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CII
Confederation of Indian Industry

GREEN MANUFACTURING

Imperatives for Indian Industry

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GREEN MANUFACTURING

Imperatives for Indian Industry

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AUGUST 2013 | THE BOSTON CONSULTING GROUP

FOREWORD

India's rapid economic and industrial growth, coupled with urbanization, has led to increasing Green House Gas (GHG) emissions, rising demand for scarce resources like water and increasing waste generation. With all this progress, today, India is the fourth largest economy but at the same time, amongst the major GHG emitters in the world.

Iron and Steel, Cement, Chemicals and Petrochemicals, Pulp and Paper, and Aluminium are the five most energy-intensive industrial sectors in India. These account for 56% of India's industrial energy consumption. While the energy intensity of these industries has shown a decreasing trend, taken together they account for significant industrial GHG emissions.

Large amount of waste generation and climate change driven by emissions is impacting natural ecosystems and is expected to have adverse effects, mainly on agriculture (livelihood of ~58% of the population). Impacts such as sea-level rise, increase in cyclonic intensity, reduced crop yield in rain-fed crops, stress on livestock, reduction in productivity, increased flooding, are amongst the key symptoms that will persist and intensify given an inadequate focus on sustainability.

While specific policy interventions are required to address these challenges; at the same time, industry has an equally important role to play, with energy and emissions being two key areas to particularly focus on. Changing climate also calls for urgency of action in reducing our vulnerability to adverse impacts through sector-specific interventions and efforts.

Over the past few years, both the Government and industry have recognized the challenges posed to our country's environment by industrial growth and rapid urbanization. The government has also set some objectives through its various programmes and missions. Meeting these goals requires collective and wholehearted action from the industry and society at large.

This report captures our need to focus on green manufacturing today, in the context of the challenges and opportunities ahead of us; and it lays out key actions areas that require urgent attention of the industry and government at large. We hope it will spur all of us forward in addressing this important area.

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EXECUTIVE SUMMARY

Our rising population and increasing affluence continues to put tremendous strain on natural resources. The resulting waste from consumption and the costs of processing the same is leading to new awareness around the cost of using natural resources and premiums for greater efficiencies. Rising environmental challenges are driving consumers, government and investors to demand greater focus on sustainable actions from business entities. Many proactive corporations are beginning to view this as an opportunity, to combine measures to address sustainability challenges with competitive advantage in their realm of operations leading to increased revenues and profitability.

Sustainability orientation is proving to have a sound business case rationale for companies by:

- Developing "New Products"
- Exploring "New Businesses"
- Generating efficiencies in the company
- Avoiding regulatory costs (legislation compliance)

A recent joint BCG-MIT survey among managers and executives worldwide indicates a strong perceived link between competitive advantage and sustainability. Nearly 67% respondents believed that pursuing sustainability related strategies are necessary to be competitive. Results also highlight that companies listed customer preferences for sustainable products as a key reason for changing their business model to include sustainability. Resource scarcity, legislative or political pressures are also among the key reasons for this shift in mindset.

Further, despite economic uncertainty, price volatility and limited success in international negotiations, businesses have continued to increase their commitment to sustainability. As per the BCG-MIT survey, a clear majority (68% respondents) indicated that their organization's commitment to sustainability in terms of management attention and investment has increased.

Companies are also drawing a strong connection between innovation and sustainability. Innovation is rising in importance while focus on cost aspects is decreasing. Sustainability is changing from a corporate communication and PR issue to a core strategic topic, closely linked to operations. "Early movers" are embedding sustainability in their vision, organizational set–up, governance model and stakeholder management, amongst other things.

New and emerging technologies are playing a key role in creating green manufacturing processes such as industry efficiency technologies, energy efficient fuels, and green transportation. Information,

Communication and Technology (ICT) is also playing a key role in resource optimisation and as a solutions provider for efficient manufacturing and tracking / reduction / management of wastages. ICT has already begun to play a key role in providing benefits across key sectors such as power, transportation, manufacturing, and in the operation of smart-buildings.

