliser industry</td>
<td>1.32 MMT</td>
<td>28.5 billion</td>
</tr>
<tr>
<td>Exports (G-H2 &amp; Ammonia)</td>
<td>1.25 MMT</td>
<td>26.9 billion</td>
</tr>
<tr>
<td>Others*</td>
<td>0.1 MMT</td>
<td>1.7 billion</td>
</tr>
</tbody>
</table>

*Others comprise of the steel, methanol and transportation industries

Source: Green hydrogen: Hype or game changer? (A 2022 CRISIL Report)

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**Electricity and Electrolysers: Driving the long-term price trajectory of G-H2**

- **Electrolyser plants**: $475–750/KWh
- **Electricity cost**: $40–60/MWh
- **Operational expenses**: 3–5% of capex
- **Storage and transportation**: $1–2/kg
- **Capacity utilisation**: 18–32%.

This table shows expected sectoral demand and investment potential by 2030.

Source: Bridge to India Research

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**Demand Areas**

- **Estimated Annual Consumption of G-H2 (by 2030)**
- **G-H2 Investment Potential ($)**

Source: Green hydrogen: Hype or game changer? (A 2022 CRISIL Report)
Green Investment Opportunities in India

### Key Trends

#### Renewable Energy
- Increasing RE penetration. Focus on energy storage for supply of round-the-clock power.

#### G-H2 Production
- Investments in decentralised production and centralised hydrogen hubs and valleys. Partnerships being formed between ecosystem players.

#### Electrolyser Production
- Tie-ups between international manufacturers and domestic G-H2 producers. Domestic manufacturing in early stages but scaling up.

#### Storage & Transport
- Facilities yet to be fully developed. Scope for innovation and scale to emerge.

#### End-users
- **Early adopters:** Oil refineries, ammonia producers & natural gas blending. Large private conglomerates such as Reliance, Adani and L&T, and PSUs such as NTPC and IOCL have planned billion dollar investments in G-H2 production. Companies focusing on creating market linkages and finding export markets to sell G-H2 and its derivatives.

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#### G-H2 Demand Landscape at a Glance

- **G-H2 with its high decarbonisation impact** finds applications across several major high carbon emitting sectors.
- **Currently cost of production of G-H2 is high** (> $4/kg), making it economically unviable for consumption in end-use sectors.
- **Investments in scaling up RE, electrolyser manufacturing, G-H2 production, and transport and storage infrastructure needed** to drive down costs and build value chain.
- **Near term projects to rely upon strategic partnerships and synergic collaborations** to develop and strengthen supply chain.
Policy Initiatives: Paving the Way for India’s G-H2 Pathway

2021
- **National Hydrogen Mission**
  Making India a global hub for manufacturing electrolysers while creating domestic demand and undertaking R&D activities.

2022
- **Green Hydrogen/Ammonia Policy**
  Enabling access to low-cost RE for G-H2 production via measures such as open access, banking of unconsumed RE, waiver of inter-state transmission charges, etc.

2023
- **National Hydrogen Mission**
  Launching a comprehensive policy framework for creating an enabling ecosystem for G-H2 deployment in the country and achieving at least 5 MMT/annum G-H2 production capacity and associated 125 GW of RE capacity by 2030.

- **Green Hydrogen Standards**
  Establishing emission thresholds for ‘green’ category hydrogen production in recently defined Green Hydrogen Standard by the Ministry of New and Renewable Energy (MNRE).

Landmark Policy: The National Green Hydrogen Mission (NGHM)\(^\text{14}\)

The overarching objective of the NGHM is to achieve at least 5 MMT/annum G-H2 production capacity and associated 125 GW of RE capacity by 2030.

As part of the Strategic Interventions for Green Hydrogen Transition (SIGHT) programme, under the NGHM, GoI has announced supply-side financial incentives for two types of activities:

- **Component I:** Financial incentives for electrolyser manufacturing in India. Total capital outlay of \(\text{Rs} \ 4,440 \text{ crore (\$622 million)}\) allocated to provide viability gap funding. Base incentive of \(\text{Rs} \ 4,440/\text{kW}\) announced – to be tapered down over 5 years – and awarded based on a competitive bidding process.

- **Component II:** Financial incentives for G-H2 production in India. Total capital outlay of \(\text{Rs} \ 13,050 \text{ crore (\$2 billion)}\) until 2030 allocated to provide viability gap funding. Incentives capped at \(\text{Rs} \ 50/\text{kg}\) in the first year, \(\text{Rs} \ 40/\text{kg}\) in the second year, and \(\text{Rs} \ 30/\text{kg}\) in the third year.

Green Hydrogen Standards 2023\(^\text{15}\)

**Definition**
A well-to-gate emission (i.e., including water treatment, electrolysis, gas purification, drying and compression of hydrogen) of not more than 2 kg CO\(_2\) equivalent/kg H\(_2\).

**Approach**
A detailed methodology for measurement, reporting, monitoring, on-site verification, and certification of G-H2 and its derivatives to be specified by the MNRE, with the Bureau of Energy Efficiency (BEE) being the nodal authority for monitoring, verification and certification of G-H2 production projects.

**Impact on Industry**
- Provides industry with a criteria for defining G-H2 based on the emissions footprint, compared to alternatives.
- Enables development of processes for monitoring, evaluation, verification and certification of G-H2 projects.

Summary of the Policy’s Catalysing Role

- Policy measures collectively reflect government’s commitment to support the development of G-H2 sector in the country.
- Current policy and regulatory interventions focused on incentivising private investments by defining standards and providing supply-side incentives.
- **Demand-side interventions needed** to create lead markets and drive investments across the value chain.
The Funding Initiatives

As policy interventions continue, the sector has been seeing investments in enterprises engaged across the value chain, including large-scale projects as well as cost effective innovation. Given the evolving nature of technologies involved, increasing sources and quantum of funding hold potential to build the sector.

<table>
<thead>
<tr>
<th>Development Finance Institutions (DFIs)</th>
<th>Equity Investments Support Innovation</th>
</tr>
</thead>
<tbody>
<tr>
<td>European Investment Bank</td>
<td>The Neev Fund</td>
</tr>
<tr>
<td>World Bank</td>
<td>Aavishkaar Capital, Sequoia Capital</td>
</tr>
<tr>
<td>Asian Development Bank</td>
<td>Gruhas</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Amount</th>
<th>Use of Proceeds</th>
</tr>
</thead>
<tbody>
<tr>
<td>€1 billion loan facility</td>
<td>Establishing large-scale G-H2 hubs and projects*6.</td>
</tr>
<tr>
<td>$1.5 billion loan</td>
<td>Scaling renewables, G-H2, stimulating climate finance*7.</td>
</tr>
<tr>
<td>$25 million</td>
<td>Early-stage capital support for green hydrogen production facilities*9.</td>
</tr>
<tr>
<td>$5.65 million</td>
<td>Early-stage capital support for commercial deployment of innovative, low cost electrolyser technology*10.</td>
</tr>
<tr>
<td>$2.4 million</td>
<td>Early-stage capital support towards innovative G-H2 production process with waste carbon as input*11.</td>
</tr>
</tbody>
</table>

*Debt Financing | *Equity Financing
Sector Level Challenges to Scaling Investments

While the sector has been seeing investments across the value chain, it remains characterised by challenges that limit funding at scale. These include:

- **High cost of production:** Current cost of G-H2 production above $5/kg (largely as per cost of RE and electrolysers), against $1-2/kg for grey hydrogen.

- **Supply chains yet to be established:** Large scale addition of RE capacity, modernised electricity grids, hydrogen pipelines and storage facilities at an evolving stage.

- **Lack of visibility regarding demand:** Restricted foresight into forthcoming G-H2 demand, influenced by cost economics and the absence of government mandates.

Investment Risks for Electrolyser Manufacturing

- **Supply chain linkages:** Most metals and minerals (nickel, platinum group metals and rare earth metals like lanthanum, yttrium and zirconium) required for manufacturing electrolysers concentrated in specific geographies, presenting supply chain risk to manufacturers.

- **Supply–demand gap:** Technological innovations to build efficiency and reduce costs, still at an evolving stage, with further investments hampered by ambiguity over demand offtake.

Investment Risks for G-H2 Production

- **Off-take risk:** Absence of long-term offtake contracts (specifying both price and volume) with strong counter-parties leading to uncertainty of revenues.

- **Project completion risk:** G-H2 projects require integration of various technologies and are faced with significant risks during early development and construction phases.

- **Infrastructure development:** Underdeveloped infrastructure for G-H2 transportation and storage infrastructure as well as grid infrastructure for absorbing increasing levels of RE.

Essential Funding Avenues to Drive Down Costs

- **Investments in supporting infrastructure** (e.g., electricity grids, RE, hydrogen transport and storage systems, manufacturing hubs) needed in parallel from both public and private sectors.

- **G-H2** prices are determined largely by the cost of electrolysers and RE. Therefore, a substantial imperative exists to establish electrolyser manufacturing, either through the utilisation of existing technologies to achieve scalability or the innovation of novel ones and to lower RE costs to further lower production costs.
Emerging Business Models: Investment Announcements by the Industry

The initiatives listed indicate emergence of business model strategies that seek to address various investment risks and barriers arising from the need for technology demonstration and the development of functioning market and value chain for G-H2 and its derivatives.

**Announcements**

**NTPC**
To develop a G-H2 hub in Andhra Pradesh consisting of RE, G-H2 and ammonia production, and manufacturing of clean technologies. Hub to cater to domestic and international demand.

**ACME Group**
Agreement with Tata Steel Special Economic Zone in Odisha to set up a large-scale G-H2 and ammonia production plants. Access to Gopalpur Port Facility for transport and exports to international markets.

**Amplus Solar**
MoU with state government of Andhra Pradesh to set up multiple decentralised G-H2 plants for consumption in multiple industries.

**Hygenco**
G-H2 offtake agreement with Jindal Stainless to build, own and operate a multi-megawatt G-H2 facility. India's first long-term off-take agreement.

**Larsen & Toubro**
Joint venture with industry majors ReNew and Indian Oil Corporation to undertake large-scale investments in G-H2 and derivatives.

**Key Features**

- Large-scale centralised model, combining investments in critical supporting infrastructure, manufacturing and deployment to capitalise on synergies and minimise costs.
- Moderate-scale centralised production model. Leverages existing infrastructure for storage, logistics and exports.
- Small-scale decentralised production model to supply G-H2 to multiple off-takers closer to consumption centers. Reduced need for transportation.
- Assured off-take of green hydrogen to manage demand (price and volume) risk.
- Strategic partnerships with industry players leveraging expertise. Co-investments for risk sharing and scaling up investments.

**Business Model Variables**

- **RE Generation**
  - On-site Generation
  - Off-site Generation with Transmission

- **G-H2 Production**
  - Centralised & Decentralised Production

- **Transportation**
  - Pipelines, Trucks, Ships

- **Storage**
  - Salt & Rock Caverns, Depleted Oil Fields, Tanks
Overview

- KfW launched the world’s first G-H2 financing platform and set up the PtX Development Fund and PtX Growth Fund.

- PtX (Power to X) means turning renewable energy like solar and wind into hydrogen.

- Germany has allocated €550 million for G-H2 in developing countries and €300 million for European company projects.

- The PtX Development Fund aids local value chains and hydrogen use in developing nations.

- The PtX Growth Fund supports international G-H2 market expansion with European company involvement.

Impact Created

- KfW Group’s PtX Platform offers funding and financial advisory for large-scale PtX projects outside Europe, acting as both a funding platform and advisor.

- It offers tailored financing (grants, debt, equity) to boost bankability in non-EU industrial PtX projects, supporting green hydrogen projects worldwide.

- It enables knowledge-sharing by allowing German and Germany-affiliated companies to invest in non-European Union (EU)/European Free Trade Association (EFTA) PtX projects.

Case Study – How a DFI is Driving G-H2 Projects

The two funds launch regular calls for expressions of interest (EoIs) for qualified applicants.

The applicants apply for grant financing by the funds and an optional/additional KfW-financing (grant, equity, debt).

In accordance with the ministries, KfW selects projects that receive the grants after a selection process based on a clearly defined criteria.

KfW provides a customised and financing package, potentially consisting of grants, equity and debt financing.
The Financing Structure

**Project Funding through the PtX - Platform**

**Ptx Platform:**
- Funding through commercial banks
- KfW Funding
- Further Sponsors

**Investor**

**Funding Package:**
- Grants for investments, grants for analysis/project studies, subsidised loans, equity capital, debt capital

**Advisory Board**

**Other Instances of Support Extended by DFIs**

**World Bank & IFC:**
Offer strategy & policy development, legal & regulatory framework build-up, capacity building support to emerging G-H2 economies.

**World Bank’s Hydrogen for Development (H4D) Partnership:**
H4D drives substantial hydrogen investment from public and private sectors, fostering capacity, regulations, and technology rollout for low-carbon hydrogen in developing nations.

**United Nations’ Green Climate Fund (GCF):**
Joined hands with IDB for first regional fund to promote electric mobility (e-mobility) and G-H2 in Latin America and the Caribbean.

**European Investment Bank:**
Supports G-H2 projects via its funding platform, InnovFin Energy Demonstration Projects, to help finance innovative first-of-a-kind demonstration projects.

**Inter-American Development Bank (IDB):**
Provides pre-feasibility studies, legal advice to governments.

The aforementioned case studies exemplify a DFI’s role in funding G-H2 projects via financial and technical assistance. It underscores the essential role of development finance in advancing the G-H2 value chain.
Green Investment Opportunities in India

Programme

Accelerating Smart Power and Renewable Energy in India

Entities involved

A bilateral programme between the Foreign, Commonwealth and Development Office (FCDO) and the Ministry of Power and the MNRE

Objective

To support the state government of Tamil Nadu to understand the value chain for electrolyser manufacturing via an assessment study.

Case Study – The UK–India Partnership for Advancing Electrolyser Manufacturing in India

The following case study exemplifies the critical role of partnerships in fostering the development of the Indian G-H2 ecosystem. This illustrative example showcases the transformative power of collaboration between countries in driving sustainable solutions for our energy needs and how the government can forge more such partnerships to build the supply chain and disseminate knowledge and expertise among the stakeholders.

Project description

- Analyse production chain for localising electrolyser manufacturing.
- Provide actionable policy recommendations to enable and facilitate electrolyser manufacturing, fostering a favourable investment environment in Tamil Nadu.
- Enhance knowledge and skills in electrolyser manufacturing, empowering local companies to participate in the G-H2 industry.

Expected outcome

Improved investment environment in Tamil Nadu and enhanced knowledge and skills in electrolyser manufacturing.
### Investor Preview: A Snapshot of the Landscape

<table>
<thead>
<tr>
<th>Country Priority</th>
<th>High</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Government aspiration to position India as a global hub for the production, usage, and export of green hydrogen</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Achieve 5 MMT/annum green hydrogen production capacity by 2030</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Support the development of green hydrogen infrastructure</strong></td>
<td></td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Policy environment</th>
<th>Supportive</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Supply-side financial incentives announced to promote commercial production of green hydrogen and electrolyser manufacturing</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Budget outlay of ₹19,744 crore (~$2.38 billion) prescribed</strong></td>
<td></td>
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<tr>
<td><strong>Emission standards prescribed</strong></td>
<td></td>
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<tr>
<td><strong>Scope to implement demand-side interventions for assurance of demand offtake</strong></td>
<td></td>
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</table>

<table>
<thead>
<tr>
<th>Mitigation potential</th>
<th>High</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Scope to abate 3.6 GtCO(_2) by 2050</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Second most important decarbonisation lever for the economy after electrification with clean energy</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Critical for decarbonising several transport and industrial sectors such as steel, ammonia, methanol, shipping, etc.</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Zero-carbon hydrogen (counting direct Scope I and II emissions) possible using electrolysis</strong></td>
<td></td>
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</table>

<table>
<thead>
<tr>
<th>Technology complexity</th>
<th>Moderate to High</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>High scope of application across major high carbon emitting sectors</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Demand expected to pick up with reduction in input costs and introduction of economic incentives for application sectors</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Investments in storage, transportation and hub infrastructure required to support the predicted demand</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Large volumes of investment announcements by large players and investments in SMEs being observed</strong></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Commercial readiness</th>
<th>Moderate</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Startups and SMEs deploying technologies across the value chain</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Large corporations setting up integrated projects</strong></td>
<td></td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Enterprise types</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Towards large-scale integrated projects being implemented by MSMEs</strong></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Investment / Funding suitability</th>
<th>Equity &amp; Debt Capital</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Towards startups and SMEs across the value chain</strong></td>
<td></td>
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</tbody>
</table>

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*Please note that the ratings provided on a “High to Low” scale here are subjective, based on the authors’ analysis and stakeholder inputs, and may not precisely mirror the market reality.*

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38 Green Investment Opportunities in India
What is Needed: A Systemic Approach

Reducing Input Costs
Increasing capacity of RE and electrolysers to in turn achieve economies of scale

Assuring Demand Off-take
Demand-side incentives or policy mandates to ensure long-term consistent offtake

Developing Value Chain
Focus on upstream, midstream and downstream linkages

Fostering Innovation
Building technological advancements to enhance efficiency and reduce cost of production processes

Fostering Collaborations
Collaborations and ecosystem partnerships between different value chain players
What is Needed: Policy

The successful advancement of the G-H2 sector hinges on a synergistic partnership between the government and the private sector. While the government sets the policy framework and provides a conducive ecosystem, the private sector brings innovation, expertise, and investment to drive tangible outcomes. This collaboration creates a dynamic environment where policy incentives and market-driven solutions converge, accelerating the adoption of G-H2 technologies. The following section highlights the policy interventions that the government should execute to build the G-H2 ecosystem in the country.

Defining sectoral transition pathway and setting decarbonisation targets

Develop sector-specific net-zero emissions (NZE) pathways and set interim and long-term decarbonisation targets.

DFIs, Industry, Academia

Advisory support for developing sectoral low-carbon transition roadmaps/pathways (at national and sub-national levels).

DFIs & Philanthropic Foundations

Knowledge-sharing resources, international best practices, guiding principles and certification standards for G-H2 projects.

Introducing demand-side incentives/mandates

Hydrogen Purchase Obligations (HPOs) for firm demand from end-user sectors. Green public procurement to create demand for green products such as steel.

Supporting infrastructure

Investments in hubs, ports, storage and transportation infrastructure for G-H2 and its derivatives.

Carbon pricing mechanisms and Carbon Contract for Differences (CCfDs)

Well designed national carbon market can help level the playing field between green and conventional technologies. CCfDs for unviable projects in the initial stages of market development.

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Well designed national carbon market can help level the playing field between green and conventional technologies. CCfDs for unviable projects in the initial stages of market development.
Building upon policy interventions, there is immense scope for private capital inflows to build financial as well as technical capacity for the sector. The following section highlights the interventions that ecosystem players can implement by advancing capital support.

## Financial and Technical Assistance for Ecosystem Building

### Challenges
- High cost of green hydrogen

### Nature of support
- Supporting innovation and scale-up of electrolyser manufacturing

### Intervention*

#### R&D Funding and Technical Assistance for Startups and SMEs
- Dedicated R&D funding and early-stage technical, knowledge sharing and mentorship support to startups engaged in electrolyser manufacturing.
- Collaboration with industry bodies for creating knowledge-sharing centres to help SMEs gain technical assistance, further fostering R&D.

#### Financing Programmes for Commercialisation of Technologies
- Public-private partnerships for setting up demonstration funds to support innovative technologies cross the valley of death and reach market.
- Investment funds with flexibility to extend grant/equity/debt/hybrid financing instrument to support early and growth-stage enterprises.

### Actors Involved

#### Financing actors:
- DFIs, Philanthropic Foundations, Incubators, Accelerators

#### Supporting actors:
- Think Tanks, Industry Associations

### Nature of support
- Lowering the cost of Round-the-Clock (RTC) renewable power and scale production of G-H2

### Intervention*

#### Blended Finance for RE, BESS and G-H2 Projects
- Use of concessional finance to provide low-cost, long-term financing for RTC (RE + Energy Storage Systems) and G-H2 production projects.

#### Credit Risk Mitigation
- Risk mitigation instruments such as credit guarantees and first loss default guarantee to improve risk appetite of lenders of RE + ESS and G-H2 projects.

### Actors Involved

#### Financing actors:
- Corporates, DFIs, Philanthropic Foundations, Impact Investors (VCs), PE, NBFCs

#### Financing actors:
- DFIs, Commercial Banks

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*Intervention details may vary based on specific context and local policies.*
## What is Needed: Capital

### Financial and Technical Assistance for Ecosystem Building

<table>
<thead>
<tr>
<th>Challenges</th>
<th>Intervention*</th>
<th>Actors Involved</th>
</tr>
</thead>
<tbody>
<tr>
<td>High cost of green hydrogen</td>
<td><strong>Technical Assistance / Project Preparatory Facility for Project Developers</strong></td>
<td><strong>Financing actors:</strong> DFIs, Philanthropic Foundations</td>
</tr>
<tr>
<td>Technical assistance and advisory support to G-H2 projects</td>
<td>• Technical advisory (sharing best practices, standards and guidelines) and financial assistance (for undertaking technical feasibility studies, impact assessment, etc.) to project developers for development and implementation of pilot projects across G-H2 value chain.</td>
<td><strong>Implementing actors:</strong> Industry Associations, Think Tanks, Consulting Firms</td>
</tr>
<tr>
<td>• Extend financial advisory to financing intermediaries for pre-investment feasibility studies and designing of financial structures.</td>
<td><strong>Market Access Platform for Value Chain Entities</strong></td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Platform linking upstream, midstream and downstream players with prospective funders, enabling price discovery and fostering partnerships.</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Challenges</th>
<th>Intervention*</th>
<th>Actors Involved</th>
</tr>
</thead>
<tbody>
<tr>
<td>High cost of green hydrogen</td>
<td><strong>Infrastructure Fund/Financing Facility</strong></td>
<td><strong>Financing actors:</strong> DFIs, Corporates, Impact Investors (VCs), PEs, Commercial Banks</td>
</tr>
<tr>
<td>Investments in G-H2 storage and transport infrastructure</td>
<td>• A public-private partnership fund / financing facility to undertake investments in hubs, and pilot and commercial scale transportation and storage projects.</td>
<td></td>
</tr>
</tbody>
</table>

*Note: Some of the interventions proposed here may have already been put into action, however, given the scope of application, the table suggests actions for implementation at scale.*
Fuelling the Clean Energy Transition

Energy Transformation

BATTERY ENERGY STORAGE SYSTEMS

Scaling robustness for RE projects

Integral to EV Charging Infrastructure

Building a reliable and robust clean energy system
The case for Lithium-Ion Batteries

Within ESS, electrochemical storage, specifically lithium-ion batteries (LIBs), has emerged as a rapidly expanding domain due to its applications in stationary storage, transportation and power grid management. These storage systems are valuable towards ensuring stability of the electricity grid, enhancing the integration of renewable energy sources and scaling up deployment of EVs. LIBs offer distinct advantages, including high power and energy density, extended operational lifespan, and reduced maintenance costs.