According to a global consumer survey by BCG, increasing number of consumers in developing countries are buying environmentally friendly products and services. There is also an increasing willingness among consumers to pay a premium for green products. The willingness to pay more depends on a product's category and perceived benefits. In developing markets, trust and availability of environmentally friendly products also play a significant role in consumers not buying green.

Government has taken multiple initiatives to promote sustainable manufacturing through several bodies. India has adopted the National Action Plan on Climate Change (NAPCC) in 2008. Government also plans to achieve reduction in emissions through a multi-sector low carbon development strategy as per the 12th Five Year Plan. In addition, the Government has set up a National Clean Energy Fund (NCEF) aimed at supporting projects, programmes and policies that promote clean energy technologies.

The National Mission for Enhanced Energy Efficiency (NMEEE) is one of the key focus areas for government action on energy efficiency. Within it, a scheme called 'Perform Achieve and Trade' (PAT) for trading in energy efficiency certificates has been formulated and initiated. Central Electricity Regulatory Commission (CERC) is developing market-based instruments such as Renewable Energy Certificate (REC) mechanism in which utilities companies should procure a certain percentage of their electricity from renewable energy sources. Department of Industrial Policy and Promotion's (DIPP) manufacturing policy also outlines some of the key initiatives and incentives such as creation of Green Manufacturing Committee, Technology Acquisition and Development Fund, Industry emission norms, amongst other initiatives.

There is a lot of action happening on the ground with the risk of confusion and getting lost in tactical approaches. Going forward, we propose a 10 point action agenda that will enable policy makers and industry to drive sustainability objectives in a structured and comprehensive manner:

1. Business entities need to articulate their green manufacturing related strategies at the earliest and ensure these are an integral part of their overall business strategy to remain competitive.

2. Business entities must develop a clear business case and value proposition for sustainability. This must be accompanied with clarity on necessary changes to business models required to incorporate sustainability in day-to-day operations and decision making.

3. Business entities must ensure focus on development of green products for customers and providing them with due recognition of their quality / trustworthiness as green products.

4. Business entities must define clear internal governance mechanisms and embed responsibilities within their organizational structure to drive and ensure ownership of the sustainability agenda.

5. Manufacturing strategy needs to incorporate the development and leveraging of ICT tools that enable green manufacturing.

6. Business entities need to systematically evaluate, embrace and leverage new legislations and policy measures being put in place to speed up the adoption of green technologies and focus on sustainability.

7. Policy makers need to sharpen policy measures that promote private sector investment in green manufacturing.

8. Policy makers must establish and widely promote a framework to recognize green products through 'Green' ratings based on criteria that recognizes green manufacturing and operations as a key element, apart from performance characteristics of the product.

9. Policy makers need to strengthen policies and coordinate incentives from multiple agencies to promote efficiency measures during manufacturing and production within key energy and resource intensive industries.

10. Government should ensure greater coordination across institutions promoting sustainability and green manufacturing to hold private companies accountable while avoiding market distortions resulting from green manufacturing incentives.

INTRODUCTION

The Sustainability Challenge

Our world is facing a multi-dimensional challenge, and if left unaddressed, it threatens to affect and shape adversely the fragile eco-systems and environment we all live in.

Firstly, with ever increasing population and industrialization, the consumption of natural resources is rapidly on the rise, while their availability is shrinking. This has led to mismatches in demand-supply and highly fluctuating prices, impacting both corporate margins and consumer spend. There is an urgent need to adequately manage the use of these resources in a sustainable manner and at the same time develop alternatives which are less scarce.

GHG emissions have increased rapidly in the recent past and their growth is further accelerating. As a consequence, global temperatures have increased by 0.74°C over the last century - the fastest warming observed in the history of Earth. At the current rate, emissions will double by 2050, compared to the 2000 levels. This could mean a corresponding temperature rise of 4-6°C over pre–industrial levels by the end of this century. This unprecedented change is expected to have a large impact on the global ecosystem, hydrological system, sea level and crop production and related activities.

Increased industrialization and urbanization have led to significant growth in waste generation and environmental pollution. Industrial waste with chemical composition can be potentially dangerous to health, and its disposal without treatment is leading to land and water pollution. The release of industrial effluents in rivers and other water bodies is destroying local habitats. As the demand and use of electronic products rise, e–waste is also becoming a major source of environmental pollution.