Understanding the BESS Value Chain

Material Sourcing
- Mining critical minerals like lithium, cobalt and nickel
- Players: Himadri, Epsilon Carbon, Allox

Cell Component Manufacturing
- Manufacturing/chemical processing of components like anodes, cathodes, electrodes, separators & casings
- Players: Log9 Materials, Godi Energy, Amara Raja, e-TRNL

Cell Manufacturing
- Manufacturing cells from cell components

Battery Pack Manufacturing & Assembling
- Configuring cells into battery packs and battery modules
- Players: Amara Raja, Exide, Log9 Materials, Cygni Energy

Stationary Storage Applications (SSAs)

Deploying

e-Mobility

Grid Management & Ancillary Services

Project developers engaged in integration and deployment of batteries across different applications.

Key Players: Greenko, Fluence India, ReNew Power

Source: Authors, 2023

BESS improves integration of variable utility-scale RE and enables provision of Round-the-Clock (RTC) power.

It reduces RE curtailment through distributed-scale and off-grid RE systems for commercial, industrial and residential (behind-the-metre) applications.

Improves RE dispatchability, firmness and penetration, ensuring stable power supply.

Application in EVs (2Ws, 3Ws and 4Ws) and supporting infrastructure (battery-as-a-service, battery swapping, RE + BESS charging stations).

BESS can improve grid resilience and power system flexibility through peak load management and energy arbitrage.

It can provide ancillary services such as frequency response, voltage control, black start, etc., to maintain grid reliability and power quality. It also optimises transmission capacity and reduces network congestion.

*We have excluded consumer electronics from the possible applications since our focus is on sectors with a climate impact.
Leveraging BESS for India’s Green Transition

BESS is critical for India to ensure a sustainable scale up of key climate impact sectors such as RE and clean mobility.

LIBs are gaining prominence over lead acid batteries (LABs) given their more superior performance and rapidly declining costs.

Alternate cell chemistries are being developed (such as sodium-ion batteries), indicating an opportunity to explore, invest and develop an ecosystem for alternative cell chemistries.

Deployment of LIBs is mainly expected in stationary storage and transportation, and high-value utilisation in ancillary services.
## The LIB Demand Outlook: A Multi-Billion Dollar Opportunity

<table>
<thead>
<tr>
<th></th>
<th>Electric Vehicles (GWh/Year)</th>
<th>Stationary Storage &amp; Other Grid Applications (GWh/Year)</th>
<th>Market Potential (US$ billion/Year)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Conservative</strong>*</td>
<td>2022</td>
<td>2026</td>
<td>2030</td>
</tr>
<tr>
<td></td>
<td>4</td>
<td>20</td>
<td>46</td>
</tr>
<tr>
<td><strong>Accelerated</strong></td>
<td>2022</td>
<td>2026</td>
<td>2030</td>
</tr>
<tr>
<td></td>
<td>11</td>
<td>51</td>
<td>130</td>
</tr>
</tbody>
</table>

*Assumes battery demand rises in line with the most conservative expert forecasts

**Assumes the current policy momentum for EVs, renewables, and other end-use applications

India aims to have EV sales accounting for 30% of private cars, 70% for commercial vehicles and 80% for 2Ws and 3Ws by 2030.

Rules mandating a shift from diesel gensets to cleaner energy, thus promoting energy storage systems.

Need for ESS to integrate variable RE. Recently discovered hybrid RE + BESS tariffs stand competitive against new thermal power.

### BESS: Other Drivers

**Rapidly declining costs**: LIB costs have fallen over 90% in the last decade and are expected to fall further to $100/kWh by 2023 and $58/kWh by 2030.

**Strengthening policy & regulatory environment**: This has been good news for application of BESS in stationary storage and grid management.

**Roll-back of net-metering policies**: This has led to reduction of credits for sending excess energy back to the grid. It incentivises energy storage and maximisation of self-consumption in distributed applications.

**Repurposing of EV battery packs for second-life application**: This has resulted in second life application in energy storage services that thereby adding salvage value and improving life cycle economics.
Emerging Industry Trends

- **Cells:** 65% of total cost
  - Currently large dependence on imports. Domestic production capacities/Gigafactories being established. New cell chemistries being developed.

- **Batteries:** 15% of total cost
  - Battery pack manufacturers & assemblers moving from LABs to LIBs. Backward integration noted as they move towards cell production.

SMEs and large project developers deploying batteries in various applications. Massive scale up in deployment expected over next few years.

**Key Trends**

Source: Authors, 2023

**Decoding the Industry Dynamics**

- The immediate requirement is to accelerate deployment of BESS and scale-up of cell and battery manufacturing facilities in India to meet the growing demand.
- Adequate funding is crucial to support R&D efforts, technology innovation, and infrastructure development across the value chain.
Powering BESS Growth: Key Policy Enablers

- **National Programme on Advanced Cell Chemistry (ACC) Battery Storage**: PLI scheme launched worth $2.4 billion to promote domestic cell manufacturing\(^4\).

- **The Electricity (Promotion of Generation of Electricity from Must-Run Power Plant) Rules**: Mandating compensation for must-run RE plants to prevent curtailment, thus incentivizing ESS adoption\(^5\).

- **ESS projects** commissioned before October 1, 2023, not required to pay inter-state transmission charges for 25 years\(^6\).

- **Electricity (Amendment) Rules, 2022**: Grant legal status to ESS\(^7\).

- **Ancillary Services Regulation**: Term “energy storage” included under secondary and tertiary reserves with performance-based incentives by the Central Electricity Regulatory Commission (CEA)\(^8\).

- **BESS guidelines**: Procurement and utilisation of BESS as part of generation, transmission and distribution assets, and ancillary services\(^9\).

- **The Electricity (Rights of Consumers) Amendment Rules**: Mandates consumers using diesel gensets to transition to cleaner energy within 5 years\(^10\).

- **Energy Storage Obligation**: RE along with storage to comprise 4% of total consumption of discoms by 2030\(^2\).

- **Energy Storage Obligation**: RE along with storage to comprise 4% of total consumption of discoms by 2030\(^2\).

- **Viability Gap Funding (VGF) Approved for BESS projects**: Initial capital outlay of ₹9400 crore (~$ 1.1 billion), with budgetary support of ₹3760 crore (~$455 million) for development of 4,000 MWh of BESS projects by 2030-31. Financial support of up to 40% of the capital cost aimed to reach a levelised cost of storage of ₹5.5 - 6.6 ₹/kWh.

- **Guidelines for the third phase under The FAME (Faster Adoption and Manufacturing of Electric Vehicles Scheme) drafted specifying an outlay of ₹40,000-₹50,000 Crore (~$5-$7 billion)\(^5\). This is a follow up to FAME I and FAME II aimed at financially incentivising the EV industry.

The Framework released in August 2023, unveils a comprehensive strategy; a timeline for implementation of the same is yet to be specified

- **Sovereign green bonds** for funding green infrastructure. Financial institutions like Power Finance Corporation (PFC), Rural Electrification Corporation (REC) and Indian Renewable Energy Development Agency (IREDA) may extend long-term loans to ESS projects.

- Principles of reduce, reuse, and recycle may be included in the bidding documents of all ESS projects.

- Mandates for **ESS installation in new RE projects** above 5 MW.

- Investing in **R&D** of emerging and existing ESS technologies.

- ESS using RE for charging may be provided with **carbon credits**, improving project economics.

- **Tax incentives and exemption of Electricity Duty (ED) and Cross Subsidy Surcharge (CSS)** on input power. States may also exempt land acquisition for ESS.

- Central Electricity Authority (CEA) **safety and technical standards** may be updated to cover ESS.

- Financial assistance and advisory for PSUs to undertake **pilot/demonstration projects**.

- Standards for repurposing ESS components for reuse in different applications. **Guidelines for developing resource adequacy plans** incorporating ESS to be issued by Central Government in consultation with the CEA. CEA to also release long-term national resource adequacy plan for next 10 years.

- Comprehensive and integrated regulations and policies that govern ESS revenue sources to facilitate ease of doing business.

- ESS developers to offer **various market-based energy and power products**, encouraging financial and commercial viability.

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**Policy’s Catalysing Role**

The policies introduced by the Government of India signal a strong commitment to promoting domestic battery manufacturing and battery energy storage. As the policy environment strengthens there is an strong case for continued action and detailed implementation plans for value chain development, from both public and private players.
Enterprise Focus across Key Segments: A Closer Look

Cell Manufacturers
- Companies establishing large-scale cell manufacturing facilities
- MSMEs developing newer chemistries

Battery Pack Manufacturers & Assemblers
- Players establishing production capacities to ensure scalability
- Battery manufacturers & assemblers backward integrating as they move towards cell manufacturing

Project Developers
- Players developing RE + BESS projects for EVs, charging infrastructure and grid services

Sector Level Challenges towards Deployment & Scaling

Reliance on imports:
In 2020-21, the India LIB import bill stood at ~$1,193 million, with China and Hong Kong combined accounting for 87% of imports, presenting a risk of supply chain disruption and price volatility. The absence of an established domestic supply chain for battery manufacturing is a critical challenge. Coupled with limited understanding with consumers and financers on emerging battery technologies and the high capital expenditure involved, this creates constraints for ecosystem-level investments at scale.

Challenges for Battery Storage Deployment Projects
- High upfront costs hinder RE + storage system adoption.
- Consumers perceive energy storage as complex, unwanted, and costly.
- Technical risk in integrating cell packs and battery management systems for safe charge/discharge.
- Lack of clear policy framework and pricing mechanisms for ancillary services.
- Limited financial support to early movers and lack of access to low-cost, long-term financing, particularly for small players.

Challenges for Cell Manufacturing, Battery Pack Manufacturing & Assembling
- Very high capital investment required to set-up manufacturing facilities.
- High technological complexity, lack of technical skills and manufacturing capabilities.
- Cost-effective supply of critical raw materials needed.
- Significant R&D investment and continuous adaptation needed to emerging technologies.

Overcoming Challenges to Secure the Supply Chain
- High dependence on import of critical minerals and LIBs is challenging. Battery recycling and reuse ecosystem needed to reduce its import dependence and meet increasing demand. End-of-life batteries also hold potential for second life applications.
- Investments in R&D of alternative battery chemistries, an important consideration for India to achieve sustainable supply chain less dependent on critical minerals.
Funding Landscape: Noteworthy Investments in SMEs and Startups

<table>
<thead>
<tr>
<th>Company</th>
<th>Purpose</th>
<th>Fund Raising</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grinntech²⁸</td>
<td>To enhance performance of its EV batteries; and introduce high-tech batteries along with its proprietary IoT-enabled BMS.</td>
<td>(2021) $2 million (equity) from existing investors including HNIs</td>
</tr>
<tr>
<td>Cygni Energy²⁹</td>
<td>To build a battery manufacturing gigafactory in Telangana and scale its manufacturing capacity by over 4x.</td>
<td>(2022) $12.5 million led by Meridian Global Ventures (equity) and Indian Overseas Bank (debt)</td>
</tr>
<tr>
<td>Battery Smart³⁰</td>
<td>To expand its battery-swapping business across geographies.</td>
<td>(2023) $33 million from Tiger Global, Blume Ventures, the Ecosystem Integrity Fund and British International Investment (equity)</td>
</tr>
<tr>
<td>Log9 Materials³¹</td>
<td>To expand its battery manufacturing capabilities and commission India’s first fully integrated lithium-ion cell production line.</td>
<td>(2023) $40 million led by Amara Raja Batteries and PETRONAS (equity+debt)</td>
</tr>
<tr>
<td>Godi Energy³²</td>
<td>To set up supercapacitor and lithium-ion cell manufacturing facilities across India.</td>
<td>(2021) $4.52 million from Blue Ashva Capital (equity)</td>
</tr>
</tbody>
</table>

Priority Areas

- **Battery Pack Manufacturers & Assemblers**
- **Battery Pack Manufacturers & Assemblers + Deployment**
- **Deployment**
- **Cell + Battery Pack Manufacturers & Assemblers**
## Industry Gears up: Investment Announcements

<table>
<thead>
<tr>
<th>Company</th>
<th>Project Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Amara Raja</td>
<td>Gigafactory in Telangana to manufacture lithium-ion cells and batteries with an R&amp;D centre.</td>
</tr>
<tr>
<td>Exide</td>
<td>Lithium-ion cell and battery manufacturing gigafactory in Bengaluru with a capacity of 6 GWh.</td>
</tr>
<tr>
<td>Ola Electric</td>
<td>Manufacturing of electric cars; Lithium-ion cell gigafactories coming up in Tamil Nadu.</td>
</tr>
<tr>
<td>TDSG</td>
<td>Lithium-ion cell and battery manufacturing plant in Gujarat. To produce 30 million cells/year by 2025.</td>
</tr>
<tr>
<td>TATA Power</td>
<td>Lithium-ion cell and battery manufacturing gigafactory in Gujarat with capacity of 20 GWh.</td>
</tr>
</tbody>
</table>

### Priority Areas

<table>
<thead>
<tr>
<th>Year</th>
<th>Project Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>2021</td>
<td>Planned investment of ~$1 billion over the next 10 years</td>
</tr>
<tr>
<td>2022</td>
<td>Planned investment of ~$800 million over the next 8-10 years</td>
</tr>
<tr>
<td>2023</td>
<td>Planned investment of ~$920 million</td>
</tr>
<tr>
<td>2020</td>
<td>JV between Suzuki Motor Corp., Toshiba Corp. and Denso Corp. To invest ~$689 million over 2 phases</td>
</tr>
<tr>
<td>(2023)</td>
<td>Planned investment of ~$1.58 billion</td>
</tr>
</tbody>
</table>

### Projects

| Battery Pack Manufacturers & Assemblers | Battery Pack Manufacturers & Assemblers + Deployment | Deployment | Cell + Battery Pack Manufacturers & Assemblers |

## A Case for Collaborations

### India’s first grid-scale battery-based energy storage system

**Project Developers:** TATA Power, AES Corporation, Mitsubishi Corporation  
**BESS Deployer:** Fluence India

The 10 MWh grid connected system, located at Delhi, is being operated by Tata Power Delhi Distribution Limited (Tata Power-DDL) and provides grid stabilisation, better peak load management, added system flexibility, enhanced reliability thereby protecting critical facilities for 2 million consumers served by Tata Power-DDL. Fluence India acts as the technology provider for deployment of battery storage.

Such collaborations between project developers and BESS deployers highlight the potential for collaborations resulting in the development of the BESS value chain.
Global Energy Storage Program: A Collaborative Effort

The Global Energy Storage Program (GESP) is a funding window under the Clean Technology Fund (CTF) - one of the two multi-donor trust funds of the Climate Investment Funds (CIF)- making CIF the world’s largest multilateral fund supporting energy storage. GESP is a global partnership of governments, development finance institutions, and private corporations committed to delivering on a climate-smarter future through energy storage technologies.

Geographies covered: Sub-Saharan Africa, Middle East & North Africa, Asia, Europe & Central Asia, Latin America & The Caribbean

Scope of the Programme

- Storage systems, including, but not limited to, gravity-based technologies, thermal storage, and electrochemical batteries
- Large-scale demonstration projects supporting less mature, but technically viable, long-duration storage technologies
- Solar, wind, and hybrid power projects with storage for grid services; Mini-grids and distributed energy applications
- Policy and regulatory reforms that promote:
  - Battery recycling
  - Environmentally friendly storage technologies
  - Participation of full range of energy storage services
- International cooperation initiatives to address key research, development, and knowledge gaps

Funding from CIF is only accessible through DFIs who serve as implementing partners.

Programme focuses on concessional finance, including but not limited to grants, to mobilise DFIs as well as other public and private sector financing.

Emulating a programme of this caliber can help solve the sector’s current challenges. Nevertheless, realising this objective hinges on the enthusiastic participation of the private sector and a proactive stance from government policies. This collaborative endeavour involving governmental bodies, public and private stakeholders sets forth a promising blueprint for energising sectoral expansion, capable of fostering sustainable and ingenious solutions. The pivotal role played by DFIs in propelling sectoral growth is further underscored by the subsequent case study:
The Role of Development Finance: ADB-funded Tata Power’s BESS Pilot

**Project:**
Tata Power Delhi Distribution Limited (Tata Power DDL) Battery Energy Storage System (BESS) Pilot Project

**Scope:**
Set up a 10-MWh BESS to reduce grid instability and integrate renewable energy.

**Financing:**
$2 million grant from the Climate Innovation and Development Fund and Goldman Sachs, administered by the Asian Development Bank.

**Programme description:**
South Asia’s first grid-scaled BESS at the distribution transformer level enabling electricity storage and on-demand delivery, reducing grid instability and facilitating RE integration.

**Expected outcome:**
A resilient power distribution system for New Delhi, with improved RE integration and valuable insights for future BESS projects, contributing to India’s clean energy goals.

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The Faraday Institution: Pioneering Research in Cell Chemistries

**Programme:**
Faraday Institution - the UK’s flagship battery research programme

**Objective:**
Pioneering research in electrochemical energy storage research while simultaneously working on skill development, market analysis, and early-stage commercialisation.

**Programme description:**
- **Faraday Institution Research Initiative:** Collaborative research combining scientists and industry partners to reduce battery cost, weight, and volume, enhancing performance and reliability
- **Interreg North-West Europe (NWE) STEPS Programme:** Strengthening competitiveness of innovative energy storage providers through a demand-driven approach to expedite product development.

**Expected outcome:**
Shorten typical technology demonstration timeline for energy storage SMEs from an average of 5 years to 1-2 years.
## Investor Preview: A Snapshot of the Landscape

<table>
<thead>
<tr>
<th>Category</th>
<th>Rating</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Country priority</strong></td>
<td>High</td>
<td>Critical pathway towards ensuring uninterrupted supply of energy generated from renewable sources. Regarded as most efficient energy storage systems for India’s area of focus - electric vehicles (EVs)</td>
</tr>
<tr>
<td><strong>Policy environment</strong></td>
<td>Supportive</td>
<td>National Framework launched to promote and deploy Energy Storage Systems (ESS) in stationary storage and grid management. Viability Gap Funding schemes announced for Battery Energy Storage Systems (BESS). Production Linked Incentive (PLI) schemes for developing a domestic battery manufacturing chain. Transmission charges waived (up to 2025) for renewable energy (RE) developers, including BESS.</td>
</tr>
<tr>
<td><strong>Mitigation potential</strong></td>
<td>High</td>
<td>Key technology for scaling up RE generation, reliable and flexible grid infrastructure and EVs. Indirect mitigation in power and transport sectors, which together account for 44% of India’s total CO₂ emissions.</td>
</tr>
<tr>
<td><strong>Technology complexity</strong></td>
<td>High</td>
<td>Ability to be deployed swiftly at scale compared to other energy storage technologies. Rapidly declining costs increasing cost competitiveness for deployment in stationary grid applications and EVs. Lithium-ion batteries high on efficiency and salvage value, making them suitable for multiple applications.</td>
</tr>
<tr>
<td><strong>Commercial readiness</strong></td>
<td>Moderate to High</td>
<td>Startups and SMEs innovating with battery pack manufacturing and alternate cell chemistries, developing distributed-scale RE + BESS projects, battery swapping and battery-as-a-service. Large corporations setting up integrated cell manufacturing projects and developing utility-scale RE + BESS projects, charging infrastructure.</td>
</tr>
<tr>
<td><strong>Enterprise types</strong></td>
<td></td>
<td>Towards cell and battery pack manufacturers. Towards project developers of stationary storage projects.</td>
</tr>
<tr>
<td><strong>Investment or Funding suitability</strong></td>
<td></td>
<td>Towards startups innovating in the development of alternate battery chemistries. Towards startups and SMEs developing distributed-scale RE + BESS projects and providing battery-as-a-service.</td>
</tr>
</tbody>
</table>

*Please note that the ratings provided on a “High to Low” scale here are subjective, based on the authors’ analysis and stakeholder inputs, and may not precisely mirror the market reality.*
## What is Needed: Building the Value Chain

<table>
<thead>
<tr>
<th>Developing Value Chain</th>
<th>Knowledge Sharing</th>
<th>Building Ecosystem for Battery Recycling</th>
</tr>
</thead>
<tbody>
<tr>
<td>Focussing on material sourcing, cell manufacturing, and battery pack manufacturing and assembling</td>
<td>Enabling investors and lenders to understand the value proposition of BESS</td>
<td>Creating Material Circularity to help lower the costs of critical minerals and metals</td>
</tr>
</tbody>
</table>

### Fostering Innovation
- Introducing novel cell chemistries to enhance efficiency and reduce import reliance

### Fostering Collaborations
- Creating ecosystem partnerships between different value chain players

## What is Needed: Policy

The BESS sector’s requirements can be summarised into three key facets - scalability, innovation, and a favourable policy environment. Consequently, to nurture the sector’s progress, it becomes imperative for both the private sector and the government to take proactive measures in creating a harmonious ecosystem that fosters its growth. The ensuing section elucidates the interventions, delineating the role that policy can enact to ensure the robust advancement of BESS.

### Domestic exploration and international partnerships
- Bolster efforts to domestically explore deposits of critical minerals. Trade partnerships with resource-rich countries to secure supply of raw materials to boost domestic manufacturing

### Industry Associations, DFIs
- Industry associations to spearhead domestic exploration efforts; DFIs to help build international partnerships.

### Material circularity to reduce import dependence
- Strengthening the ecosystem for battery recycling to improve mineral recovery. International cooperation for development and sharing of technologies required.