A major environmental concern in urban centres relates to high levels of water pollution due to poor waste management and disposal, inadequate sewerage and drainage, and improper disposal of industrial effluents. The dumping of solid waste in low-lying areas contributes to both land and groundwater pollution. This is leading to a challenge already apparent on sustaining adequate availability of fresh water supplies.

Transformation to Green Manufacturing

Manufacturing companies can and must play a large role in addressing these concerns by focussing on the following:

Firstly, green energy involves production and use of cleaner energy. Green energy includes both deploying renewable energy sources like CNG, wind, solar and biomass, and achieving higher energy efficiency in operations.

Developing greener products is the second step in this transformation. 'Recycled', 'Low carbon footprint', 'Organic' and 'Natural' are associated with Green products. Developing Green products can often mean higher costs. However, by developing green products that are sought by consumers, and effectively marketing them, companies can derive additional volumes and price premiums, which can offset their cost of development.

The third area is implementing green processes in operations. This entails efficient use of key resources, reducing waste generation through lean operations, bringing down the carbon foot-print and conserving water. Employing green processes improves operational efficiency and lowers costs.

Key Drivers and Benefits

Competitive Necessity

Sustainability initiatives have a positive impact on the environment and also have a business case rationale specifically oriented to creating value and competitive advantages for companies, such as:

- Developing "New Products"
- Exploring "New Businesses"
- Generating efficiencies in the company
- Avoiding regulatory costs (legislation compliance)

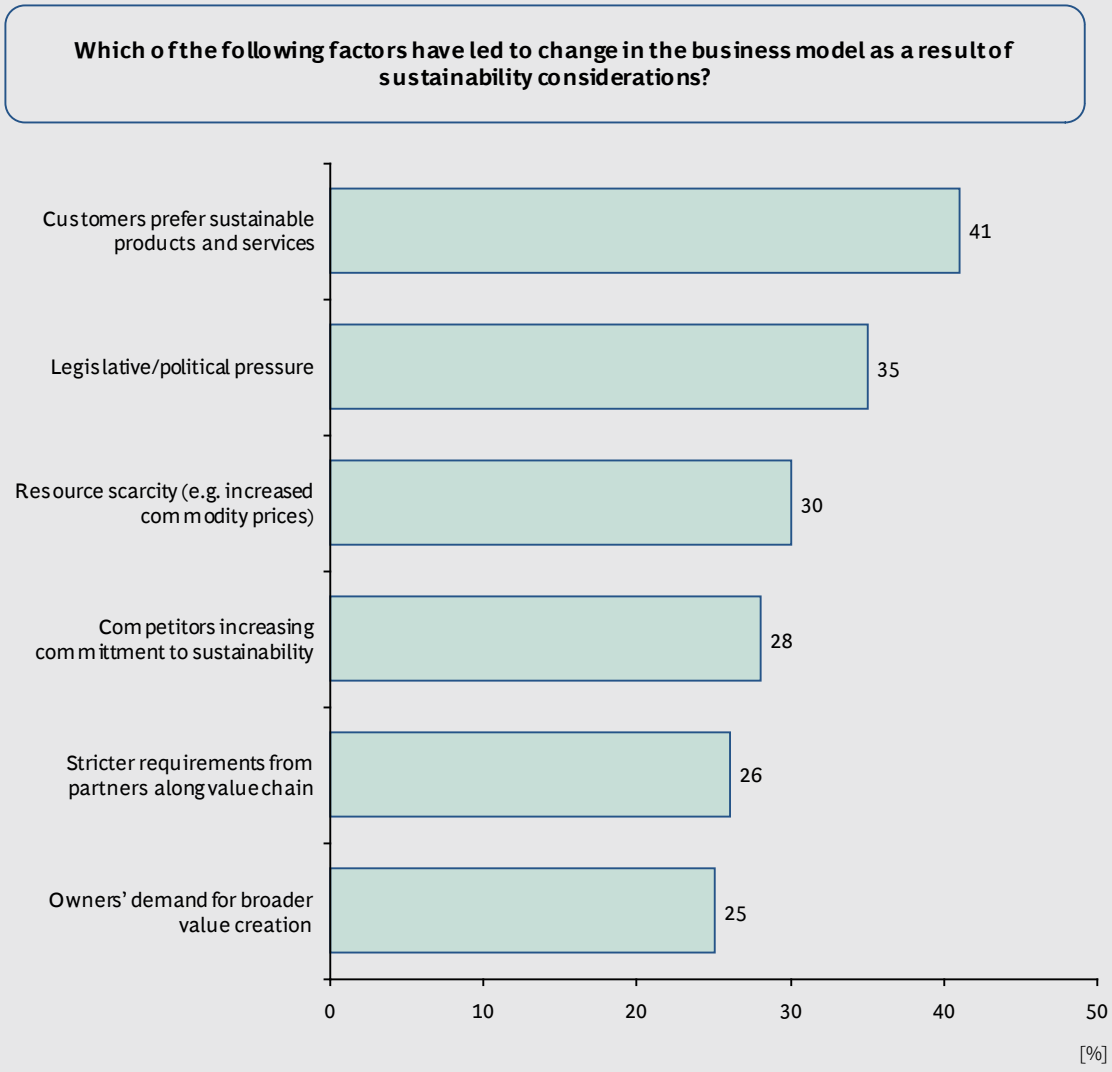
Sustainability is increasingly becoming necessary to be competitive for a firm, according to a joint BCG-MIT survey recently conducted among managers and executives from companies around the world (4000 managers from 113 countries). Managers believe that there is a strong link between competitive advantage and sustainability. Over 67% survey respondents believed that pursuing sustainability related strategies are necessary to be competitive. A large number of companies feel the pressure and need for sustainability related strategies; 33% of the ones that used to believe it is future thing in a previous version of the survey now see it as a current necessity.