### DFIs, Academia
- Create framework for specialised fund enabling research and deployment of sustainable battery recycling technologies.
**What is Needed: Policy**

### Market expansion for ancillary services, enabling BESS value stacking
Accelerate efforts to expand and streamline the Secondary and Tertiary reserve ancillary services markets at Central and State level. Introduce Primary Reserve Ancillary Services (PRAS) market and ensure ESS is eligible to participate in PRAS.

### Skill development and technology transfer programme
Public and private funded programs for improving battery technology know-how by training of workforce and transfer of manufacturing technologies.

### Inclusion of BESS in energy systems planning
Include BESS in National Energy Policy as key technology to enable higher penetration of RE, provide grid management services, and electrify transport. National RE targets could be linked to those for BESS.

### Investing in R&D for creating alternative chemistries
Investments in R&D of alternative cell chemistries, enabling development and commercialisation of high performance BESS suitable for the Indian context.

### Scaling demand for BESS
Planning and investments in EV charging infrastructure needed to address range anxiety, which will promote faster adoption of battery EVs. Introduce time of day (ToD) pricing, enabling BESS adopters to benefit from price differential between peak and off-peak tariffs.

### Industry Associations
Support design, development and scaling up of ancillary services markets.

### DFIs, Industry Associations
Facilitate public-private partnerships to promote workforce training and technology transfer, enhancing industry expertise.

### DFIs
Share knowledge resources, international best practices, guiding principles for integration of BESS in energy system.

### Enterprises, Academia
Collaborate with government to fund and shape R&D programmes, and facilitate knowledge sharing.

### Corporates, Academia, Think Tanks
Public-private partnerships for charging infrastructure. Advisory support for developing ToD tariff structures.
What is Needed: Capital

While the previous section delved into the government’s role in shaping policy interventions, the following section focuses on the critical role the private sector must play in advancing the BESS sector. It outlines key interventions and initiatives that private stakeholders should undertake to foster the robust development of this domain.

Financial and Technical Assistance for Creating a Conducive Investing Environment

<table>
<thead>
<tr>
<th>Challenges</th>
<th>Nature of support required</th>
</tr>
</thead>
<tbody>
<tr>
<td>Limited focussed support for innovation and scaling up of early-stage enterprises</td>
<td>Support early and growth stage enterprises across the BESS value chain - cell manufacturing, battery assembly, battery deployment and battery recycling</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Intervention*</th>
<th>Actors Involved</th>
</tr>
</thead>
<tbody>
<tr>
<td>Research, development &amp; demonstration (RD&amp;D) Facilities</td>
<td>Financing actors: Philanthropic Foundations, Accelerators, Incubators, Governments, DFIs, Impact Investors (VCs)</td>
</tr>
<tr>
<td>• RD&amp;D funding programmes for development and demonstration of alternative/advanced chemistry cells.</td>
<td>Implementing actors: Investors, Consulting Firms, Industry Associations</td>
</tr>
<tr>
<td>• Knowledge-sharing platforms/centres for sharing best practices, international standards and guidelines on technology development and associated policy and regulatory frameworks.</td>
<td>Financing actors: Philanthropic Foundations, DFIs, Impact Investors (VCs), PEs, NBFCs</td>
</tr>
</tbody>
</table>

- **Project preparatory / technical assistance facilities for early-growth stage enterprises**
  - Provide project preparation support - technical advisory, feasibility studies, market assessments, project development support - for SMEs to address investment barriers, particularly in the cell and battery manufacturing, and distributed-scale stationary storage segments.
  - Facilitate networking and partnerships with investors and large corporate players in the EV and RE sectors.

- **Dedicated funding programme for scaling up BESS enterprises**
  - Investment funds with flexibility to extend grant/ equity/ debt blended financing and long investment horizons to support scaling up of growth stage enterprises, particularly for capex-heavy manufacturing and businesses.
What is Needed: Capital

Financial and Technical Assistance for Creating a Conducive Investing Environment

<table>
<thead>
<tr>
<th>Challenges</th>
<th>Intervention*</th>
<th>Actors Involved</th>
</tr>
</thead>
<tbody>
<tr>
<td>Limited understanding and awareness of BESS</td>
<td><strong>Technical assistance, capacity building, knowledge sharing and market places on BESS</strong></td>
<td>Financing actors: Philanthropic Foundations, DFIs</td>
</tr>
<tr>
<td></td>
<td>• Research, advisory and effective communication of the value proposition and the differentiated role of BESS against other energy storage alternatives to all stakeholders, to improve the awareness of the wide-ranging use-cases of BESS.</td>
<td>Supporting actors: Consulting Firms, Industry Associations</td>
</tr>
<tr>
<td></td>
<td>• Technical assistance and capacity building programmes for FIs for conducting appraisals of BESS projects.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Knowledge hubs dedicated to the BESS value chain for sharing research, policy and regulatory announcements, updates on latest developments in the sector.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Online marketplace development for connecting businesses with investors and consumers, and consumers with asset financiers.</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Challenges</th>
<th>Intervention*</th>
<th>Actors Involved</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dependence on international supply chains and imports</td>
<td><strong>Improve ecosystem for battery recycling and reuse</strong></td>
<td>Financing and Implementing actors: Corporates</td>
</tr>
<tr>
<td></td>
<td>• Partnerships between EV sector OEMs, battery recyclers and RE project developers for sourcing, re-purposing and reuse of EV batteries in stations storage applications.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Co-investments by partners in developing the supporting infrastructure required for managing end-of-life batteries.</td>
<td></td>
</tr>
</tbody>
</table>
## What is Needed: Capital

### Financial and Technical Assistance for Creating a Conducive Investing Environment

<table>
<thead>
<tr>
<th>Challenges</th>
<th>Nature of support required</th>
</tr>
</thead>
<tbody>
<tr>
<td>Access to low cost finance for projects and consumers</td>
<td>Increase finance for stationary storage and e-mobility applications</td>
</tr>
</tbody>
</table>

#### Intervention*

**Low-cost financing for project developers of stationary storage projects**
- Increase provision of blended finance instruments, both equity and debt, to mobilise private investments in BESS projects.
- Large companies to increasingly consider tapping into domestic and international markets to raise low-cost capital through available instruments such as green and sustainability-linked bonds and loans.

**Credit risk mitigation instruments for lenders**
- Extend risk mitigation instruments such as credit guarantees and first loss default guarantee to FIs lending to the BESS sector

**Enabling low-cost EV financing**
- Improve affordability of EV adoption by providing low-cost, end-user financing to consumers.

#### Actors Involved

**Financing actors:**
DFIs, Governments, NBFCs, Commercial Banks, Corporates

**Supporting actors:**
Consulting Firms, Industry Associations

*Note: Some of the interventions proposed above may have already been put into action, however given the scope of application, the table above suggests actions for implementation at scale.*
Food, Agriculture and Livestock

CLIMATE SMART AGRICULTURE

Transforming India’s Priority Sector

Agriculture: A victim of as well as contributor to climate change

Share to GHG emissions: ~14%
Crop losses: ~50%

Climate Smart Agri practices - Pathway to mitigate and adapt to climate change
### Impact of Climate Change and Sources of GHG Emissions across Agricultural Value Chain

<table>
<thead>
<tr>
<th>Pre-production</th>
<th>Production</th>
<th>Processing</th>
<th>Marketing</th>
<th>Consumption</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Sources of Emissions</strong></td>
<td><strong>Sources of Emissions</strong></td>
<td><strong>Sources of Emissions</strong></td>
<td><strong>Sources of Emissions</strong></td>
<td><strong>Sources of Emissions</strong></td>
</tr>
<tr>
<td>- Land use</td>
<td>- Soil and manure management</td>
<td>- Energy intensive processing machinery</td>
<td>- Transportation emissions</td>
<td>- Food wastage</td>
</tr>
<tr>
<td>- Application of nitrogen fertilisers</td>
<td>- Methane emissions from crop cultivation</td>
<td>- Crop wastage</td>
<td>- Food wastage</td>
<td>- Shifts in consumption patterns</td>
</tr>
<tr>
<td>- Energy intensive cold storage</td>
<td><strong>Impact of Climate Change</strong></td>
<td><strong>Impact of Climate Change</strong></td>
<td><strong>Impact of Climate Change</strong></td>
<td><strong>Impact of Climate Change</strong></td>
</tr>
<tr>
<td></td>
<td>- Reduced seed quality (poor germination)</td>
<td>- Reduced yield</td>
<td>- Congestion/ damage to transportation routes</td>
<td>- Inconsistency in availability of agri commodities</td>
</tr>
<tr>
<td></td>
<td>- Low availability of resilient varieties</td>
<td>- Crop failure</td>
<td>- Higher moisture content</td>
<td>- Price volatility</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Poor growth/ stunting/rotting</td>
<td>- Lower prices for farmers</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Additional time and labour required for weeding, harvesting and drying</td>
<td>- Increased food losses in processing</td>
<td></td>
</tr>
</tbody>
</table>

- Source: International Institute for Sustainable Development (IISD)

Given the duality of the agricultural sector with regards to climate, effective mitigation measures and appropriate adaptation technologies must be taken to reduce GHG emissions from the sector and make it resilient to the impacts of climate change.

### India’s Climate Smart Agriculture Landscape

Climate Smart Agriculture (CSA) is an integrated approach aimed at transforming the agricultural value chain towards green and climate resilient practices, while enhancing productivity and food security. Given the diversity of agro-ecological regions and land holdings in India, a one-size-fits-all set of practices cannot be adopted by every farmer. These practices need to be localised, based on the extent of vulnerability to climate change, nature and size of farmlands, and types of crops sown.

CSA includes an array of climate resilient and green practices driven by a combination of data analytics, innovative technologies and practices, and traditional knowledge. While such approaches help to sustainably increase agricultural productivity and incomes, given the majority are smallholder farmers, there is an equal need to bring behavioural change among farmers. It can be through:

- **Guaranteed income support:** Providing income assurance during the transition to green practices.
- **Reduced upfront costs:** Offering grants and subsidies to lower adoption costs.

### Decoding Adoption of CSA

The combination of behavioural change and reduced adoption costs will play a pivotal role in driving the widespread adoption of climate smart practices, benefiting farmers and India’s sustainability goals.
The Evolving Industry Landscape

<table>
<thead>
<tr>
<th>Input Suppliers</th>
<th>Farmers / Farmer Producer Organisation (FPOs) / Farmworkers</th>
<th>Traders</th>
<th>Wholesalers &amp; Retailers</th>
<th>Consumers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Climate Resilient Seeds</td>
<td>Low Carbon Fertilisers</td>
<td>Soil Health Monitoring</td>
<td>Crop Health Monitoring</td>
<td>Robotic Agriculture</td>
</tr>
</tbody>
</table>

Source: Authors, 2023
Emerging landscape of the Agricultural Sector

<table>
<thead>
<tr>
<th>Increasing awareness towards new age practices</th>
<th>Utilising weather monitoring to plan farm activities</th>
</tr>
</thead>
<tbody>
<tr>
<td>Example: Using climate resilient seeds, low carbon fertilisers and climate smart farming equipment (drip, sprinklers etc) that improve farm yield</td>
<td>Example: Farmers using rain forecasts during sowing/ harvesting/ spraying chemicals</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Minimising intermediaries</th>
<th>Building Climate resilience as well as livelihoods</th>
</tr>
</thead>
<tbody>
<tr>
<td>Example: Enterprises building market linkages for farmers, assuring sale of farm produce</td>
<td>Example: Sowing climate resilient crops, optimising usage of farm, and organic farming practices to increase avenues for farm revenue</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Creating Ecosystem partnerships</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Example: Enterprises building partnerships with FPOs and civil society organisations to improve awareness and technical capacity of farmers</td>
<td></td>
</tr>
</tbody>
</table>

Source: Author’s analysis and references from the report by The Nudge Institute: ‘Smallholder Farmers & Climate Change’
### Climate Smart Agriculture Solutions

<table>
<thead>
<tr>
<th>Category</th>
<th>Solution</th>
<th>Application</th>
<th>Startups*</th>
<th>Mitigation/Adaptation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Climate Smart Agri Inputs</td>
<td>Climate Resilient Seeds</td>
<td>To use locally adapted and improved seeds that are heat and drought tolerant.</td>
<td><a href="#">SAHAJA SEEDS</a></td>
<td>![Green Leaf]</td>
</tr>
<tr>
<td></td>
<td>Low Carbon Fertilisers</td>
<td>Use of low carbon and organic fertilisers to reduce GHG emissions, reduce soil degradation and improve production quality.</td>
<td><a href="#">GREENSTAR</a></td>
<td>![Green Leaf]</td>
</tr>
<tr>
<td>Precision Agriculture &amp; Robotics</td>
<td>Soil Health Monitoring</td>
<td>Monitoring to help with informed and sustainable soil management practices to address climate change induced changes in soil nutrient balance, fertility, erosion and degradation.</td>
<td><a href="#">KRISHITANTRA</a></td>
<td>![Green Leaf]</td>
</tr>
<tr>
<td></td>
<td>Robotic Agriculture</td>
<td>Robots to automate labour intensive farming tasks such as planting seeds, weed control, spraying fertilisers, harvesting, crop monitoring and soil analysis.</td>
<td><a href="#">NIQO ROBOTICS</a></td>
<td>![Green Leaf]</td>
</tr>
<tr>
<td></td>
<td>Crop Health Monitoring</td>
<td>To assist farmers identify disease outbreaks and nutrient deficiencies, and make more informed decisions to ensure climate proofing of crops and optimal yield.</td>
<td><a href="#">pixcel</a>, <a href="#">Fasa</a></td>
<td>![Green Leaf]</td>
</tr>
<tr>
<td>RE Powered Storage &amp; Processing</td>
<td>Cold Storage</td>
<td>RE powered cold storage to reduce energy emissions, food wastage and pest incidences due to climate change induced increase in temperatures and humidity.</td>
<td><a href="#">ecozien</a>, <a href="#">S4S</a></td>
<td>![Green Leaf]</td>
</tr>
<tr>
<td></td>
<td>Food Processing &amp; Harvesting</td>
<td>To overcome the short shelf life of agriculture produce and reduce post-harvest losses that in turn reduce emissions and enhance food security.</td>
<td><a href="#">ecozien</a>, <a href="#">S4S</a></td>
<td>![Green Leaf]</td>
</tr>
</tbody>
</table>

*Note: The list of startups mentioned above are illustrative and not exhaustive.*
In a Nutshell

- These solutions, encompassing both upstream and midstream solutions, prioritise reducing the impact of climate change, while enhancing income and yields at both individual farm and farmer levels.

- The relevance of technology driven solutions that monitor crop growth and yield holds ground with financing intermediaries as they seek to use farm and farmer level data to improve visibility of the agricultural activity, thereby aiding credit underwriting.

Applications of Climate Smart Agriculture Solutions

Agriculture Intermediaries

- While upstream and midstream solutions lend their direct usage by farmers, some solutions have potential to engage with agri intermediaries, including large corporates, widening their depth and scope of impact and application.

- The increasing impact of CSA solutions can be found in sectors such as FMCG, food processing as well as among the average consumer.

- The impact of these solutions can be maximised by localising them to meet the requirements of different value chain players.

Agriculture Financing

- Farm and farmer level data insights gathered by agri solutions hold the potential to aid traditional credit underwriting, thereby holding potential to fasten lending decisions, bring operational efficiency and enable new-to-credit farmers with access to credit.

- Climate and weather data enable building a framework for timely assessment of yield losses, giving way to a weather index-based parametric insurance model, leading to timely crop insurance payouts.

Solutions hold potential for building a pathway to a robust agriculture financing system.

With the applicability of climate smart agriculture solutions across the agri value chain, we witness a few climate smart agricultural enterprises witnessing increasing adoption among the farmers and other stakeholders in the value chain. The following section helps in understanding their business model and their unique features.
### Noteworthy Mentions

<table>
<thead>
<tr>
<th>Name</th>
<th>Solution offered</th>
<th>Value chain stage</th>
<th>Unique about the business</th>
<th>Nature of funding</th>
<th>Latest funding stage</th>
</tr>
</thead>
</table>
| Fasal         | Crop intelligence system          | Pre-Harvest & Harvest       | 1. Localised and tailored crop and farm specific advisory services for farmers to grow better and reduce losses.  
2. Incentivising farmers to use their solutions to save water by offering them monetary benefits.     | Grant, Equity          | Seed                               |
| S4S Technologies | Solar powered food dehydrator   | Post-harvest                | 1. Gender lens focus by tying up with women farmers.  
2. Enabling market linkages & assurance of produce offtake.  
3. Improved quality assurance & input traceability for buyers.  
4. Enabling access to affordable financing for the purchase of CSA solutions | Grant, Equity, Debt  | Series A                           |
| Cropin        | Crop intelligence system          | Pre-Harvest & Harvest       | 1. Platform enabling market linkages for farmers  
2. Partnerships with agri input companies, agri businesses and lending/insurance companies to offer real-time soil & crop monitoring insights and develop localised farmer-centric solutions.  
3. Farm-to-fork traceability to assure quality produce to buyers.     | Equity, Debt           | Series C                           |

### Enabling access to finance
- To purchase climate smart solutions

### Enabling access to markets
- To assure a price and a buyer for agri produce

### Creating awareness programmes
- To build technical & technological understanding at last mile

### Sharing information & resources
- To address agri value chain inefficiencies

---

**Key strategies that helped these enterprises scale up**
Policy as a Strategic Enabler for Progress and Growth

Enterprises along the agri value chain need technical capacity building as well as financial support to achieve impact and commercial viability at scale. Given the priority sector status of the sector and the geographical variations in farm economics and behaviour, different policy interventions—at both the Central and state levels—have come recently, underscoring the criticality and focus towards climate resilient agri practices.

Nationally Determined Contributions under Paris Agreement
Emphasises agriculture as a priority adaptation sector for the country.

National Mission for Sustainable Agriculture
Enables sustainable agricultural practices in India through adaptation measures such as improved crop seeds, water use efficiency, pest management, nutrient management, access to Information, etc.

National Adaptation Fund for Climate Change
Focusses on enabling climate resilient agriculture across climate vulnerable geographies.

Sub-Mission on Agricultural Mechanisation
Facilitates the adoption of drones for assessing crop damage, applying pesticides and fertilisers, and combatting locust invasions.

National Initiative on Climate Resilient Agriculture
Improves resilience and reduces climate vulnerability of the sector through strategic research and technology demonstration.

The Agriculture Accelerator Fund
Provides early-stage funding to innovative AgTechs, acting as a catalyst for Indian agtechs to scale.
### The SDG Lens: Achieving social impact at scale

<table>
<thead>
<tr>
<th>SDG Goal</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. IMPROVING LIVELIHOODS</td>
<td>Zero Hunger</td>
</tr>
<tr>
<td>2. INCREASE YIELD</td>
<td>No Poverty</td>
</tr>
<tr>
<td>5. TARGETED IRRIGATION</td>
<td>Clean Water &amp; Sanitation</td>
</tr>
<tr>
<td>8. GIVING THE POWER OF INFORMATION</td>
<td>Decent work &amp; Economic growth</td>
</tr>
<tr>
<td>11. IMPROVED INTEGRATION</td>
<td>Sustainable Cities &amp; Communities</td>
</tr>
<tr>
<td>12. MONITOR WASTE PRODUCTION</td>
<td>Responsible consumption and production</td>
</tr>
<tr>
<td>15. IMPROVED LAND MANAGEMENT</td>
<td>Life on Land</td>
</tr>
<tr>
<td>9. IMPROVING SUPPLY CHAINS</td>
<td>Industry, Innovation &amp; Infrastructure</td>
</tr>
<tr>
<td>17. ALLOW SHARING OF INFORMATION</td>
<td>Partnership for the Goals</td>
</tr>
</tbody>
</table>

---

### Policy Driving Innovation and Impact

Policy interventions are paving the way for fostering technological innovation and building investor confidence in climate focussed agri solutions, thereby achieving a double whammy - social impact coupled with climate action.
Exploring the funding landscape

Government support, channeled through accelerator programmes and policies geared towards promoting sustainable agriculture and climate smart practices, has spurred investor interest in agtech enterprises. These are focused on improving smallholder farmers’ access to markets, quality inputs, storage, and institutional credit. Beyond government support, various stakeholders, including foundations, non-profit organisations, and patient capital providers, are making multiple efforts to endorse these solutions and make a positive impact on the livelihoods of small-scale farmers.

Equity

In recent years, Indian agtechs have thrived with growing venture equity capital (VC) interest. From 2018 to 2021, VCs invested around $1.6 billion and an additional investment of nearly $1.2 billion in 2022 alone through 114 deals. Downstream agtechs, boosting farmers’ incomes through assured prices and buyers, saw rising adoption, securing >60% of VC investments in 2022.8

Conversely, only around 30% of the agtech funding in 2022 was allocated to upstream and midstream solutions.9 As the impact of climate change on agriculture intensifies and gains relevance in today’s context, there is a compelling need for patient capital to actively facilitate the development and deployment of upstream and on-farm CSA solutions.

Venture Capital investment in Indian agtech companies, 2018-22

<table>
<thead>
<tr>
<th>Year</th>
<th>Total Funding $ billion</th>
<th>Average deal size, $ million</th>
<th>Number of deals</th>
</tr>
</thead>
<tbody>
<tr>
<td>2018</td>
<td>0.2</td>
<td>2</td>
<td>82</td>
</tr>
<tr>
<td>2019</td>
<td>0.3</td>
<td>3</td>
<td>120</td>
</tr>
<tr>
<td>2020</td>
<td>0.4</td>
<td>4</td>
<td>97</td>
</tr>
<tr>
<td>2021</td>
<td>0.8</td>
<td>9</td>
<td>89</td>
</tr>
<tr>
<td>2022</td>
<td>1.2</td>
<td>10</td>
<td>114</td>
</tr>
</tbody>
</table>

VC investments in Indian agtech companies (2022)

<table>
<thead>
<tr>
<th>Category</th>
<th>Total Funding $ million</th>
<th>Deal Numbers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Agriculture mechanization/automation</td>
<td>63</td>
<td>13</td>
</tr>
<tr>
<td>Upstream agtech</td>
<td>80</td>
<td>16</td>
</tr>
<tr>
<td>Farm-to-fork brands</td>
<td>92</td>
<td>7</td>
</tr>
<tr>
<td>Agriculture biotech</td>
<td>113</td>
<td></td>
</tr>
<tr>
<td>Midstream agtech</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Digital Solutions and precision agtech</td>
<td></td>
<td></td>
</tr>
<tr>
<td>End-to-end ecosystem</td>
<td>707</td>
<td>4</td>
</tr>
<tr>
<td>Downstream agtech</td>
<td>114</td>
<td>20</td>
</tr>
</tbody>
</table>

Source: McKinsey
Debt

Debt financing in agriculture is directed towards farmers, FPOs, agri-focussed fintechs and NBFCs, and largely downstream agtech companies. However, given the substantial size of the sector, there lies immense potential for debt providers to reorient their lending strategies and financing products to align with the seasonality of the agriculture sector.

De-risking mechanisms through public finance and concessional private capital can open capital flows to this sector by easing credit access towards farmers and enterprises otherwise perceived as low on creditworthiness.

Extending credit across the value chain also enables commercial banks fulfill their Priority Sector Lending (PSL) requirements. With increasing number of enterprises providing asset backed products such as cold storage solutions (e.g. Ecozen) or processing and harvesting solutions (e.g. S4S Technologies) commercial banks extend capital to them with asset as a collateral. However, as more enterprises scale up their operations, the need for more concessional debt finance persists.

Untapped Investment Potential

- While agtechs are seeing support from equity investors, majority of the funding is towards downstream agtechs, which are enhancing farmer income through their farm-to-fork models, thereby underscoring the untapped potential for capital investments towards on-farm and closer-to-farm solutions.
- Given the varying nature of the land, types of crops grown, and limited knowledge, upstream and on-farm CSA solutions require localisation, training, and providing financial access to farmers to adopt these solutions. To effectively meet these on-ground necessities and promote the advancement of CSA, we need patient capital and innovative financing structures to foster the ecosystem.
- Access to concessional debt finance can also play a large role in building scale for innovation to emerge across climate focussed enterprises.
## Blended Finance Intervention to Scale: Acumen Resilient Agriculture Fund (ARAF)

**Grant providers:** GFC, IKEA Foundation, FCDO and FMO  
**Funded enterprises:** SunCulture, Farmerline, Stable Foods

### About the Fund
ARAF is the first climate adaptation-focussed agriculture investment fund to support African agribusinesses that help smallholder farmers adapt to climate change.

### Impact beneficiaries
- **Agtech enterprises**
- **Agri focussed financial intermediaries**

### Funding Structure: ARAF
- **Technical assistance facility funded by grants**
  - To provide farmers with hands-on support
- **Equity and quasi equity**
  - To support Agribusinesses

### Grant providers:
GFC, IKEA Foundation, FCDO and FMO

### Funded enterprises:
SunCulture, Farmerline, Stable Foods

## AGRI 3 Fund: Catalysing private capital for sustainable agriculture

**About the Fund**
Aims to provide smallholder farmers access to financing and skills to transition to sustainable and climate smart agriculture.

**Implementing partners:**
UN Environment Programme, Rabobank, IDH The Sustainable Trade Initiative, and FMO

**Geography focus:**
Brazil, Indonesia and India

### Intervention
- Technical assistance for developing agriculture focussed enterprises.

### Funding Structure: AGRI 3 Fund
- **Capacity building of agriculture focussed enterprises to accelerate development of investable opportunities.**
- **De-risking mechanisms, subordinated financing structures and innovative financing mechanisms to catalyse additional private, non-concessional funding.**

## Assam Agribusiness Investment Fund: boosting agricultural productivity

**About the Fund**
Aims to strengthen rural infrastructure and foster agricultural productivity in the state of Assam by providing patient capital to small and medium agricultural enterprises.

**Implementing partners:**
Assam Rural Infrastructure and Agricultural Services (ARIAS) Society, State Government of Assam, Caspian Equity, World Bank

### Geography focus:
India

### Intervention
- A public-private sector specific fund to deploy low cost capital towards agricultural enterprises.
- Collaboration with geography focussed incubators and accelerators to identify and develop local agriculture SMEs.
- A multi-donor innovative funding structure, extending different forms of capital including debt and equity to develop the agriculture ecosystem.

## Case Study - Multifaceted Approaches

To provide farmers with hands-on support and to support Agribusinesses, the Acumen Resilient Agriculture Fund (ARAF) aims to catalyse private capital for sustainable agriculture. The fund supports agribusinesses that help smallholder farmers adapt to climate change, focusing on agtech enterprises and agri focussed financial intermediaries.

The AGRI 3 Fund, another initiative, focuses on catalysing private capital for sustainable agriculture by providing technical assistance and fostering the development of agribusinesses in Brazil, Indonesia, and India.

In Assam, the Assam Agribusiness Investment Fund is designed to boost agricultural productivity with a focus on small and medium agricultural enterprises, utilizing a multi-donor innovative funding structure to extend different forms of capital.

These initiatives demonstrate the multifaceted approaches taken to support green investment opportunities in India, targeting various sectors and regions to enhance sustainability and resilience in the agricultural sector.
While blended finance interventions are crucial in the development of climate-smart agricultural solutions and livelihood of smallholder farmers, another on-farm practice that can help improve the livelihoods of smallholder farmers and reduce the sector’s impact on climate change is of carbon sequestration and trading. This section explores a carbon sequestration program initiated by Rabobank.

**About the Programme**

- Partnership with Microsoft for building a global, transparent, and technology-enabled marketplace for carbon sequestration.
- Equipping farmers to transition to agroforestry and sell carbon credits to industries.
- Empowering farmers with additional source of income and incentivising them to graduate to climate resilient agri practices.

**Implementing partners:**

Rabobank, Microsoft

**Geography focus:**

Africa, Latin America and Asia

**Interventions**

- **Awareness programmes among farmers on agroforestry practices**
  
  Building awareness among farmers on diversifying the crops sown for carbon sequestration.

- **Partnerships to build the ecosystem**
  
  Collaborations with large corporates to build the carbon trading platform and on-ground civil societies to promote agroforestry.

- **Leveraging technology for efficient implementation**
  
  On-farm monitoring with satellite imaging technology and machine learning models to assess farm development and ensuring traceability between corporates and smallholder farmers with the platform.
### Investor Preview: A Snapshot of the Landscape

**Country Priority**  
High  
- India’s priority sector and highly susceptible to climate change  
- CSA covered as part of India’s and the G20 nations’ Sustainable Development Goals (SDGs) vision to optimise national agriculture productivity, resilience, and emissions in response to climate change  
- Potential to address the triple bottom line of climate change, food security and economic growth

**Policy environment**  
Supportive  
- Government Initiatives announced to extend financial and incubation support to emerging climate focussed agri solutions  
- Agriculture Accelerator Fund set up to encourage innovative agri-startups in rural India  
- National Adaptation Fund for Climate Change set up for promoting climate resilient agriculture across climate-vulnerable geographies

| Mitigation & Adaptation Potential | Mitigation - Moderate  
|----------------------------------|-----------------------  
<table>
<thead>
<tr>
<th>Adaptation - High</th>
<th>Technology complexity</th>
<th>Low</th>
<th>Technology readiness</th>
<th>Moderate</th>
</tr>
</thead>
</table>
| *High scope of application across geographies, although affordability likely to remain a challenge*  
*Certain solutions necessitate localisation to the geographical and demographical context*  
*Enabling environment needed to equip farmers with financial and technical capacity to adopt CSA solutions*  
----------------------------------|-----------------------|-----|---------------------|----------|

**Commercial readiness**  
Moderate

**Enterprise types**  
- SMEs and startup enterprises innovating CSA solutions

**Investment or Funding suitability**  
- **Early-stage Equity & Grant Capital**  
  - Towards innovation-driven startups and SMEs  
- **Debt Capital & De-risking Mechanisms (e.g.: Credit Guarantees)**  
  - Towards agri-focussed NBFCs or commercial banks lending to agtechs, farmers and farmer collectives

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*Please note that the ratings provided on a High to Low scale here are subjective, based on the author’s analysis and stakeholder inputs, and may not precisely mirror the market reality.*
What is Needed: Building the Agri Ecosystem

Building market linkages
Partnerships with institutional buyers & mandis to ensure guaranteed offtake of grown produce.

Building capacity at farm level
Awareness and on-ground capacity building programmes on new agri practises and solutions.

Enabling access to finance
Institutionalising credit to smallholder farmers to transition to CSA practises.

Building livelihood of smallholder farmers
Improving farmer income by enabling access to market linkages and CSA practises that can uplift their livelihoods.

Offering blended capital to support innovative CSA technologies
Blending capital to support funding towards high perceived risk solutions and leveraging expertise of multiple stakeholders for developing and deploying CSA solutions.

Credit enhancement support to early and growth-stage enterprises

Challenges
Limited access to affordable finance

Intervention*
Financial assistance
Concessional finance and risk mitigation to agri-focussed financing intermediaries. The de-risking mechanisms can include:
- Guarantee backed support
- First Loss Capital
- Co-lending mechanism
- Blended finance

Actors Involved
Financing actors:
DFI, Philanthropic Foundations

Supporting actors:
Commercial Banks and NBFCs

Nature of support
Risk mitigation mechanisms to FIs
## What is Needed: Capital

### Building awareness and training smallholder farmers on adoption of new age climate smart agri practices

<table>
<thead>
<tr>
<th>Challenges</th>
<th>Nature of support required</th>
<th>Intervention*</th>
<th>Actors Involved</th>
</tr>
</thead>
</table>
| Limited digital literacy and awareness, with small and marginal farmers adopting new age solutions in limited capacity. | Financial & capacity support to reach smallholder farmers & increase awareness | **Technical assistance**  
- Geography-aligned Technical capacity building programmes & support to local government authorities to develop FPOs and farmer collectives with appropriate technical know-how. | **Financing actors:**  
CSR, Philanthropic Foundations |  
**Supporting actors:**  
Civil Society Organisations, District Level Government Authorities | **Financial assistance**  
- Philanthropic capital for piloting and initial deployment of new age solutions near farmlands to increase awareness and adoption.  
- Extend technical and financial assistance to SMFs for on-farm deployment of solutions. |

### Developing impact measurement frameworks for attracting capital

<table>
<thead>
<tr>
<th>Challenges</th>
<th>Nature of support required</th>
<th>Intervention*</th>
<th>Actors Involved</th>
</tr>
</thead>
</table>
| Limited visibility of climate impact of innovative solutions; hindering early-stage investment | Advisory for developing impact frameworks for a CSA investment portfolio | **Technical assistance**  
**Facilitation and development of an open access platform showcasing:**  
- Curated set of vetted climate smart solutions with their climate impact assessment results based on pilots  
- Farm-level data capturing climate impact for better visibility of cash flow  
**Training and capacity building of farmers to access digital platforms hosting localised climate data** | **Financing actors:**  
DFI, Philanthropic Foundations |  
**Supporting actors:**  
Industry Associations, Consulting Firms, Civil Society Organisations |
### Enabling access to affordable financing

**Challenges**
- Limited financial capacity of smallholder farmers to pay for climate smart solutions

**Nature of support required**
- Low-cost financing to ag-fintechs or agri focussed NBFCs

**Intervention***

**Technical assistance**
- Building technical knowledge of financial institutions on climate risks and emerging climate smart agri technologies

**Financial assistance & Advisory**
- Designing financing products and services for extending farmer financing for:
  - Purchasing CSA assets such as solar pumps, cold storage units
  - Cash flow-based financing for farmers, based on produce purchase guarantee extended by solution provider
  - Credit enhancement and risk mitigation structures to commercial banks for extending low cost financing to agri-focussed NBFCs

**Actors Involved**
- **Financing actors:** DFIs, Philanthropic Foundations
- **Supporting actors:** Commercial banks, NBFCs

### Enabling easier access to Agricultural Insurance

**Challenges**
- Complexity in designing and implementing weather indices-based crop insurance or parametric crop insurance

**Nature of support required**
- Data driven frameworks and processes to implement weather-linked crop insurance model

**Intervention***

**Technical assistance**
- To develop tailored, localised, need based and simplified insurance products based on area specific climate change, weather variability and farmers’ vulnerability
- Collaboration with agtech and climate tech enterprises to improve access to farm and farmer linked data, climate and weather information
- Awareness and capacity building of farmers on understanding and accessing available weather-based insurance products

**Financial assistance**
- Public-private partnerships (PPP) between government and commercial banks to deploy weather-based/ parametric crop insurance schemes through innovative financing structures

**Actors Involved**
- **Financing actors:** DFIs, Commercial Banks
- **Supporting actors:** Agri Cooperatives, Government, Agri enterprises, Civil Society Organisations
## What is Needed: Capital

### Economic incentives to farmers

<table>
<thead>
<tr>
<th>Challenges</th>
<th>Intervention*</th>
<th>Actors Involved</th>
</tr>
</thead>
<tbody>
<tr>
<td>Limited economic incentive to farmers to transition to CSA solutions</td>
<td><strong>Technical assistance</strong>&lt;br&gt;Developing a carbon credit programme for small and marginal farmers and FPOs, for integrating farmers into the carbon credit market</td>
<td>Financing actors:&lt;br&gt;DFIs, Philanthropic Foundations</td>
</tr>
</tbody>
</table>

**Allocation of funds and technical assistance for carrying out the following:**
- Creating awareness at farmer and FPO level for participation in voluntary carbon credit markets
- Collaborating with third-party verification parties for verifying and approving farming projects enlisted for availing carbon credits

**Nature of support required**<br>Income incentive programmes for farmers

**Supporting actors:**
- Civil Society Organisations, Industry Associations, Think Tanks, Consulting Firms, District Level Government Authorities

### Building bankability of climate smart solutions in agriculture

<table>
<thead>
<tr>
<th>Challenges</th>
<th>Intervention*</th>
<th>Actors Involved</th>
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</thead>
<tbody>
<tr>
<td>Innovative technologies yet to reach commercial scale</td>
<td><strong>Technical assistance</strong>&lt;br&gt;- Mentorship to early-stage enterprises&lt;br&gt;- Facilitate collaboration with agri intermediaries to data gathering and feasibility analysis of solutions&lt;br&gt;- Knowledge transfer of successful international pilots and technological trends</td>
<td>Financing actors:&lt;br&gt;Incubators, Impact Investors (VCs)</td>
</tr>
</tbody>
</table>

**Financial assistance**<br>Grant and equity support to early-stage enterprises for:<br>- On-ground deployment of solutions<br>- Ongoing R&D efforts to build effectiveness of solutions

**Nature of support required**<br>Financial support for nascent technologies

**Supporting actors:**
- Think Tanks, Industry Associations

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*Note: Some of the interventions proposed above may have already been put into action, however, given the scope of application, the table above suggests actions for implementation at scale.*
Increasing quantum and diversity of waste

4% of GHG emissions: Attributed to waste alone

Waste collection to management: A complex chain

Waste and Circular Economy:
Waste Management & Material Circularity

Tackling India’s Growing Waste Problem
### India’s waste management value chain

<table>
<thead>
<tr>
<th>Waste Generation</th>
<th>Collection</th>
<th>Segregation &amp; Processing</th>
<th>Recycling</th>
<th>Upcycling</th>
<th>Consumption</th>
</tr>
</thead>
<tbody>
<tr>
<td>Key Players</td>
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<tr>
<td>Municipal Authorities, Urban Local Bodies (ULBs)</td>
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<tr>
<td>Civil Society Organisations (CSOs)</td>
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<tr>
<td>Startups / SMEs setting up collection &amp; segregation facilities</td>
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<tr>
<td>Key Value Add</td>
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<tr>
<td>Potential to organise the unorganised waste picker workforce</td>
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<tr>
<td>Better segregation of different forms of waste</td>
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<tr>
<td>Geography-specific waste management programmes</td>
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<tr>
<td>Small, mid and large-scale enterprises</td>
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<tr>
<td>Startup Enterprises</td>
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<tr>
<td>Innovative technologies for recycling</td>
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<tr>
<td>Better efficiency in waste management systems</td>
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<tr>
<td>Building scale with recycling solutions</td>
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<tr>
<td>Innovative upcycled products</td>
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<tr>
<td>Market demand creation for upcycled products</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Consumer awareness creation</td>
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</tbody>
</table>

The waste generated in the country is diverse in type and scale. While the below table is not exhaustive, it enlists the key forms of waste that are pose a waste management challenge - plastic waste, battery and high value metal waste, construction material waste, and agricultural and food waste. Given the volume of waste generated, it is imperative to develop holistic solutions (e.g. Blue Planet Environmental Solutions, NEPRA) to sustainably manage and dispose off different forms of waste.
### Waste Management: A Growing Market Opportunity

<table>
<thead>
<tr>
<th>Types of waste</th>
<th>Current landscape in India</th>
<th>Key application</th>
<th>Demand potential</th>
</tr>
</thead>
<tbody>
<tr>
<td>Battery (lithium) and high-value metal waste</td>
<td>50,000 tonnes of lithium-ion battery waste generated every year, with only 10% of waste is being recycled</td>
<td>Electronics, electric vehicles, stationery energy storage</td>
<td>Lithium-ion battery recycling is expected to grow at 37.5% y-o-y, creating a $1 billion opportunity for battery recycling by 2030⁴</td>
</tr>
<tr>
<td>Plastic waste</td>
<td>3.4 million tonnes of plastic waste produced every year, only 30% of it being recycled⁵</td>
<td>Packaging</td>
<td>Indian plastic recycling market is valued at $520 million and expected to grow at a CAGR of 7.58%⁶</td>
</tr>
<tr>
<td>Construction and Demolition (C&amp;D) waste</td>
<td>150 million tonnes of C&amp;D waste generated every year, only 1% being recycled⁷</td>
<td>Construction industry</td>
<td>A circular economy approach in infrastructure is expected to derive benefits of $76 billion by 2050⁸</td>
</tr>
<tr>
<td>Agricultural and food waste</td>
<td>350 million tonnes of agricultural waste every year⁹</td>
<td>Agriculture</td>
<td>A circular economy approach in the food systems is expected to create annual benefits of $61 billion by 2050⁰</td>
</tr>
</tbody>
</table>

### Outlook of India’s Waste Management Scenario

The global circular economy is anticipated to reach **$4.5 trillion by 2030**; and India, which currently holds only a 1% share in this market, has the potential to grow to a **$45 billion market**⁸. Surmounting waste, necessitates solutions that build efficient waste management processes in a scalable and sustainable manner. Policy interventions have been setting the base for such innovations.
**Catalysing Transformation: The Vital Function of Policy as an Enabler**

**2021**

*EPR Guidelines on Plastic Packaging, 2021*
Producers to recycle up to 50% of plastic they use or produce until 2025

**2022**

*Battery Management Rules, 2022*
Producer & importer is responsible for collection & recycling of battery waste

*E-waste Management Rules, 2022*
ULBs to facilitate establishment of waste collection, segregation & disposal systems

*Swachh Bharat Mission 2.0*
Source segregation of trash & safe sanitation in urban areas

**2023**

*GOBAR-Dhan Scheme, 2023-24*
Allocation of Rs. 10,000 crore to set up waste-to-wealth plants

---

**Funding Landscape**

While we witness both equity investors and debt providers supporting the development and growth of this sector, investments in waste management solutions are yet to see high traction. The funding landscape in this section pertains to the entirety of the waste management sector, with focus on the emerging area of battery recycling, which is attracting increasing attention from equity investors.

**Debt**

Debt support can be witnessed towards relatively mature enterprises such as Anthony Waste Limited and Attero that have achieved scale and have integrated solutions. The well-established value chain of such enterprises not only offers recycling facilities but also provides efficient on-ground waste collection, segregation and transportation.

Such scalable models are fewer in number and capital is needed to develop more such enterprises. With adequate capital support these solutions have the potential to recycle and manage India’s growing waste problem.

**Equity**

Increasing number of startups with innovative technology to recycle waste are attracting equity investments.

During 2020-2022, as per IIC’s analysis of startup enterprises attracting equity capital, investors have invested close to $161 million - across 41 deals - into enterprises that process, recycle and upcycle different forms of waste.

Enterprises such as Phool.co, Ricron Panels and Green Joules, engaged in recycling and upcycling agricultural waste, plastic waste, and industrial waste into various value-added products and raw materials, demonstrate investor interest with innovative solutions.

Notably, solutions engaged in lithium-ion waste recycling stand out with ~$19 million invested across 7 equity deals. Battery recycling startups such as Ace Green Recycling, Lohum Cleantech, Batx Energies and Metastable Materials are seen developing innovative solutions to recycle lithium-ion batteries; a strong indication of the increasing potential this space holds.

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**Avenue for Investments**

The waste management & material circularity sector is evolving and holds scope for different sources of capital to support two broad segments:

- Enterprises building efficiency and scale across the value chain
- New age startups with innovative technologies processing different types of waste

An advancing economy and government impetus have, especially, resulted in battery recycling garnering early stage equity support. Its wide scope of application makes it a space to watch out for.
An Emerging Space: Battery Recycling

As the discussion around waste management and recycling solutions gains traction, presenting investable opportunities to multiple stakeholders, one space that increasingly stands out is that of battery recycling.

Lithium (Li) batteries play a pivotal role in EVs, grid storage applications, and electronic devices. As the demand for batteries in these three sectors continues to surge, effectively handling battery waste becomes vital to reduce environmental repercussions and enhance efficient use of resources. With Li-ion battery demand expected to cross 235 GWh by 2030 in India,12 leveraging battery recycling and repurposing them is crucial, presenting a lucrative opportunity for recycling and repurposing companies.