In several product industries such as Commodities, Automotive, Energy and Utilities, Construction, etc; sustainability initiatives are seen as highly necessary to be competitive as well as one having strong business case for sustainability.

Drivers for Embracing Sustainability

The reasons or key drivers for the strengthening trend in favour of sustainability globally are numerous, involving both internal and external drivers. According to the joint BCG-MIT survey, customers are the most common reason for companies to change their business models to meet sustainability requirements. Over 40% of companies listed customer preferences for sustainable products as the key reason for changing their business model. Resource scarcity, legislative or political pressures are also among the key reasons for this business shift. Exhibit 1 lists the key factors for the business model shift among companies globally.

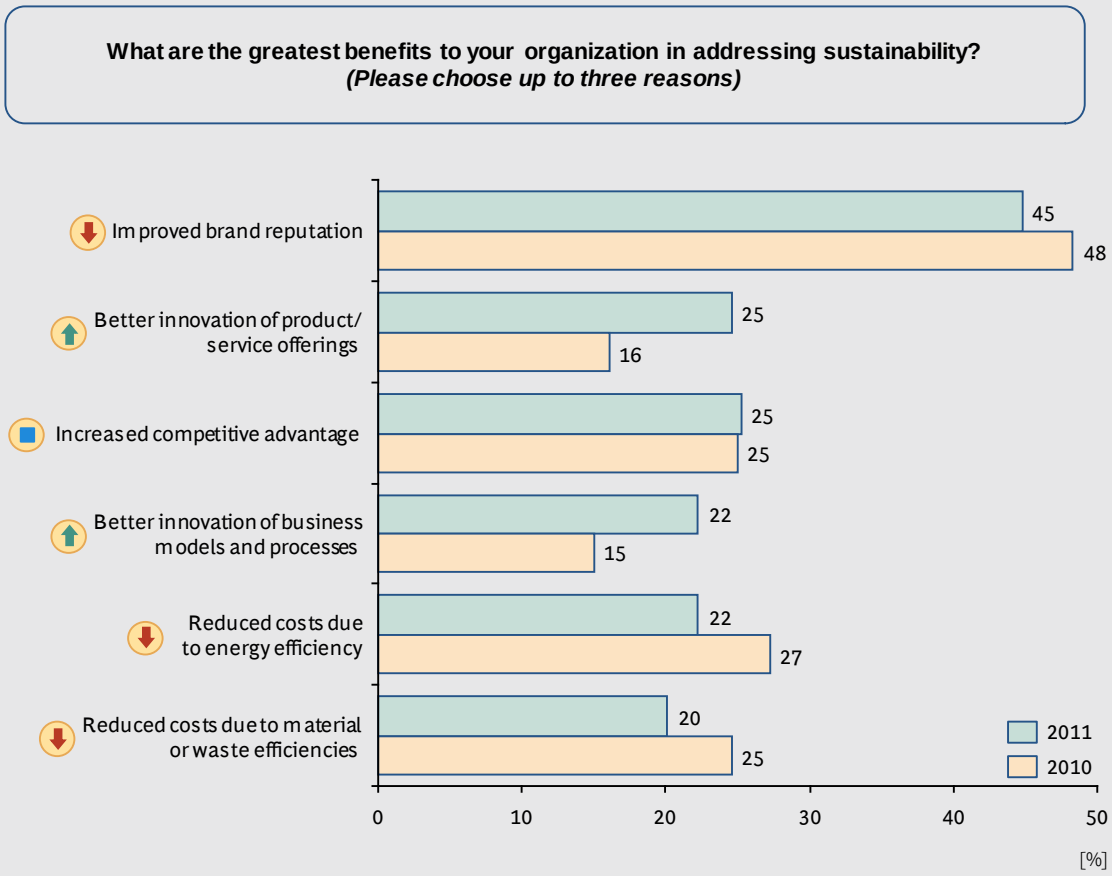
Exhibit 1: Drivers of sustainable business practices (Focus on top 6)