Unpacking the Value Chain

Total CO₂ emissions from battery cell production from a nickel-based Li-ion battery with virgin vs recycled materials

<table>
<thead>
<tr>
<th>Raw Material</th>
<th>Active material production</th>
<th>Cell production</th>
</tr>
</thead>
<tbody>
<tr>
<td>Virgin raw materials</td>
<td>29</td>
<td>22</td>
</tr>
<tr>
<td>Recycled raw materials</td>
<td>53</td>
<td>22</td>
</tr>
</tbody>
</table>

-28%

Source: Battery recycling takes the driver's seat - Mckinsey

Source: Authors, 2023
Factors Propelling Demand for Battery Recycling

- **Resource scarcity:** Limited reserves of key input materials such as lithium make recycling crucial to reduce imports
- **Policy focus:** Impetus towards responsible battery lifecycle management by manufacturers
- **Li-waste generating industries on high growth path:** Strong demand for Li battery storage from EVs, consumer electronics and stationary energy storage
- **Burgeoning Supply Chain:** Increasing capacities towards domestic cell and battery manufacturing
- **Access to battery recycling technology:** Developed by Ministry of Electronics and Information Technology (MeitY) for recycling enterprises, fostering growth of battery recycling

Battery Recycling: Looking Ahead

- With the increasing application of Li-ion batteries across industries, the demand for lithium raw materials and battery recycling is projected to grow significantly. This trend presents a highly promising and lucrative opportunity for stakeholders including battery recycling enterprises and investors.
Objective:
Financing enterprises across the plastic recycling and waste management value chains, including early-stage startups focused on innovative technology

Key players (Investors):
PepsiCo, Coca-Cola, Unilever, Mondelēz International, USAID

Intervention:
- Leveraging capital from diverse stakeholders including DFIs, philanthropic foundations, venture capitalists, and family offices to support early-stage waste management enterprises
- The fund can assume junior or subordinate positions, enabling higher potential returns for co-investors
- Guarantees up to 50% of the loan value to de-risk private co-investors investments

India Funded enterprises (Equity):
Srichakra Polyplast, Recykal, Ricron panels and Dalmia Polypro Industries

Case Studies - Exploring Synergistic Approaches

Given the high volume and multiple forms of waste generated within the country, it is essential to understand and learn from successful pilots on how they tackled the challenge of waste management and achieved the intended impact.

Circulate Capital Ocean Fund

Objective:

To promote source segregation, home composting, Material Recovery Facilities and recycling by formalising the waste picker workforce, providing technical advisory and financial assistance through innovative financing mechanisms.

Key Ecosystem Players:
MoEFCC, MoHUA, NAMA Facility, Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH, SIDBI

Intervention:
- Support for ULBs
  - Grant support & technical assistance in setting up waste management facilities
  - Capacity building of ULB’s workforce & other stakeholders
  - Integration of the waste pickers workforce
  - Awareness programmes to promote source segregation & home composting
- State & National Level Support
  - Technical support Unit at MoHUA
  - Sub-national EPR policy development & implementation
  - Developing SOPs and national standards for waste management facilities
  - Onboarding Swachhata knowledge partners
- Financing Support
  - Grant Funding Mechanism for waste management projects
  - Risk Sharing Facility - Credit Guarantees of up to 50% to commercial lenders

India – Waste Solutions for a Circular Economy (A NAMA Facility Project)
Objective:
Effective management of waste generated in Indore city by building and developing waste management value chain of waste collection, disposal and recycling.

Key Ecosystem Players:
Indore Municipal Corporation (IMC), Sarthak (NGO), Basix (NGO) and private recycling units like GPS Renewables and NEPRA

Intervention:
- **Segregating waste at source**: Mandated waste segregation at households through policy, improving waste collection and processing
- **Building traceability across value chain**: Leveraging technology to digitise the value chain, with GPS enabled vehicles to efficiently monitor waste collection and disposal
- **Creating awareness campaigns**: Increased community involvement and support for the waste management programme through awareness campaigns
- **Formalising unorganised waste pickers**: Collaborations with NGOs to integrate the informal workforce, improving waste segregation and their livelihoods
- **PPP for Infrastructure development**: PPP to develop Material Recovery and Recycling Facilities, reducing the financial burden on municipal corporations

Role of emerging innovative startups
- **GPS Renewables**: Commissioned Asia’s largest BioCNG plant in Indore
- **NEPRA Resource Management**: Setup state-of-the-art Material Recovery facility
## Investor Preview: A Snapshot of the Landscape

<table>
<thead>
<tr>
<th>Country priority</th>
<th>High</th>
<th>Decreasing population and rapid urbanisation with low GHG emissions attributed to landfills</th>
<th>High potential to develop a scalable, domestic, circular economy leading to increased employment opportunities, improved livelihoods and high climate impact</th>
</tr>
</thead>
<tbody>
<tr>
<td>Policy environment</td>
<td>Supportive</td>
<td>Swachh Bharat Mission 2.0 emphasising waste segregation at source</td>
<td>Extended Producer Responsibility (EPR) rules outlined to encourage waste management practices</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Battery Management Rules 2022 focussing on efficient battery recycling practices</td>
<td>Battery Recycling Technologies extended by the Ministry of Electronics and Information Technology (MeitY) to recycling enterprises</td>
</tr>
<tr>
<td>Mitigation potential</td>
<td>Moderate</td>
<td>Technology complexity</td>
<td>Moderate</td>
</tr>
<tr>
<td>Commercial readiness</td>
<td>Moderate</td>
<td>EPR rules mandate waste management for waste producers, thus inducing demand for waste management solutions.</td>
<td>Increasing demand for recycled materials such as LiB owing to inconsistent supply of critical inputs materials</td>
</tr>
<tr>
<td>Enterprise types</td>
<td><em>Startups and SMEs engaged in waste recycling and/or extending waste management solutions</em></td>
<td><em>Municipal corporations &amp; Urban Local Bodies (ULBs) implementing waste management projects</em></td>
<td></td>
</tr>
<tr>
<td>Investment or Funding suitability</td>
<td>Debt Capital</td>
<td>Towards waste management projects set up by local municipal authorities/Urban Local Bodies (ULBs)</td>
<td>Early-Stage Equity &amp; Grant Capital</td>
</tr>
</tbody>
</table>

*Please note that the ratings provided on a 'High to Low' scale here are subjective, based on the authors' analysis and stakeholder inputs, and may not precisely mirror the market reality.*
What is Needed: Building a Sustainable Value Chain

Mandating waste Segregation at source
Availability of clean segregated waste improves recoverability from waste and attracts higher number of recyclers

Organising the unorganised waste pickers
Integration of rag pickers and kabadiwalas to ensure efficient collection and segregation while improving livelihoods

Digitising the waste management value chain
Tracking waste generated from source to waste collector and to material recovery centres, ensuring easy governance

What is Needed: Capital

Derisking mechanisms to attract private capital
Reducing risks associated with lending to waste management enterprises through guarantee support

Supporting innovative waste management technologies with patient capital
Longer than market sector focussed funds to develop innovative forms of recycling technologies

Waste management and recycling is a highly fragmented sector with multiple intermediaries across the value chain. The high dependency on every intermediary in the value chain makes a case for a holistic approach to not only deploy different forms of capital across the value chain but also establish partnerships and collaborations to build capacity and scale. We propose the following structural interventions that can support the overall ecosystem building as well as create technological advancements for an efficient and self sustainable value chain.
Green Investment Opportunities in India

**Challenges**
- Fragmented unorganised workforce for waste collection
- Geographical variations in waste management models implemented by municipal authorities/ULBs

**Nature of support required**
- Organisation of the waste picker workforce
- Supporting on-ground social enterprises & civil society organisations working to organise waste collection
- Geography-specific projects/models & solutions for waste collection & segregation

---

**Credit enhancement support to early and growth-stage enterprises**

**Intervention***
- **Technical assistance**
  - Geography aligned capacity-building programmes to organise & train the workforce for providing:
    - Mentorship for enterprises involved in collection & segregation
    - Technical training to train the unorganized workforce
    - Sharing of best practices from successful pilots
    - On-ground partnership and mentorship support to civil society organisations and Self Help groups

**Financial assistance**
- Financial support for aggregation of unorganized workers, enabled through a Results-based or outcome-based financing structure

**Actors Involved**
- **Financing actors:**
  - DFIs, Philanthropic Foundations
- **Supporting actors:**
  - Commercial Banks and NBFCs

---

**Building traceability and organising the waste collection and segregation workforce**

**Challenges**
- High perceived credit risk for early & growth-stage waste management & recycling enterprises
- Geographical variations in waste management models implemented by municipal authorities/ULBs

**Actors Involved**
- **Intervention***
  - **Technical assistance**
    - Mentorship for enterprises involved in collection & segregation
    - Technical training to train the unorganized workforce
    - Sharing of best practices from successful pilots
    - On-ground partnership and mentorship support to civil society organisations and Self Help groups

**Supporting actors:**
- Civil Society Organisations and Self-Help Groups

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**What is Needed: Capital**

**Challenges**
- High perceived credit risk for early & growth-stage waste management & recycling enterprises
- Geographical variations in waste management models implemented by municipal authorities/ULBs

**Nature of support required**
- Organisation of the waste picker workforce
- Supporting on-ground social enterprises & civil society organisations working to organise waste collection
- Geography-specific projects/models & solutions for waste collection & segregation

**Actors Involved**
- **Financing actors:**
  - CSR, Philanthropic Foundations
- **Supporting actors:**
  - Commercial Banks and NBFCs
## Support to municipal corporations for effective design and delivery of waste management projects

### Challenges

Challenges for ULBs and municipal corporations in building self-sustainable, scalable, and viable waste management models.

### Nature of support required

Support in project design and planning, implementing, and establishing linkages for waste management solution providers.

### Intervention*

#### Technical assistance

- Designing, planning and implementation of waste management projects and extending specialized strategic, financial and technical advisory services to ULBs and municipal corporations.
- Building awareness among debt providers and waste management enterprises on innovative financing mechanisms involving guarantee support.

#### Facilitation

- Facilitating creation of digitised platform enabling better linkages between solution providers and local municipal authorities, thus aiding:
  - Ease of discovery of waste management projects underway.
  - Aggregation of solution providers.
  - Transparency in price discovery of solution providers.
  - Showcase of validated, credible, high-impact waste management and recycling solutions.

#### Financial assistance

- Improve and build waste management facilities at local municipal level.
- Development capital invested in waste management projects implemented by municipal authorities.
- Subscription to sovereign green bonds.
- Provide credit guarantee support for waste management solution providers, seeking debt capital.

### Actors Involved

**Financing actors:**
DFIs, Philanthropic Foundations

**Supporting actors:**
ULBs, Municipal Corporations, Social Enterprises, Commercial Banks, Industry Associations, Consulting Firms, Civil Society Organisations.

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**What is Needed: Capital**
## What is Needed: Capital

### Technical and financial assistance to emerging technologies for enabling commercial deployment at scale

<table>
<thead>
<tr>
<th>Challenges</th>
<th>Nature of support required</th>
<th>Intervention*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Early-stage innovative recycling enterprises constrained by limited capital and technical guidance</td>
<td>Early-stage capital for innovating, and building investment pipeline</td>
<td><strong>Technical assistance</strong>&lt;br&gt;Setting up financing platform connecting curated and high-impact early stage solutions with prospective funders &amp; incubators</td>
</tr>
<tr>
<td><strong>Financial assistance</strong>&lt;br&gt;• Grant capital directed towards R&amp;D investments&lt;br&gt;• Deployment grants that fund the cost of deploying early-stage technologies&lt;br&gt;• Dedicated sector-focused funds for extending low-cost venture capital to early-stage startups in order to:&lt;br&gt;• Support research and advancement of innovative &amp; sustainable recycling technologies&lt;br&gt;• Support the deployment of technologies at scale</td>
<td><strong>Actors Involved</strong></td>
<td></td>
</tr>
<tr>
<td>Financing actors: DFIs, Philanthropic Foundations</td>
<td>Supporting actors: Social Enterprises, Impact Investors (VCs), Incubators, NBFCs, Industry Associations</td>
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<table>
<thead>
<tr>
<th>Nature of support required</th>
<th>Actors Involved</th>
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<tbody>
<tr>
<td>Early-stage capital for innovating, and building investment pipeline</td>
<td>Financing actors: Incubators, Impact Investor (VCs), Philanthropic Foundations</td>
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<tr>
<td>Supporting actors: Think Tanks, Civil Society Organisations</td>
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## Economical demand-side incentives and improved consumer awareness to scale

<table>
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<tr>
<th>Challenges</th>
<th>Nature of support required</th>
<th>Intervention*</th>
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<tr>
<td>Limited economic incentives to transition to recycled materials as input</td>
<td>Enable economical demand-side incentives by facilitating setting up voluntary carbon credit trading platform</td>
<td><strong>Facilitate collaboration between industry and policy &amp; regulation to leverage expertise of both to build carbon trading platform</strong>&lt;br&gt;<strong>Facilitate bilateral partnerships for carbon trading</strong></td>
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<tr>
<td><strong>Actors Involved</strong></td>
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</tr>
<tr>
<td>Financing actors: DFIs</td>
<td>Supporting actors: Philanthropic Foundations, Civil Society Organisations, Industry Associations, Think Tanks</td>
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*Note: Some of the interventions proposed above may have already been put into action, however given the scope of application, the table above suggests actions for implementation at scale.*
Impacts of climate change threaten to cause widespread damage to India’s economy, people and ecosystems, making adaptation the need of the hour.

Barriers to scaling private sector investments and engagement in adaptation are manifold.

The public sector plays a crucial role in de-risking and building an enabling environment for scaling private capital flows in adaptation.

With the growing need for adaptation, multiple sectors will hold immense opportunities for India’s private sector in the medium-to-long term.
Why Adaptation?

Enabling adaptation to climate change is imperative for India’s economic, social and environmental transformation. The country’s economy, people and ecosystems are highly vulnerable to the impacts of climate change, with 12% of the total land area exposed to floods, 68% land area to droughts, landslides, and avalanches, and 75% of the coastline extremely vulnerable to cyclones and tsunamis.

In 2021, India suffered a total loss of $3.2 billion from heavy rains and flooding alone. In the absence of timely action, India may lose anywhere between 3–10% of its GDP annually by 2100 due to the impacts of climate.

The poor and marginalised sections of the population who are dependent on climate sensitive sectors such as agriculture and highly exposed to heatwaves and extreme events, lack adequate access to welfare resources and are often located in climate vulnerable locations are at climate risk twice over.

State of Financing Adaptation in India

Total finance for adaptation in India in 2019-20 was about ₹74 thousand crore ($10 billion), vis-à-vis the estimated requirement of ₹28.9 lakh crore ($4 trillion) by 2020.

Currently, most investment in adaptation is driven by public capital. The private sector’s contribution to adaptation financing remains limited and will need to increase considerably to meet India’s targets.

According to an estimate, 80% of the markets in key adaptation solutions in India are currently at a nascent or mid-level stage with the potential for high growth, but private investment in these solutions is mostly low to medium.

Globally, the economic case for adaptation is established, with research indicating that around $1.8 trillion worth of investments globally can generate close to $7.1 trillion in total net benefits during 2020-2030 in five areas: i) early warning systems, ii) building resilience of new infrastructure, iii) enhancing dryland agriculture production, iv) mangrove protection, and v) building resilience of water resources management.

Priority Adaptation Sectors for India

**Built environment & infrastructure**
- Coastal protection
- Embankments
- All weather road technology
- Cool roofs

**Agriculture**
- Precision agriculture
- Climate resilient varieties
- Soil health monitoring
- Cold storage

**Water**
- Rainwater harvesting and storage
- Sustainable water supply
- Desalination
- Wastewater treatment and recycling

**Ecosystem based adaptation**
- Mangrove restoration
- Wetland conservation
- Urban forests
- Slow-forming terrace farming systems

**Climate change forecasting & monitoring**
- Early warning systems
- Weather forecasting
- Meteorological equipment
- Aerial LIDAR remote sensing
Climate Adaptation: The Imminent Need for Financing

- Assets, businesses and people across the country are already facing the impacts of climate change.
- India’s transition to resilient growth will require significant investment, which can be delivered through strong and sustained private sector engagement.
- While climate change poses huge risks, it also presents opportunities in various forms, such as development of new products and services in response to climate change, increasing efficiency and reducing operational costs, business continuity and improved risk management, supply chain resilience and leadership in the emerging adaptation market, among others.
- However, due to the public good nature of key adaptation sectors such as water, critical infrastructure and ecosystems, and lack of viable business cases and pipelines in India, adaptation investments are mostly driven by public capital from domestic (national and state budgets) and international sources (multilateral institutions).
Current Policy Environment & Government Initiatives

- **India’s NDCs** emphasise the need to enhance investments in climate vulnerable sectors including agriculture, water resources, coastal regions and disaster management⁶.

- **National Action Plan on Climate Change (NAPCC) and State Action Plans on Climate Change (SAPCCs)** at the national and sub-national levels outline national missions, priority sectors for adaptation and adaptation activities⁹.

- **National Adaptation Fund for Climate Change** was established in 2015 with a budget provision of ₹350 crore for 2015-16 and 2016-17 to support adaptation missions and measures as identified in NAPCC and SAPCCs⁹.

- The Government of India has launched two schemes, **Amrit Dharohar Yojana** and **MISHTI (Mangrove Initiative for Shoreline Habitats and Tangible Incomes) Yojana** to revive wetlands and mangroves under the Ministry of Environment, Forests and Climate Change (MoEFCC)¹¹.

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**Why are Private Investments in Adaptation Not Scaling up?**

Barriers to private sector investments in adaptation

- High risk perception
- Lack of financial incentives for private sector investment such as PPP frameworks
- Technological or skill limitations
- Long-time horizons
- Uncertainty in revenue
- High capital requirement
- Complexity in due diligence procedures
- Low market rates of return or none
- High operational expenditure
- Limited access to climate information
- Lack of policy and regulatory direction to shape markets

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Sources:
- Climate Policy Initiative
- The World Bank
- Observer Research Foundation
Role of Private Sector in Enabling Adaptation

**Safeguarding internal operations**
Building measures to adapt to climate change in internal operations and supply chains

**Financing adaptation**
Providing concessional finance to enterprises and projects engaged in providing or adopting climate adaptation solutions

**Developing climate resilient solutions**
Engaging in research, development and deployment of innovations that help build resilience of sectors towards climate change, e.g., early warning systems and climate analytics data

Source: Climate Policy Initiative, 2022

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From challenge to opportunity

- India has clear policy directives for adaptation at the national and sub-national levels. However, India’s adaptation financing needs and actions, including levels of private sector engagement, remain difficult to quantify due to lack of standardised taxonomies, methodologies and financing approaches.

- Scaling private investments in adaptation continues to be a challenge due to the lack of an enabling environment as well as business and funding barriers, which in turn make it difficult to develop a pipeline of bankable adaptation projects.

- As it stands, currently, public finance plays a crucial catalytic role in translating adaptation needs to business opportunities through de-risking investments and creating an enabling environment for scaling investments and mobilising commercial finance.
Case Study - Green affordable housing for women

ADB’s Urban Climate Change Resilience Trust Fund (UCCRTF)12

About the Technical Assistance (TA)

- **Fund structure:** TA grant of $1 million from UCCRTF under the Urban Financing Partnership Facility to help identify and overcome obstacles to enabling an ecosystem for green certified, resilient and affordable housing in India. This TA will inform the ADB project on ‘Supporting Access to Affordable Green Housing for Women’, for which debt financing of $58 million and a loan of $10 million have been administered to IIFL Home Finance Limited.

- **Objective:** Accelerate the adoption of green and climate resilient building technologies by developers and align them to home buyer needs in the affordable segment. This fits into UCCRTF’s overarching goal of rolling out 25 infrastructure projects and other resilience measures to protect around 2 million poor and vulnerable people in select Asian cities and leverage about $1 billion in investments from public, private and municipal sources.

Focus areas of the TA:

- Conducting market research of the green housing market
- Creating awareness on green-certified housing standards
- Developing climate adaptive strategies in housing
- Identifying cost effective & innovative green technologies

Project and TA investors:

Asian Development Bank (ADB), The Rockefeller Foundation, Governments of Switzerland and the UK, Canadian Climate Fund for the Private Sector in Asia

Private sector partners:

IIFL Finance, Housing Finance Institutions, Housing Developers
Green Climate Fund (GCF)\textsuperscript{13}

About the Project

- **Fund structure:** $130.3 million including $43.4 million grant funding from GCF, the largest multilateral climate fund, and co-financing of $86.9 million from the Government of India and State Governments of Andhra Pradesh, Maharashtra and Odisha.

- **Objective:** Enhancing climate resilience of India’s coastal communities in Andhra Pradesh, Maharashtra and Odisha. The project specifically aims to strengthen the lives and resilience of the most vulnerable communities, especially women, to climate change and extreme events in coastal areas through an ecosystem-centered and community-based approach. This falls within the purview of the objectives of GCF.

Focus areas:

- Enhancing resilience of coastal and marine ecosystems and their services
- Promoting climate adaptive livelihoods and developing associated value chains
- Strengthening governance and institutional frameworks for climate-resilient management of coastal areas including integration of ecosystem-based adaptation principles into planning for resilient infrastructure development

 Investors: Green Climate Fund, State Governments of Andhra Pradesh, Maharashtra & Odisha, MoEFCC

Financial support: Senior & Subordinated Loans, Equity, Guarantees, Grants, Returnable Grants, In-kind Support

With increasing awareness about the impacts of climate change and recognition of the opportunities arising from it, investments in adaptation require the strategic use of both private and public capital and use of blended finance solutions to address existing barriers to scaling private sector investments. The two case studies presented above showcase climate resilience measures that use blended finance structures and lay the potential foundation for private investments at scale.

While the report highlights these case studies for their potential for scaling private investments, it also recognises ongoing efforts by various private sector organisations in climate proofing their businesses, and value chains and introducing pilot projects on enabling climate change adaptation.
India’s pathways to a net-zero economy merit investments in sectors that hold significant potential to mitigate climate change as well as help build a domestic economy that is adaptive to the changing climatic conditions. While this includes investment opportunities in several sectors, each holding a potential to accelerate India’s decarbonisation ambitions, it is also apparent that most of them are emerging spaces.

Critical emerging sectors and decarbonisation solutions can be scaled up further, provided they are supported by public and private sector led interventions. Our research highlights four key investment opportunities for different forms of capital to step in. While these emerging areas vary in their relative stages of growth and maturity, they are united by their climate impact and by the important role they play in India’s net-zero transition.

**In Conclusion: The Road Ahead…**

In Conclusion:

As the narrative around green financing for India sharpens, there is a key role for every stakeholder to play.

Each of these sectors present a unique investment opportunity.

**Green Hydrogen**
- Electrolyser manufacturing
- Green hydrogen production

**Battery Energy Storage Systems**
- Lithium-ion battery (LIB) manufacturing
- LIB application in power and transportation sectors

**Climate Smart Agriculture**
- Innovative on-farm and closer-to-farm solutions for building farmer livelihoods & resilience to climate change

**Waste Management & Material Circularity**
- Strengthening the waste management value chain
- More focus on LIB recycling

Apart from a positive climate impact, some of these emerging areas also hold the potential to drive social change and improve livelihoods. These sectors, therefore merit greater attention from investors and development of investment strategies that are devised in-keeping with the nuances of these sectors.

As the narrative around green financing for India sharpens, there is a key role for every stakeholder to play.

Time is ripe for the financing actors to foster collaborations and partnerships and nurture the financing and impact ecosystem. With policy and regulatory actions clearly outlining India’s commitment to a green transformation, it is only through a combined play of both commercial and concessional capital, that the next rung of emerging ‘green’ sectors could receive the support they merit.
Green Hydrogen: Gamechanger for Energy Transition

Anjana Seshadri
Vice President, Neev Fund, SBICAP Ventures

Green hydrogen could be a crucial piece in helping India reduce greenhouse gas emissions and achieve its ambitious targets of net-zero emissions by 2070. Over the last couple of years, several factors have improved the investment climate in India for green hydrogen including government support schemes such as National Green Hydrogen Mission, abundant renewable energy resources, decrease in cost of electrolysers, and growing need to decarbonize the industrial and transportation sectors which currently rely heavily on grey hydrogen.

The growing global momentum towards hydrogen could mean that the demand in India for hydrogen is set to quadruple by 2050, accounting for nearly 10% of global hydrogen demand; on a price parity basis alone, green hydrogen’s share of this demand could increase from 16% in 2030 to nearly 94% by 2050.

With India’s economic growth heavily dependent on abundant and cheap energy availability, we could see an increased reliance on green hydrogen manufacturing, which is at an inflexion point in India and has also attracted investments in firms across the value chain. There are also few sub sectors, where we are seeing increased traction from both government and private players:

a) Offtake from Private Sector: Several private sector players across Industries such as steel and fertilizers are investing in green hydrogen and ammonia production to decarbonize their operations.

b) Electrolysers: The cost of electrolysers has fallen significantly in recent years, making them more commercially viable. In 2021, the Government of India launched the Production Linked Incentive (PLI) Scheme for electrolysers to promote the manufacturing of electrolysers in India and provide financial incentives to manufacturers based on their incremental sales. The PLI Scheme is expected to attract significant investment in the electrolyzer manufacturing sector in India and is expected to help India become a global leader in electrolyzer manufacturing.

c) Storage and transportation: Green hydrogen needs to be stored and transported before it can be used. There are several emerging technologies for storing and transporting green hydrogen, such as liquid organic hydrogen carriers and metal hydrides. Several Indian companies are developing and commercializing these technologies.

The sector is still in its early stages of development, and the technologies involved are constantly evolving. More capital inflows are needed to support early-stage R&D projects in the sector to accelerate the development of new technologies and drive down the costs across the value chain. Also, with new projects coming up, there is a growing need for innovative financing instruments to make the projects more financially viable.

We at Neev Fund, believe green hydrogen and associated compounds such as green ammonia & green methanol would find applications in many industries, with Commercial and Industrial sectors (chemical, steel, glass and oleochemical industries) and hydrocarbon players being the early adopters given the cost parity between green and grey hydrogen has already been established in these sectors. We’ve seen the emergence of different viable business models such as Build-Own-Operate and Build-Own-Operate-Transfer basis and commodity offtake and Global C&I players enter into long-term offtake contracts for green hydrogen in India, reinforcing our commitment to the sector.

With the increasing demand of the sector, investments and policy support from both the public and private organizations are essential for the development of green hydrogen sector in India. We’ve already witnessed the rollout of the National Green Hydrogen Mission which aims to develop green hydrogen production capacity of at least 5 MMT/annum, alongside adding renewable energy capacity of about 125 GW in India by 2030. The policy has an initial outlay of INR 19,744 crore, which includes incentives for production of green hydrogen and manufacturing electrolysers.

The Policy initiatives reflect the government’s commitment to make India a global hub for producing, using and exporting green hydrogen. With the current policy and regulatory framework, focused more on supply side incentives, we also need to focus on demand interventions such as green hydrogen purchase obligations and price subsidies.
Overall, the green hydrogen sector in India is at a critical stage of development and is poised to attract significant investment in the coming years. The improved investment climate in India for green hydrogen is good news for the investors as they now have several opportunities to invest in various parts of the value chain, depending on their risk appetite and investment horizon.

**About Neev Fund:**
Founded in 2015, the Neev Fund, managed by SBICAP Ventures Limited, invests in SMEs that have a transformative impact and seek growth and catalytic capital. In a market first initiative, the fund’s performance is measured by its financial as well as developmental returns. The Fund aims to provide growth and expansion capital to SME companies working towards climate, environment and social infrastructure sectors. More about the Neev Fund: [https://neevfund.com/](https://neevfund.com/)
Battery Energy Storage Systems (BESS): The Key to the Energy Transition

Vasudha Madhavan
Founder & CEO,
Ostara Advisors

Setting the Context: Global trends in Green Energy

Global investments in Energy Transition technologies reached a record high of $1.3 trillion in 2022, a 19% increase from 2021, according to the International Renewable Energy Agency (IRENA), with major share of the investments flowing into solar and wind technologies.

In the first six months of 2023, new investments in Renewable Energy which is a sub-set of the Energy Transition, reached $358 billion, a 22% increase compared to the start of last year and an all-time high for any six-month period. This amply illustrates the growing importance of Renewable Energy globally as countries chart their paths to Net Zero.

At the heart of these transformative shifts lies the battery - an unassuming yet indispensable component that is reshaping industries, powering our lives, and enabling a sustainable future.

Renewable energy, while environmentally friendly, has faced challenges with intermittency, a problem that hinders its ability to provide a constant energy supply. This issue is linked to the concept of “base load” energy, which refers to a power source’s ability to provide a minimum, uninterrupted amount of energy to a grid. Batteries play a crucial role in addressing intermittency through energy storage and reducing dependence on continuous baseload power from a single source.

The India BESS Opportunity

As India moves towards greater use of renewable energy, having set a goal of meeting 50% of its energy requirement from renewable or non-fossil energy sources by 2030, it will need to invest in Battery Energy Storage Systems (BESS). As of FY23, India had around 37MWh of BESS capacity, and according to the Central Electricity Authority, the requirement for battery storage will reach 236.22 gigawatt-hours by 2031-32.

India’s BESS market is estimated to grow from US$3.10b in 2022 to US$5.27b by 2028, registering a CAGR of over 11.20% during the forecast period, as per Mordor Intelligence. RMI and NITI Aayog estimate a conservative scenario of 106GWh of BESS installed capacity coming on stream by 2030, representing an annual market of over US$6 billion a year and say that localising parts of the BESS supply chain could enable the country to capture “significant value”.

Lithium-ion batteries and pumped Hydrogen are emerging as the two most likely technologies for large-scale BESS deployments while other battery technologies are in early stages of testing and validation.

Key Stakeholders in Financing India’s BESS deployments

This is a huge investment opportunity and will require proactive financial support and collaboration between the Public Sector and Private Industry. Let’s take a look at key players who might be instrumental in Financing and/or Operating BESS frameworks.

As in any new industry, the Government will play the most important role in terms of both regulatory and financial support for BESS. Following through on the Finance Minister’s announcement in the 2023 Union Budget of a Viability Gap Funding facility for 4000 MWh of Battery Energy Storage capacity, the Union Cabinet approved a $455m viability gap fund (VGF) in Sep 2023. Under the scheme, the government will provide financial support, in the form of grants, of up to 40% of the capital cost of BESS projects totalling 4,000 MWh till FY31. An official statement in Sep 2023 said the scheme aims to reduce the levelized cost of storage (LCoS) to ₹5.50-6.60 per kilowatt-hour (kWh), making storage a viable option to manage peak power demand. According to industry estimates, the LCoS currently stands at around ₹10-11 per kWh.

The Ministry of Power is also working on a production-linked incentive (PLI) scheme which will enable local production of large battery energy storage systems. There is also a move to reduce the goods and services tax (GST) on grid-scale battery storage to 5%, from the current 18% applicable on lithium-ion BESS.

On the back of this significant policy push, we expect private players including Renewable Energy Asset Developers, large Global and Indian Energy companies to make BESS a central element in their New Energy business strategies.

This will also accelerate private capital flows from global and Indian strategic and financial investors into Indian startups that are working in areas incl advanced battery storage packs and related
electronics, software and data analytics solutions for monitoring BESS assets, Vehicle-to-grid solutions as well as Circular economy solutions that focus on repurposing EV batteries for energy storage applications.

At Ostara Advisors, we are bullish on the investment opportunity that this energy transition entails and continue to engage closely with startups and investors in this domain.

Sources: World Bank, Know How, Livemint, Mordor Intelligence

About Ostara Advisors:
Founded in 2015, Ostara Advisors is India’s first specialist investment banking firm focused on Electric Mobility and Sustainability, providing growth capital raising and M&A solutions to climate-positive businesses. Taking a thought-leadership based approach in these sectors, the firm is an early mover in institutionalizing fund-raising for the Indian Mobility & Sustainability ecosystem, having successfully closed marquee M&A and fund-raise deals including India’s first Electric Vehicle two-wheeler M&A transaction, Greaves Cotton Limited’s acquisition of pioneering EV two-wheeler company, Ampere Vehicles, as well as one of the largest growth capital rounds in the EV three-wheeler space, to name a few. The firm was founded by Ms. Vasudha Madhavan, who is one of the first investment bankers in India to specialize in Electric Mobility. She has over 20 years of experience in Corporate and Investment Banking and was featured in the Top 20 on the All-India M&A League Tables by Venture Intelligence in late-2018. More about us on our website www.ostara.co.in.
Empowering Change: The Positive Impact of Gender Lens Investing in Combating Climate Change

Bram Spann
Lead Program Manager, Asia, Rabobank

The climate crisis is one of the most pressing challenges of our time, threatening our planet’s ecosystems, economies, and the well-being of billions of people. As we grapple with the urgent need to reduce greenhouse gas emissions and adapt to a changing climate, it has become increasingly clear that addressing gender equality and climate change must go hand in hand. Gender lens investing, an approach that considers the gender-related impacts of investments, is emerging as a powerful tool for driving positive change in both areas.

Investing for women empowerment involves evaluating the social and economic implications of investments through a gender-sensitive lens. It seeks to promote gender equality and empower women and girls while generating financial returns. The core idea behind this is that by considering the specific needs, opportunities, and contributions of women, investments can yield both social and financial benefits.

Women as Climate Leaders

One of the key positive impacts of gender lens investing in relation to climate change is the recognition and support of women as climate leaders. Women around the world have played pivotal roles in advocating for environmental sustainability, resilience, and adaptation strategies. By investing in women-led initiatives and organizations, gender lens investors are helping to amplify the voices and contributions of women in the climate movement.

It is well known that companies with greater gender diversity at the executive and board levels tend to perform better in terms of environmental, social, and governance (ESG) criteria. These companies are more likely to adopt environmentally sustainable practices, prioritize renewable energy, and make responsible choices regarding resource consumption.

Fostering Inclusive Innovation

Gender lens investing also fosters inclusive innovation within the climate sector. Women entrepreneurs and scientists bring unique perspectives and innovative solutions to address climate challenges. By providing financial support and mentorship to women-led startups and initiatives, gender lens investors help unleash the untapped potential of female innovators in climate-related fields. Their innovations not only contribute to reducing carbon emissions but also create economic opportunities and improve the livelihoods of marginalized communities.

Advancing Climate Resilience

Climate change disproportionately affects women, particularly in vulnerable and marginalized communities. Gender lens investing recognizes this reality and seeks to advance climate resilience by supporting projects and initiatives that empower women and enhance their capacity to adapt to a changing climate.

Investments in women’s agricultural cooperatives, for instance, can help build resilient food systems by promoting sustainable farming practices and diversifying income sources. Similarly, access to clean energy technologies, often led by women-focused initiatives, improves the resilience of households and communities to climate-related disasters.

Bridging the Gender Gap in Access to Finance

One of the critical barriers that gender lens investing addresses is the gender gap in access to finance. Women entrepreneurs and climate leaders often face greater challenges in securing funding for their ventures compared to their male counterparts. By investing in women-led businesses and projects, gender lens investors are helping to bridge this financial gap, enabling more women to participate in climate action.

Driving Sustainable Supply Chains

Gender lens investing can also drive sustainable supply chains by encouraging businesses to adopt ethical and environmentally responsible practices. Companies that prioritize gender equality in their supply chains are more likely to engage in sustainable sourcing, reduce waste, and promote fair labor practices. When investments are directed towards businesses that support women-owned suppliers and female workers, it creates a ripple effect that positively impacts the entire supply chain.

Conclusion

Gender lens investing is a potent force for positive change in the context of climate change. By recognizing and empowering women as climate leaders.
leaders, fostering inclusive innovation, advancing climate resilience, bridging the gender gap in access to finance, and driving sustainable supply chains, gender lens investing addresses critical aspects of the climate crisis while promoting gender equality.

At Rabo Foundation we acknowledge the important position of women to combat climate change, while at the same time they are amongst the most vulnerable ones, especially in marginalized communities. Therefore, in 2022 we launched a program in India specifically addressing the financial needs of women-led agri enterprises and companies working with female farmers in combination with climate-smart solutions. The 5-year program should empower women in the agri value chains to strengthen their position as essential stakeholders in the battle against climate change. By increasingly focusing on women as an investment for a sustainable future, we hope to inspire others in doing the same.

The time to act is now, and gender lens investing is a powerful tool in our arsenal for a more resilient and equitable world.

About Rabo Foundation:
As a provider of impact funding, Rabo Foundation operates worldwide to achieve continuous positive change to vulnerable groups: economic, social and ecological. The foundation focuses internationally on access to finance and related support for producer-based agricultural cooperatives, agri-enterprises and agtech start-ups. Also, Rabo Foundation works closely together with local financial intermediaries to unlock capital for the described target group. More about Rabo Foundation: [https://www.rabobank.com/about-us/rabo-foundation](https://www.rabobank.com/about-us/rabo-foundation)
Investing in Climate Smart Agriculture: The Vital Role of Financial Institutions in India’s Sustainable Future

Luca Torre
Founder & Co-CEO, GAWA Capital

Indian agriculture faces unprecedented challenges due to climate change. Erratic weather patterns, water scarcity, and extreme events threaten crop yields and food security. Climate Smart Agriculture (CSA) emerges as a beacon of hope, offering a sustainable path forward for farmers to adapt to these new climate conditions. However, the successful implementation of CSA hinges on the active adoption of these new techniques by farmers as well as on the active participation of financial institutions.

Climate change’s impact on Indian agriculture is undeniable. Farmers grapple with unpredictable monsoons, prolonged droughts, and more frequent pest outbreaks. The need for climate-resilient practices is urgent, not only for safeguarding livelihoods but also for ensuring food security for a growing population.

CSA offers a promising solution. By integrating climate-resilient techniques, CSA enhances yields, fortifies farmers against climate-related risks and indirectly reduces greenhouse gas emissions. Moreover, it can lead to cost savings, ultimately improving farmers’ incomes.

The potential for CSA in India is immense. Investments are required in various aspects, including adopting drought-resistant crop varieties, implementing efficient irrigation systems, promoting sustainable land management practices, and developing climate-smart livestock management. Additionally, technology-driven solutions, such as data-driven decision-making tools for farmers, hold substantial promise.

India has developed some of the best climate solutions in the agricultural technology and precision agriculture space. It is now time to work on adoption. At GAWA Capital, amid this transformative journey, financial institutions occupy a pivotal role. They possess the resources, expertise, and capacity to drive CSA investments to scale. Here’s how:

Providing Capital: Financial institutions can offer loans and credit lines to farmers for CSA adoption. These funds enable farmers to invest in resilient practices, such as drip irrigation and climate-resilient crop varieties.

Investing in CSA Initiatives: Financial institutions can channel their investments into CSA-focused initiatives. By supporting these projects, they not only diversify their portfolios but also contribute to sustainable development.

Technical Expertise: Financial institutions can bring technical expertise to the table. They are well-versed in risk assessment and project management, crucial for evaluating the viability of CSA projects.

Partnerships and Collaborations: Collaboration is key. Financial institutions can partner with agritechs and climate tech to build embedded finance solutions. They must also continue collaboration with government agencies, non-governmental organizations, and other stakeholders to create synergistic approaches to CSA financing. Government policies can further incentivize financial institutions to invest in CSA. Subsidies and risk-sharing mechanisms can promote CSA adoption and financial institutions can be great channels to deliver them to vulnerable communities.

Around India, there are notable examples of financial institutions that have already embraced supporting CSA practices. These institutions have invested in projects aimed at enhancing climate resilience, improving farmer incomes, and reducing emissions.

But more is needed: at GAWA Capital we are launching a new fund called Kuali which aims at promoting climate adaptation among farming communities by investing and providing technical assistance to financial institutions that finance climate smart agriculture. The fund will also invest in climate solutions providers to ensure that farmers have access to technologies and practices that lead to real changes in the way farmers work their fields. The fund aims at building synergies between financial institutions and climate tech through embedded finance schemes. The fund is expected to invest 100 million EUR in India.

In conclusion, investing in Climate Smart Agriculture is not just a choice; it’s a necessity. India’s agricultural sector must adapt to the changing climate to ensure food security and prosperity for its people. Financial institutions are not mere observers in this transformation; they can be the driving force. By providing capital, expertise, and collaboration, they can catalyze the transition towards resilient and sustainable agriculture. The time to invest in Climate Smart Agriculture in India is now, for a more secure and sustainable future.
About GAWA Capital:
With over 14 years of experience, Gawa Capital is a European impact investment management firm committed to supporting positive social and environmental impact while generating financial returns for investors. Since its inception, GAWA has pioneered the introduction of the impact investing asset class in Spain, having launched three funds, in addition to advising a third-party fund. Each of these funds invests equity and debt in developing countries, in companies focused on providing market-based solutions to key societal issues such as poverty. More about Gawa Capital: [https://www.gawacapital.com/about-us](https://www.gawacapital.com/about-us)
Conscious Consumerism: Opportunities emerging from reimaging brands and supply chain

In recent years, India has witnessed a significant transformation in consumer behavior, largely driven by millennials and further accelerated by the COVID-19 pandemic. Increasingly, the Indian consumer is opting for sustainable choices when making purchases, signaling a burgeoning trend that has caught the attention of brands as well. According to a recent survey conducted by Bain & Company, a notable 52% of consumers in urban India anticipate increasing their spending on sustainable brands in the next two to three years. This shift, though gradual and in its early stages, is sizable enough to be noticed by the brands who are increasingly introducing products made with greener alternatives and clean ingredients to cater to this evolving market segment.

The Emergence of D2C Sustainable Brands:
The most promising development in the sustainable brand space is being seen in the food and lifestyle industries which have seen emergence of multiple startups like Foret - a vegan and sustainable fashion brand that creates bags and products using cork and banana bark, offering an ethical alternative to traditional leather goods, Superbottoms which specializes in sustainable baby and mom care products, Shumee which offers eco-friendly and child-safe toys, catering to parents who prioritize both safety and sustainability and GoodDot, a plant-based meat and vegan food brand tapping into the increasing interest in plant-based diets and sustainable protein sources. These startups exemplify how Indian entrepreneurs are recognizing the shift in consumer preferences and seizing the opportunity to provide sustainable alternatives across various product categories.

The Rise of Traceability:
Conscious consumerism is not limited to the desire for eco-friendly products; it also extends to the desire for transparency in the supply chain. Consumers are increasingly seeking information about the sourcing, production methods, and ingredients used in products. This trend is compelling companies to share more data about their processes and materials, aiming to distinguish themselves in the market as transparent and ethical brands. Technologies like IoT and blockchain will play a pivotal role in enabling this end-to-end visibility. Companies like TraceX are leveraging blockchain to enable digital traceability for food and agriculture supply chains, thus paving the way for the adoption of sustainable and climate resilient food production practices.

Government Initiatives Towards Sustainability
In parallel, Indian policymakers and regulators are actively working to build an ecosystem with a low-carbon future at its core. Several notable initiatives underscore the government’s commitment to fostering sustainability:

Extended Producer Responsibility (EPR): This government mandate holds producers of plastic or electronic waste responsible for the proper end-of-life handling of their products, thus compelling companies like ITC, HUL and many others to take responsibility for the waste they generate.

Ban on Single-Use Plastics: In July 2022, India introduced a ban on single-use plastics, a significant step in reducing plastic pollution and promoting eco-friendly alternatives. These measures not only make companies accountable for their environmental impact but also incentivize the development of sustainable alternatives to environmentally harmful materials and packaging.

Innovations in Alternative Materials: Indian companies are rising to the challenge by exploring innovative materials that can replace traditional, less sustainable options. A few noteworthy examples include companies like Zero Circle which utilizes seaweed as a raw material to produce plastic alternatives, reducing the reliance on petroleum-based plastics, Fibmold which specializes in molded fiber packaging solutions for the food and beverage industries.

The Circular Economy Imperative
India stands at a critical juncture in its economic growth, and the adoption of a circular economy is of paramount significance to future-proof this growth. It addresses pressing challenges such as waste management, resource constraints, and import dependence.

A notable example of India’s commitment to sustainability is the government’s goal to increase the share of electric vehicles (EVs) in the overall
automobile market from 2% to 30% by 2030. However, achieving this goal poses challenges, particularly regarding the supply of essential metals like lithium and cobalt needed for manufacturing Li-ion batteries which are used in these vehicles. Thus, domestic recycling of Li-ion batteries is essential for self-sufficiency. Indian startups like Lohum, MiniMines, and Metastable are already pioneering technologies for efficient battery recycling, providing essential metals like lithium, cobalt, and nickel to Indian original equipment manufacturers (OEMs).

Another innovative segment is food upcycling. Companies like Wastelink and Loopworm are converting food waste—which constitutes a staggering 40% of food produced in India—into ingredients for animal feed. This not only addresses the issue of food waste but also creates a sustainable supply chain for animal nutrition.

A Sustainable and Ethical Future

In conclusion, the rise of conscious consumerism in India coupled with the increasing regulatory push is reshaping the market and compelling businesses to embrace sustainability and transparency in their operations. By seizing these opportunities, Indian companies can meet the evolving demands of conscious consumers, contribute to a more sustainable and ethical future, foster uniqueness in a competitive market, and align with India’s AtmaNirbhar Bharat goals.

To transition to a more sustainable supply chain and circular economy, concerted efforts from businesses, government bodies, investors and consumers are essential. In our capacity as impact investors, it is incumbent on us to catalyze this transition which is still at nascent stages even as we await a critical mass of consumers to willingly and readily pay premium for sustainable products and services. This collaborative approach will prove to be a strategic imperative for India’s sustainable growth and future prosperity.

About Asha Ventures:
Asha Ventures is an Inclusion & Sustainability focused fund investing at an early growth stage in India. In order to drive Inclusion & Sustainability, the firm specifically focuses on areas of Financial Empowerment, Job Creation & Education, Healthcare for all, AgriTech and ClimateTech. Across these sectors, Asha Ventures partners with ambitious entrepreneurs who leverage technology to build Innovative businesses for India’s Emerging Middle Class. More about Asha Ventures: https://ashaventures.in/
From Crisis to Innovation: Housing Solutions in the face of Climate Change

Anoop Nambiar
Country Director (India), Terwilliger Center for Innovation in Shelter, Habitat for Humanity International

The challenge of climate change does not exist in a vacuum. Rather, it intersects with multiple global trends, including growing urbanization, migration, rising systemic inequity and loss and damage from extreme events. The dual crises of climate change and the global affordable housing shortage are intertwined: in low-income countries, where the effects of the climate crisis on communities are felt the most, climate change is profoundly related to housing, which is where the bulk of unmet housing need is located.

At the same time, the built environment produces a third of the world’s waste. Every year about 100 billion tons of raw materials are extracted for use across the buildings and construction sector and annually, buildings are responsible for about 39% of energy-related global carbon emissions. The use of these materials is also set to increase, especially in low-income countries where new infrastructure and housing growth is anticipated to accelerate most, due largely to rapid urbanization and the quality limitations of existing housing stock. Housing has a huge role to play in adapting against a changing climate while also mitigating emission impacts by embracing more circular, sustainable practices.

The global housing shortage is growing: Worldwide, 1.6 billion people lack adequate housing, including 1 billion living in slums and informal settlements, a situation that severely undermines efforts to address and eradicate all facets of poverty. The United Nations estimates that 3 billion people — 40% of the world’s population — will need access to adequate housing by 2030, equivalent to 96,000 new affordable and accessible housing units every day. Affordable housing has a direct impact on numerous global calls to climate action, including Sustainable Development Goals (SDGs), notably SDG11: Sustainable Cities and Communities among other SDGs.

Low-income families experience unequal impact: The impacts of climate change are vastly unequal and felt the most by the world’s poorest communities. The 46 least-developed countries only account for 1.1% of total world carbon dioxide CO2 emissions from fossil-fuel combustion and industrial processes, despite being home to 1.1 billion people, approximately 14% of the world’s population. These countries were affected by less than a fifth of climate-related disasters yet have suffered 69% of deaths worldwide attributable to the same occurrences. For those who live in coastal areas, climate change poses an existential threat due to rising sea levels. Housing can be the best defense against a changing climate, including protection from increasingly erratic weather events, disasters as well as rising temperatures.

Adaptation efforts must include quality housing: Habitat’s Terwilliger Center, works to expand low-income families’ access to innovative housing products, services, and financing. The Center’s MicroBuild Fund supports microfinance institutions to develop affordable, housing-specific loan products tailored to the needs of low-income families. When it launched in 2012, MicroBuild was the first housing-specific microfinance investment vehicle in the world. The fund invests in financial institutions, which on-lend this capital as housing microfinance loans directly to low-income borrowers. The fund has distributed over USD 160 million, across 33 countries impacting 1.08 million individuals so far, with 69% of the borrowers being women. The total investee housing microfinance portfolio stands at over USD 1.55 billion.

The fund has allowed families to build and improve their homes, and in places like coastal areas of India and the Philippines that means disaster resilience.
Additionally, in Bosnia and Herzegovina the fund has helped link families with energy efficiency improvement loans. In addition, the Center has been advancing innovative housing solutions for climate mitigation and adaptation, supporting startups worldwide through its global platform, ShelterTech, as well as with patient capital via the Shelter Venture Fund. So far, the Center has supported over 110 startups focused on affordable and sustainable housing worldwide, including 17 in India, and have made 11 investments through the fund. A good example is Indian startup ReMaterials that makes ModRoof, a modular system of lightweight roofing panels from cardboard waste combined with natural binders, that significantly reduces the indoor temperature inside homes, improving habitability and health of families.

Given that those who are most impacted by climate change are also those most affected by the global housing shortage, any measures to support climate change mitigation and adaptation must incorporate housing needs to succeed. Quality, affordable, and sustainable housing can help low-income families build resilience against the perils of climate change.

References:

About the Terwilliger Center for Innovation in Shelter:
Habitat for Humanity’s Terwilliger Center for Innovation in Shelter focuses on the most pivotal yet uncharted intervention points in global housing markets. We conceptualize, pilot, and accelerate scalable solutions that have the greatest potential to close the global affordable housing deficit for low-income communities. The Terwilliger Center has helped over 36.5 million people access improved housing through market-based approaches. Anoop Nambiar serves as the Country Director for India. More about Terwilliger Center for Innovation in Shelter: https://www.habitat.org/our-work/terwilliger-center-innovation-in-shelter
As India prioritizes its ambitious goals of decarbonizing energy to 50% and achieving 500 GW of green energy capacity by 2030, and a long-term net zero strategy, the role of regulations in fostering and accelerating green investments is crucial. Few of such key recent regulatory reforms in the green sectors are discussed below.

**Renewable Energy**

India’s installed renewable energy capacity stands at 179.322 gigawatts (GW) as of July 2023, which is globally the fourth largest installed capacity of renewable energy, as per the International Renewable Energy Agency’s Renewable Energy Statistics, 2023. The renewable energy sector in India has witnessed exponential growth over the last decade, and supporting regulatory reforms are a key reason. Recent regulatory developments that continue to provide impetus for green investment:

(a) **Electricity sector reforms**

- The introduction of the Central Electricity Regulatory Commission (CERC) (Connectivity and General Network Access to the Inter-State Transmission System) Regulations, 2022 (GNA Regulations) marked a new paradigm in transmission system planning by enabling flexible and non-discriminatory open access. Generating stations now have open access without need to identify the consumer, unlike the erstwhile regulations. This enables the flexibility to schedule and dispatch surplus power to demand centers across the country. Honoring the “must-run” status of generating stations based on renewable energy sources (REGS), the regulations clarify that bilateral transactions and collective transactions of power, based on conventional sources will be curtailed before the transactions involving REGS.

- The recent CERC (Sharing of Inter-State Transmission Charges and Losses) Regulations, 2020 provide a 25 years’ waiver of the transmission charges payable for scheduling power sourced from REGS commissioned up to 30 June 2025. Further, the transmission charges for battery energy storage system (BESS) charged with REGS, commissioned up to 30 June 2025, is also waived for 12 years.

- The Ministry of Power (MoP) notified the Electricity (Promoting Renewable Energy Through Green Energy Open Access) Rules, 2022 (GEOA Rules) which aim to encourage the use of clean energy including from waste-to-energy plants, by eliminating capacity limits for captive consumers, allowing for renewable energy banking and providing for appointment of nodal agencies for streamlining the open-access approval process. The GEOA Rules allow consumers with a sanctioned load of 100 kW or above to purchase electricity directly from the renewable power producers through open access (DISCOMs). These rules benefit Commercial and Industrial (C&I) sector and MSME consumers who can purchase green power and allows captive consumers to take power with no minimum limitation. The GEOA Rules provide a significant boost for private renewable energy procurement in India and support individual consumers in their choices to decarbonise through open access.

- The GEOA Rules also grant incentives such as fixing standards for levy of the cross-subsidy surcharge (for C&I consumers) and standby charges, exempting the open access consumers from levy of additional surcharge if the power is produced from offshore wind projects commissioned up to 2032, and exempting levy of cross subsidy surcharge and additional surcharge if the power is produced from non-fossil fuel based waste-to-energy plants or is utilised for production of green hydrogen or green ammonia.

(b) **Green Hydrogen**

- The Green Hydrogen Policy was introduced by the Government in 2022 to promote the generation and procurement of green hydrogen and green ammonia. The policy incentivizes production of green hydrogen and green ammonia by waiving inter-state transmission charges for green hydrogen projects commissioned before 30 June 2025 and capping banking charges. The policy also eases the allotment of land for green hydrogen projects by providing allotting land in renewable energy parks and creating manufacturing zones for such projects.

- The Government has also launched the National Green Hydrogen Mission with the aim to create green hydrogen production capacity of 5 million metric tons per annum and add 125 GW of renewable energy capacity by 2030. The mission seeks to attract over INR 8,00,000 crores in investments, reduce fossil fuel imports, and decrease annual greenhouse gas emissions by nearly 50 million metric tons.

- The Ministry of New and Renewable Energy recently unveiled an INR 4 billion research
and development (R&D) road map for the National Green Hydrogen Mission. The roadmap recommends R&D actions for each aspect of the green hydrogen value chain and prioritizes technologies, infrastructure and safety to improve the efficiency and reliability of green hydrogen production, storage and transportation. The roadmap categorises projects basis their impact horizon and gives first priority to initiation of projects with up to 5 years of impact horizon. The mission will also facilitate a public-private partnership framework for R&D.

(c) Energy Storage
In its effort to transition from simple vanilla grid connected REGS to REGS with energy storage solutions to manage peak power demand nationwide, the government has approved the Viability Gap Funding (VGF) scheme for the development of 4,000 MWh of battery energy storage systems (BESS) projects by 2030-31. This is to ensure to round-the-clock supply of power and access to such green power. Under the VGF scheme, the government will provide financial support up to 40% of the capital cost as VGF. Pumped Storage Projects (PSPs) form a crucial component of the Government’s renewable energy integration strategy as they form clean, green, safe sources of energy without any poisonous/harmful output. The Government has notified guidelines to promote PSPs by granting incentives such as exemptions from stamp duty and registration fees, grant of government land at concessional rates and waiver of electricity duty and cross subsidy surcharge.

Transport and Mobility
- The Government had introduced the National Electric Mobility Mission Plan (NEMMP), 2020 to boost the manufacturing and adoption of electric vehicles in India. As a part of NEMMP, 2020, the Ministry of Heavy Industries (MoHI) is currently implementing the second phase of ‘Faster Adoption and Manufacturing of Hybrid & Electric Vehicles in India’ scheme (FAME), to facilitate the deployment of e-vehicles in public transportation by providing charging infrastructure and demand incentive for consumers (in the form of an upfront reduced purchase price of certain categories of hybrid and electric vehicles to enable wider adoption, which will be reimbursed to the OEM by Government). The cabinet has also recently approved the ‘PM e-Bus Sewa’ scheme under which the Government aims to augment city bus operations with 10,000 e-buses along with associated infrastructure, on public private partnership model.

Circular Economy
- With the emergence of more sustainable production and consumption practices across the globe, the Indian Government in 2021, recognised 11 focus areas to expedite the transition of the country from linear to circular economy, i.e. an economy that incorporates the principles of reusing, re-manufacturing, and recycling. These focus areas include municipal solid waste and liquid waste, ferrous and non-ferrous scrap metal, electronic e-waste, solar panels, toxic and hazardous industrial waste, agriculture waste and end-of-life vehicles.
- To promote circular economy, Ministry of Environment, Forest and Climate Change of India (MoEFCC) notified the Plastic Waste Management Rules, 2016 (as amended in 2022), E-Waste (Management) Rules, 2016 (as amended in 2022) (E-Waste Rules) and Construction and Demolition Waste Management Rules, 2016. Pursuant to these rules, the Central Pollution Control Board (CPCB) issued guidelines on environmental management of construction and demolition wastes, 2017 and the framework for issuance and recently amended the ‘extended producer responsibility’ (EPR) which require producers and industrial users of plastic packaging to meet a minimum level of recycling of plastic packaging waste on a category wise basis.
- The Ministry of Road Transport and Highways also notified the Motor Vehicles (Registration and Functions of Vehicle Scrapping Facility) Rules, 2021, and introduced registered facilities which are authorised for scrapping of un-fit vehicles. Similarly, the Ministry of Steel issued a recycling policy for steel scraps to promote circular economy and the 6Rs principles in the steel sector, i.e. ‘Reduce, Reuse, Recycle, Recover, Redesign and Remanufacture’ through scientific handling, processing and disposal of all types of recyclable scraps, including non-ferrous scraps.

Carbon Markets
- The Energy Conservation Act, 2001 was recently amended to pave the way for an Indian carbon market. The amendment empowers the Government to specify a carbon credit trading scheme (CCTS) under which an authorized agency will certify carbon credit for trading in India. It also allows any person to purchase an energy saving certificate on a voluntary basis. Thereafter, the power ministry notified the Carbon Credit Trading Scheme, 2023 (Scheme) on June 30, 2023. The Scheme identifies a National Steering Committee and the Bureau of Energy Efficiency (BEE) to institutionalize and oversee the operations of the carbon market, formulate procedures and set emission targets for obligated entities.
The Green Credit Programme Implementation Rules, 2023 (GCP) was notified on 13 October 2023 as an innovative market-based mechanism designed to incentivize voluntary environmental actions across diverse sectors. The GCP contemplates a domestic voluntary mechanism for individuals, industries, private sectors to earn green credits which will be tradable on a domestic market platform. The Ecomark Scheme was also notified on 13 October 2023 which provides accreditation and labelling for consumer products that meet quality standards ensuring minimal environmental impact. These initiatives are intended to build consumer awareness of environmental issues, encourage eco-conscious choices and motivate manufacturers to shift towards environment friendly sustainable production.

Notes:
1. While the GEOA Rules have been notified by the Central government, the implementation of these rules remain under the purview of the State governments. The GEOA Rules have already been adopted by Karnataka, Madhya Pradesh, Haryana, Punjab and West Bengal, and various other states have introduced drafts for implementation of the GEOA Rules.
2. Earlier limit was 1 MW.

About Trilegal:
Trilegal is one of India’s leading law firms, with expertise across the full spectrum of corporate legal services. Trilegal has offices in four key cities of India.

Trilegal has been recognised as the India Deal Firm of the Year by Asian Legal Business (ALB) India Law Awards 2023; one of the ‘Best Overall Law Firms’ at the India Business Law Journal Indian Law Firm Awards 2022; ‘Firm of the year’ for Client Service Excellence by Asia Law Awards 2021; “M&A Law firm of the Year” by VCCircle Awards 2020; one of the most innovative law firms in Asia in the inaugural edition of ALB Trailblazers 2020 and ‘highly commended’ in the FT RSG Innovative Lawyers Awards 2020.
Green Investment Opportunities in India
DESCRIPTION OF TECHNOLOGIES
# Description of Technologies / Solutions

<table>
<thead>
<tr>
<th>Types of waste</th>
<th>Key Application</th>
<th>Demand Potential</th>
</tr>
</thead>
<tbody>
<tr>
<td>Power</td>
<td>Battery Energy Storage Systems (BESS)</td>
<td>A Battery Energy Storage System (BESS) is a sophisticated technology that employs advanced lithium-ion batteries to efficiently capture, store, and release electrical energy. With a focus on high energy density and long-lasting performance, Li-ion BESS excels at quickly responding to changes in power demand, smoothing out renewable energy variability, and providing robust power during peak usage. Its modular design allows for flexible scaling to meet specific energy storage requirements. This technology is significantly appealing due to its pivotal role in bolstering grid stability, facilitating the integration of renewable sources, and offering promising applications in various sectors including grid management, renewable energy optimisation, and electric vehicle infrastructure.</td>
</tr>
<tr>
<td>Hydrogen</td>
<td>Electrolysers</td>
<td>Electrolysers are advanced devices pivotal to the emergence of hydrogen as a clean energy resource. Through the process of electrolysis, these devices utilize electricity to split water into hydrogen and oxygen gases. The produced hydrogen can be stored and utilized across diverse applications, including electricity generation through fuel cells, industrial processes, and fuel for hydrogen-powered vehicles. Electrolysers offer a means to balance renewable energy fluctuations by converting excess electricity into storable hydrogen, thus aiding in grid stability. As a cornerstone of the growing hydrogen economy, electrolysers are attractive with their potential to contribute to sustainable energy solutions, align with policy incentives promoting hydrogen technologies, and play a vital role in multiple industries seeking cleaner energy alternatives.</td>
</tr>
<tr>
<td>Material Circularity</td>
<td>Batteries and E-Waste</td>
<td>Battery and electronic waste (e-waste) recycling are essential pillars of a sustainable circular economy. Three primary recycling techniques come into play: pyrometallurgy, which employs high-temperature processes to separate materials by melting points; hydrometallurgy, involving chemical solutions to extract valuable metals with precision; and direct recycling, refurbishing components for extended use. These methods collectively salvage valuable resources, curbing environmental impact by reducing waste, conserving energy, and lowering the need for fresh raw materials.</td>
</tr>
</tbody>
</table>

Source: Author's Understanding
### Description of Technologies / Solutions

<table>
<thead>
<tr>
<th>Types of waste</th>
<th>Key Application</th>
<th>Demand Potential</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Climate Smart Agriculture</strong></td>
<td><strong>Climate Smart Agriculture Inputs</strong> involve climate resilient seeds and low-carbon fertilisers, climate-resilient seeds are meticulously designed to withstand the challenges of extreme weather, fortifying crop stability, conserving water resources, and ensuring food security in the face of climate uncertainties. Simultaneously, low-carbon fertilisers, engineered to curtail greenhouse gas emissions throughout their life cycle, optimize nutrient delivery, bolster crop yields, and nurture soil health. These innovations collectively define the forefront of climate-smart agriculture, harmonizing the critical needs of adapting to a changing climate with environmental responsibility.</td>
<td></td>
</tr>
</tbody>
</table>
| **Precision Agriculture & Robotics** | **Precision Agriculture:** Precision agriculture employs sensor technology and data analytics to optimize crop management, conserving resources while fostering soil and crop health. This approach not only addresses climate-induced changes in soil nutrient balance, fertility, erosion, and degradation but also empowers informed and sustainable soil management practices.  
**Agriculture Robotics:** Agriculture robotics automates labor-intensive farming tasks such as planting seeds, weed control, spraying fertilisers, harvesting, and crop monitoring, alongside soil analysis. These robots, with their precision and efficiency, assist farmers in making more informed decisions to ensure climate-proofing of crops and optimal yields. |
| **RE Powered Storage & Processing** | **Cold Storage and Food process Solutions**, fueled by sources like solar and wind power ensure the efficient preservation of agricultural produce and the processing of food with minimal environmental impact. Renewable-powered cold storage units safeguard the freshness of harvested crops while significantly reducing energy consumption compared to conventional refrigeration methods. Simultaneously, renewable-powered food processing equipment slashes the carbon footprint associated with traditional methods, underlining their role as vital components of sustainable agriculture while offering compelling investment opportunities in the eco-conscious agricultural sector. |

*Source: Author’s Understanding*
### G-H2 production cost components

<table>
<thead>
<tr>
<th>Sector - Technology</th>
<th>Metric</th>
<th>Data</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hydrogen - Electrolyser (Alkaline)</td>
<td>TRL</td>
<td>9 (Market uptake)</td>
<td>IEA</td>
</tr>
<tr>
<td></td>
<td>Fully installed costs (based on 20 MW capacity. Includes project design, planning, contingency, overheads, etc.)</td>
<td>$850/kW (2020, global average) $300/kW (2021, China) $475-$750/kW (2030)</td>
<td>ETC, Making the Hydrogen Economy Possible (2021).</td>
</tr>
<tr>
<td></td>
<td>Cost of electricity</td>
<td>$40-$60/MWh</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Opex excluding electricity (% of Capex)</td>
<td>3 - 5 %</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Capacity utilization</td>
<td>18 - 32%</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Storage and transportation costs</td>
<td>$1-$2/kg</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Total cost of delivered hydrogen (at 7% discount rate)</td>
<td>$3.94-$9.27/kg</td>
<td></td>
</tr>
</tbody>
</table>
Green Investment Opportunities in India

GLOSSARY
### Glossary

<table>
<thead>
<tr>
<th>Term</th>
<th>Description</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adaptation</td>
<td>Climate adaptation means taking action to prepare for and adjust to the current and projected impacts of climate change.</td>
<td><a href="https://gca.org/what-is-climate-adaptation/">https://gca.org/what-is-climate-adaptation/</a></td>
</tr>
<tr>
<td>Advanced / Alternate Cell Chemistry</td>
<td>New generation of advanced storage technologies that can store electric energy either as electrochemical or as chemical energy and convert it back to electric energy as and when required.</td>
<td><a href="https://www.drishtiias.com/daily-news-analysis/national-programme-on-advanced-chemistry-cell-battery-storage#text=Advanced%20Chemistry%20Cell%20(ACC)%3A%20energy%20as%20and%20when%20required">https://www.drishtiias.com/daily-news-analysis/national-programme-on-advanced-chemistry-cell-battery-storage#text=Advanced%20Chemistry%20Cell%20(ACC)%3A%20energy%20as%20and%20when%20required</a>.</td>
</tr>
<tr>
<td>Agtech</td>
<td>Any agriculture technology that can streamline and automate farming processes while improving efficiency, sustainability and profitability.</td>
<td><a href="https://www.ensync-corp.com/blog/what-is-agtech">https://www.ensync-corp.com/blog/what-is-agtech</a></td>
</tr>
<tr>
<td>Ancillary Services</td>
<td>Help maintain the proper flow and direction of electricity, address imbalances between supply and demand, and help the system recover after a power system event.</td>
<td><a href="https://greeningthegrid.org/integration-in-depth/ancillary-services">https://greeningthegrid.org/integration-in-depth/ancillary-services</a></td>
</tr>
<tr>
<td>Battery Energy Storage Systems</td>
<td>A type of energy storage system that uses batteries to store and distribute energy in the form of electricity.</td>
<td><a href="https://www.carboncollective.co/sustainable-investing/battery-energy-storage-systems-bess">https://www.carboncollective.co/sustainable-investing/battery-energy-storage-systems-bess</a></td>
</tr>
<tr>
<td>Battery Management Systems</td>
<td>Ensures the safety of the battery pack by continuously monitoring and regulating parameters like temperature &amp; voltage.</td>
<td><a href="https://robu.in/what-is-battery-management-system-bms-building-blocks-working/">https://robu.in/what-is-battery-management-system-bms-building-blocks-working/</a></td>
</tr>
<tr>
<td>Behind-the-Meter Applications</td>
<td>Provide energy directly to your home or business without going through an electric meter and interacting with the electric grid such as rooftop solar. Ex. Distributed RE Generation.</td>
<td><a href="https://news.energysage.com/behind-the-meter-overview/">https://news.energysage.com/behind-the-meter-overview/</a></td>
</tr>
<tr>
<td>Built environment</td>
<td>The built environment includes all aspects of lives, encompassing the buildings we live in, the distribution systems that provides water and electricity, and the roads, bridges, and transportation systems we use to get from place to place.</td>
<td><a href="https://www.epa.gov/smm/basic-information-about-built-environment">https://www.epa.gov/smm/basic-information-about-built-environment</a></td>
</tr>
<tr>
<td>Capacity Building Programs</td>
<td>A structured initiative designed to enhance the knowledge, skills, and resources of individuals, organizations, or communities.</td>
<td><a href="https://www.rightmanagement.co.in/blogs-articles/choosing-capacity-building-program/#text=A%20capacity%20building%20program%20is%20and%20changing%20circumstances">https://www.rightmanagement.co.in/blogs-articles/choosing-capacity-building-program/#text=A%20capacity%20building%20program%20is%20and%20changing%20circumstances</a>,</td>
</tr>
<tr>
<td>Carbon Contract for Differences</td>
<td>The government or institution agrees with an agent on a fixed effective carbon price to be granted for all emission reductions relative to a conventional technology over a given period. The agent then receives additional payments if the carbon price is below the strike price.</td>
<td><a href="https://henrike-hahn.eu/files/upload/aktuelles/dateien/Study_CCfD_Henrike-Hahn_6.2022.pdf">https://henrike-hahn.eu/files/upload/aktuelles/dateien/Study_CCfD_Henrike-Hahn_6.2022.pdf</a></td>
</tr>
<tr>
<td>Carbon Market</td>
<td>Carbon markets aim to reduce greenhouse gas emissions enabling the trading of emission units (carbon credits), which are certificates representing emission reductions. Trading enables entities that can reduce emissions at a lower cost to be paid to do so by higher-cost emitters.</td>
<td><a href="https://www.indiancarbon.org/the-carbon-credit-market/">https://www.indiancarbon.org/the-carbon-credit-market/</a></td>
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<tr>
<td>Carbon Sequestration</td>
<td>Carbon sequestration is the process of capturing and storing atmospheric carbon dioxide. It is one method of reducing the amount of carbon dioxide in the atmosphere with the goal of reducing global climate change.</td>
<td><a href="https://www.usgs.gov/faqs/what-carbon-sequestration#:~:text=Carbon%20sequestration%20is%20the%20process%20of%20capturing%20carbon%20dioxide%20and%20storing%20it%20in%20the%20atmosphere%20for%20long%20periods%20of%20time%2C%20thereby%20reducing%20global%20warming%2C%20climate%20change%20and%20pollution.">https://www.usgs.gov/faqs/what-carbon-sequestration#:~:text=Carbon%20sequestration%20is%20the%20process%20of%20capturing%20carbon%20dioxide%20and%20storing%20it%20in%20the%20atmosphere%20for%20long%20periods%20of%20time%2C%20thereby%20reducing%20global%20warming%2C%20climate%20change%20and%20pollution.</a></td>
</tr>
<tr>
<td>Catalytic Capital</td>
<td>Defined as debt, equity, guarantees, and other investments that accept disproportionate risk and/or concessionary returns relative to a conventional investment in order to enable third-party investment that otherwise would not be possible.</td>
<td><a href="https://www.macfound.org/press/article/catalytic-capital-work">https://www.macfound.org/press/article/catalytic-capital-work</a></td>
</tr>
<tr>
<td>Circular Economy</td>
<td>The circular economy is a system where materials never become waste and nature is regenerated. Products and materials are kept in circulation through processes like maintenance, reuse, refurbishment, remanufacture, recycling, and composting.</td>
<td><a href="https://ellenmacarthurfoundation.org/topics/circular-economy-introduction/overview">https://ellenmacarthurfoundation.org/topics/circular-economy-introduction/overview</a></td>
</tr>
<tr>
<td>Climate Resilience</td>
<td>Climate resilience is the ability to anticipate, prepare for, and respond to hazardous events, trends, or disturbances related to climate.</td>
<td><a href="https://www.c2es.org/content/climate-resilience-overview/#:~:text=Climate%20resilience%20is%20the%20ability%20to%20better%20cope%20with%20these%20risks.">https://www.c2es.org/content/climate-resilience-overview/#:~:text=Climate%20resilience%20is%20the%20ability%20to%20better%20cope%20with%20these%20risks.</a></td>
</tr>
<tr>
<td>Cool roofs</td>
<td>A cool roof is one that strongly reflects sunlight (solar energy) and also cools itself by efficiently emitting any heat that was absorbed. The roof literally stays cooler and reduces the amount of heat conducted into the building below.</td>
<td><a href="https://coolroofs.org/resources/what-is-a-cool-roof">https://coolroofs.org/resources/what-is-a-cool-roof</a></td>
</tr>
<tr>
<td>Credit Guarantees</td>
<td>A financial arrangement where a third party, often a government agency or financial institution, guarantees to repay a loan if the borrower defaults. It provides lenders with assurance and encourages them to extend credit to borrowers who may not otherwise qualify.</td>
<td><a href="https://www.nabard.org/auth/writereaddata/tender/2501231152/credit-guarantee-a-de-risking-tool-in-rural-finance.pdf">https://www.nabard.org/auth/writereaddata/tender/2501231152/credit-guarantee-a-de-risking-tool-in-rural-finance.pdf</a></td>
</tr>
<tr>
<td>Derisking</td>
<td>Mitigating the risks of doing business in high-risk environments through concessionary finance or investment guarantee.</td>
<td><a href="https://www.lawinsider.com/dictionary/de-riskING">https://www.lawinsider.com/dictionary/de-riskING</a></td>
</tr>
<tr>
<td>Desalination</td>
<td>Desalination is defined as the removing of salt and minerals from sea water to make it suitable for human consumption &amp; industrial use.</td>
<td><a href="https://pureaqua.com/blog/what-is-desalination-definition-meaning">https://pureaqua.com/blog/what-is-desalination-definition-meaning</a></td>
</tr>
<tr>
<td>Early warning systems</td>
<td>An integrated system of hazard monitoring, forecasting and prediction, disaster risk assessment, communication and preparedness activities systems and processes that enables individuals, communities, governments, businesses and others to take timely action to reduce disaster risks in advance of hazardous events.</td>
<td><a href="https://www.unisdr.org/terminology/early-warning-system">https://www.unisdr.org/terminology/early-warning-system</a></td>
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<tr>
<td>Electrolysis</td>
<td>The process of using electricity to split water into hydrogen and oxygen.</td>
<td><a href="https://www.energy.gov/eere/fuelcells/hydrogen-production-electrolysis#:~:text=Electrolysis%20is%20the%20process%20of%20breaking%20water%20into%20hydrogen%20and%20oxygen%20unit%20called%20an%20electrolyzer">https://www.energy.gov/eere/fuelcells/hydrogen-production-electrolysis#:~:text=Electrolysis%20is%20the%20process%20of%20breaking%20water%20into%20hydrogen%20and%20oxygen%20unit%20called%20an%20electrolyzer</a></td>
</tr>
<tr>
<td>Electrolysers</td>
<td>A device used to conduct the process of electrolysis.</td>
<td><a href="https://www.energy.gov/eere/fuelcells/hydrogen-production-electrolysis#:~:text=Electrolysis%20is%20the%20process%20of%20breaking%20water%20into%20hydrogen%20and%20oxygen%20unit%20called%20an%20electrolyzer">https://www.energy.gov/eere/fuelcells/hydrogen-production-electrolysis#:~:text=Electrolysis%20is%20the%20process%20of%20breaking%20water%20into%20hydrogen%20and%20oxygen%20unit%20called%20an%20electrolyzer</a></td>
</tr>
<tr>
<td>Energy Storage Systems</td>
<td>A device or group of devices used to store energy and supply it for later use.</td>
<td><a href="https://www.blackridgeresearch.com/blog/all-you-need-to-know-about-an-energy-storage-system-ess-components-technologies-benefits-risks-applications-bess-battery-energy-storage-system">https://www.blackridgeresearch.com/blog/all-you-need-to-know-about-an-energy-storage-system-ess-components-technologies-benefits-risks-applications-bess-battery-energy-storage-system</a></td>
</tr>
<tr>
<td>Feedstock</td>
<td>Raw material to supply or fuel a machine or industrial process.</td>
<td><a href="https://www.merriam-webster.com/dictionary/feedstock">https://www.merriam-webster.com/dictionary/feedstock</a></td>
</tr>
<tr>
<td>First Loss Capital</td>
<td>Credit enhancement provided by an investor or grantmaker who agrees to bear first losses in an investment in order to catalyze the participation of co-investors that would not have otherwise entered the deal.</td>
<td><a href="https://missioninvestors.org/resources/catalytic-first-loss-capital-research-and-case-studies#:~:text=Catalytic%20first%2Dloss%20capital%20refers%20to%20financial%20assistance%20provided%20to%20deals%20that%20would%20not%20have%20otherwise%20entered%20the%20deal">https://missioninvestors.org/resources/catalytic-first-loss-capital-research-and-case-studies#:~:text=Catalytic%20first%2Dloss%20capital%20refers%20to%20financial%20assistance%20provided%20to%20deals%20that%20would%20not%20have%20otherwise%20entered%20the%20deal</a></td>
</tr>
<tr>
<td>Front-of-the-Meter Applications</td>
<td>Provide energy to off-site locations (like a home or business), and that energy needs to pass through a meter before it can be used. Any energy that is delivered to your home or business from the electric grid comes from a front-of-meter system. Ex. Utility Scale RE generation.</td>
<td><a href="https://www.bostonsolar.us/solar-blog-resource-center/blog/what-does-behind-the-meter-mean/">https://www.bostonsolar.us/solar-blog-resource-center/blog/what-does-behind-the-meter-mean/</a></td>
</tr>
<tr>
<td>Grants</td>
<td>A grant is a quantity of money, i.e., financial assistance, given by a government, organization, or person for a specific purpose which need not be repaid.</td>
<td><a href="https://marketbusinessnews.com/financial-glossary/grant-definition-meaning/">https://marketbusinessnews.com/financial-glossary/grant-definition-meaning/</a></td>
</tr>
<tr>
<td>Lead Acid Batteries</td>
<td>A rechargeable battery that uses lead and sulphuric acid to function.</td>
<td><a href="https://batteryaccessories.net/blogs/news/what-is-a-lead-acid-battery">https://batteryaccessories.net/blogs/news/what-is-a-lead-acid-battery</a></td>
</tr>
<tr>
<td>Levelized Cost</td>
<td>The lifetime cost of an electricity plant, divided by the amount of electricity it is expected to generate over its lifetime.</td>
<td><a href="https://ratedpower.com/blog/lcoe/">https://ratedpower.com/blog/lcoe/</a></td>
</tr>
<tr>
<td>LiDAR</td>
<td>LiDAR, or light detection and ranging, is a popular remote sensing method used for measuring the exact distance of an object on the earth’s surface.</td>
<td><a href="https://www.geospatialworld.net/prime/technology-and-innovation/what-is-lidar-technology-and-how-does-it-work/">https://www.geospatialworld.net/prime/technology-and-innovation/what-is-lidar-technology-and-how-does-it-work/</a></td>
</tr>
<tr>
<td>Lithium-ion Batteries</td>
<td>Rechargeable battery with cobalt, manganese, nickel and/or other metals as cathode and graphite anode.</td>
<td><a href="https://energsoft.com/glossary">https://energsoft.com/glossary</a></td>
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<tr>
<td>Market Linkages</td>
<td>Activity involving identification of the farmer’s products and linking them with commercial and institutional buyers.</td>
<td><a href="https://www.farmersprideinternational.org//market-linkages#:~:text=Market%20Linkage%20Activities%2C%20aggregation%20of%20service%20providers.">https://www.farmersprideinternational.org//market-linkages#:~:text=Market%20Linkage%20Activities%2C%20aggregation%20of%20service%20providers.</a></td>
</tr>
<tr>
<td>Material Recovery Facility</td>
<td>A special facility for separating recyclables materials mechanically or manually. The waste is placed in different categories like glass, plastic, paper, and metal.</td>
<td><a href="https://www.rubbishplease.co.uk/waste-management-glossary/">https://www.rubbishplease.co.uk/waste-management-glossary/</a></td>
</tr>
<tr>
<td>Methane</td>
<td>A greenhouse gas emitted during the production and transport of coal, natural gas, and oil. Emissions also result from livestock and other agricultural practices, land use, and by the decay of organic waste in municipal solid waste landfills.</td>
<td><a href="https://www.epa.gov/ghgemissions/overview-greenhouse-gases">https://www.epa.gov/ghgemissions/overview-greenhouse-gases</a></td>
</tr>
<tr>
<td>Midstream</td>
<td>Midstream refers to agriculture activities involving logistics, processing, and wholesaling.</td>
<td><a href="https://www.linkedin.com/pulse/food-systems-concept-midstream-explained-interview-dr-omamo/">https://www.linkedin.com/pulse/food-systems-concept-midstream-explained-interview-dr-omamo/</a></td>
</tr>
<tr>
<td>Mitigation</td>
<td>Climate Change Mitigation refers to efforts to reduce or prevent emission of greenhouse gases.</td>
<td><a href="https://www.unep.org/explore-topics/climate-action/what-we-do/mitigation">https://www.unep.org/explore-topics/climate-action/what-we-do/mitigation</a></td>
</tr>
<tr>
<td>Net metering policies</td>
<td>Regulations allowing energy consumers to sell excess generated power back to the grid.</td>
<td><a href="https://www.seia.org/initiatives/net-metering#:~:text=Net%20metering%20is%20a%20billing,home%20uses%20during%20daylight%20hours.">https://www.seia.org/initiatives/net-metering#:~:text=Net%20metering%20is%20a%20billing,home%20uses%20during%20daylight%20hours.</a></td>
</tr>
<tr>
<td>Net Zero Emissions</td>
<td>Balance between the greenhouse gases emitted into the atmosphere and those removed or offset, resulting in no additional contribution to global warming.</td>
<td><a href="https://www.nationalgrid.com/stories/energy-explained/what-is-net-zero">https://www.nationalgrid.com/stories/energy-explained/what-is-net-zero</a></td>
</tr>
<tr>
<td>Off-take Agreement</td>
<td>An arrangement between a producer and a buyer to purchase or sell portions of the producer’s upcoming goods.</td>
<td><a href="https://www.investopedia.com/terms/o/offtake-agreement.asp">https://www.investopedia.com/terms/o/offtake-agreement.asp</a></td>
</tr>
<tr>
<td>Outcome-based funding</td>
<td>A financial model in which payments or investments are made based on the achievement of specific, predefined outcomes or performance targets.</td>
<td><a href="https://investinresults.org/chapter/outcomes-based-funding-and-community-finance-ecosystem.html">https://investinresults.org/chapter/outcomes-based-funding-and-community-finance-ecosystem.html</a></td>
</tr>
<tr>
<td>Parametric insurance</td>
<td>Parametric insurance is an insurance type that pre-specifies the amount of payout based on concrete trigger events.</td>
<td><a href="https://techcrunch.com/2023/04/07/insurtech-parametric-insurance/?guccounter=1&amp;guce_referrer=aHR0cHM6Ly93d3cuZ29vZ2xlLmNvbS8&amp;guce_referrer_sig=AQAAAKdXmrQP_EJ4fwMftSiGapFXKymhLxZxibbamOsTany7OzTw87N5UYyqatYvCL-Ks7DxNkI2k82EDcPyqPAfqx5mxGUWxgVetGDHyxFh9Pxb8jGYmkbDCZAHW4aQ2Z0au4HTPKq-nEXrISWSPFiWpalaLY-NjSw6h">https://techcrunch.com/2023/04/07/insurtech-parametric-insurance/?guccounter=1&amp;guce_referrer=aHR0cHM6Ly93d3cuZ29vZ2xlLmNvbS8&amp;guce_referrer_sig=AQAAAKdXmrQP_EJ4fwMftSiGapFXKymhLxZxibbamOsTany7OzTw87N5UYyqatYvCL-Ks7DxNkI2k82EDcPyqPAfqx5mxGUWxgVetGDHyxFh9Pxb8jGYmkbDCZAHW4aQ2Z0au4HTPKq-nEXrISWSPFiWpalaLY-NjSw6h</a></td>
</tr>
<tr>
<td>Patient Capital / Concessional Capital</td>
<td>Loans, grants, or equity investments that are provided on more favourable terms than those available in the market. These terms may include lower interest rates, longer repayment periods, grace periods, or partial guarantees.</td>
<td><a href="https://www.linkedin.com/pulse/concessional-capital-catalyst-impactful-change-higher-leesa-soulodre#:~:text=Concessional%20capital%20refers%20to%20loans,grace%20periods%2C%20or%20partial%20guarantees.">https://www.linkedin.com/pulse/concessional-capital-catalyst-impactful-change-higher-leesa-soulodre#:~:text=Concessional%20capital%20refers%20to%20loans,grace%20periods%2C%20or%20partial%20guarantees.</a></td>
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<tr>
<td>Power-to-X</td>
<td>A collective term for conversion technologies that turn renewable energy into carbon-neutral synthetic fuels.</td>
<td><a href="https://www.ramboll.com/en-apac/net-zero-explorers/power-to-x-explained#:~:text=Power%2Dto%2DX%20(also%2C%20liquid%20fuels%2C%20or%20chemicals.)">https://www.ramboll.com/en-apac/net-zero-explorers/power-to-x-explained#:~:text=Power%2Dto%2DX%20(also%2C%20liquid%20fuels%2C%20or%20chemicals.)</a></td>
</tr>
<tr>
<td>Recycling</td>
<td>The process of transforming materials into raw materials for manufacturing new products, which may or may not be similar to the original product.</td>
<td><a href="https://www.gdrc.org/uem/waste/swm-glossary.html">https://www.gdrc.org/uem/waste/swm-glossary.html</a></td>
</tr>
<tr>
<td>Risk sharing facility</td>
<td>A financial arrangement where multiple entities collaborate to distribute and manage the financial risks associated with a project or investment, reducing the burden on any single participant.</td>
<td><a href="https://www.lawinsider.com/dictionary/risk-sharing-facility">https://www.lawinsider.com/dictionary/risk-sharing-facility</a></td>
</tr>
<tr>
<td>Tertiary reserve ancillary services</td>
<td>Further grid frequency control measures on a slightly longer timescale. Acts as a replenishment for secondary reserves.</td>
<td><a href="https://posoco.in/draft-procedure-for-tertiary-reserve-ancillary-services-comments-invited-till-03rd-march-2023/">https://posoco.in/draft-procedure-for-tertiary-reserve-ancillary-services-comments-invited-till-03rd-march-2023/</a></td>
</tr>
<tr>
<td>Upcycling</td>
<td>Upcycling converts waste and creates something new from it in its current state. During upcycling the original form is retained and processed to add value.</td>
<td><a href="https://www.forgerecycling.co.uk/blog/what-is-the-difference-between-recycling-and-upcycling/">https://www.forgerecycling.co.uk/blog/what-is-the-difference-between-recycling-and-upcycling/</a></td>
</tr>
<tr>
<td>Viability Gap Funding</td>
<td>A capital grant or subsidy or equity from the Central or State Governments to render a Public-Private Partnership (PPP) project financially viable and bankable.</td>
<td><a href="https://prepp.in/news/e-492-viability-gap-funding-indian-economy-notes#:~:text=Viability%20Gap%20Funding%20means%20a%20project%20financially%20viable%20and%20bankable.">https://prepp.in/news/e-492-viability-gap-funding-indian-economy-notes#:~:text=Viability%20Gap%20Funding%20means%20a%20project%20financially%20viable%20and%20bankable.</a></td>
</tr>
<tr>
<td>Waste Aggregators</td>
<td>A middleman who buys recyclable materials from waste generators and itinerant buyers and sells them, after sorting and some processing, to wholesale brokers or recycling industries.</td>
<td><a href="https://www.gdrc.org/uem/waste/swm-glossary.html">https://www.gdrc.org/uem/waste/swm-glossary.html</a></td>
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4. Allotment made for 50 GWh of battery capacity to 4 successful bidders for incentive under (PLI) Scheme for Advanced Chemistry Cell (ACC) Battery Storage, 2022, Ministry of Heavy Industries (https://www.governmentpublicationpage.aspx?PRID=1809037)


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3. How agtech is poised to transform India into a farming powerhouse, 2023, Mckinsey (https://www.mckinsey.com/industries/agriculture/our-insights/how-agtech-is-poised-to-transform-india-into-a-farming-powerhouse)

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23. Budget 2023: Will EVs get cheaper as govt cuts customs duty on ion batteries?, 2023, Mint (https://team-bhp.com/forum/electric-cars/262091-budget-2023-govt-removes-customs-duty-import-goods-machinery-making-li-ion-cells.html#:~:text=%22According%20to%20industry%20experts%20a%20capital%20outlay%20in%20second%20phase%20of%2020%3A%20April%202024%22%20in%20second%20phase%20of%2020%3A%20April%202024%22).


30. Battery Smart raises $33 million in funding from Tiger Global, Blume Ventures, others , 2023, Economic Times (https://m.economictimes.com/industry/renewables/amara-raja-batteries-plans-1-billion-capex-in-5-7-years-to-focus-more-on-new-age-energy-storage-systems/articleshow/85176696.cms).


33. Amara Raja Batteries plans $1 billion capex in 5-7 years, to focus more on new-age energy storage systems, 2021, Economic Times (https://m.economictimes.com/industry/renewables/amara-raja-batteries-plans-1-billion-capex-in-5-7-years-to-focus-more-on-new-age-energy-storage-systems/articleshow/85176696.cms).

34. Exide to invest ₹76,000 crore on lithium-ion cell factory, 2022, The Hindu (https://www.thehindu.com/news/national/karnataka/exide-to-invest-6000-crore-on-lithium-ion-cell-factory/article65277866.ece).


36. AEPPL to invest Rs37.15 billion in second phase of lithium battery plant, 2020, PV Magazine (https://www.pv-magazine-india.com/2020/01/02/aeppl-to-invest-rs37-15-billion-in-second-phase-of-lithium-battery-plant/#text=to%20invest%20Rs%203715%20crore%20in%20second%20phase%20of%20lithium%20battery%20plant%20in%20 Tamil%20Nadu).  


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