Source: 2011 BCG-MIT SMR Sustainability and Innovation Survey
Note: Commercial-specific survey data only – does not include Academic, Governmental or Non-profit categories; only showing top 6 named benefits

Increased brand reputation is seen as one of the key benefits of pursuing sustainability initiatives. There is a trend towards companies also drawing connection between innovation and sustainability. Innovation in product offerings and business models is seen as an advanced form of benefit from sustainability compared to the "low hanging fruit" of cost reduction. Exhibit 2 lists the key perceived benefits of pursuing sustainability strategy.

Exhibit 2: Businesses recognize new benefits from Sustainability (Focus on top 6 benefits)



Source: 2011 BCG-MIT SMR Sustainability and Innovation Survey
Note: Commercial-specific survey data only – does not include Academic, Governmental or Non-profit categories; only showing top 6 named benefits

Identifying Sustainability Related Opportunities

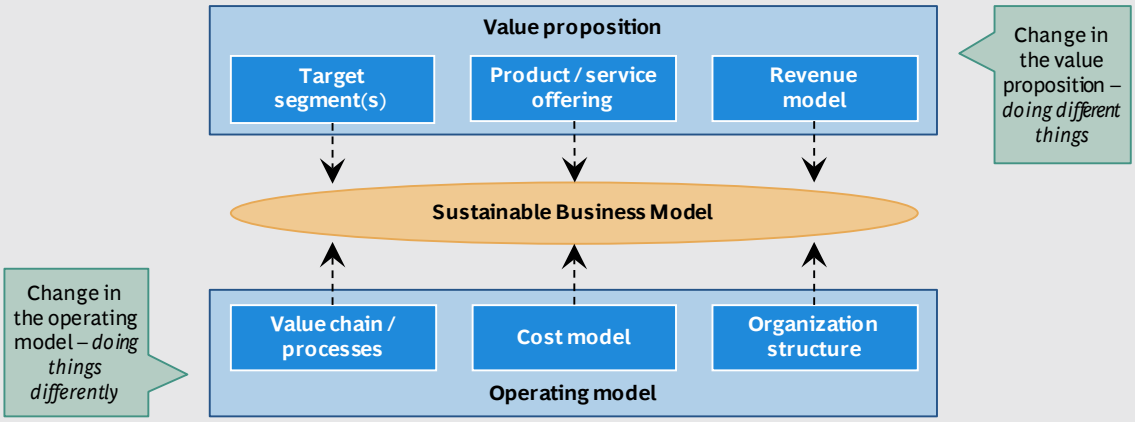
Success in adopting green requires companies to understand the full set of facts on costs and benefits. Companies then select green initiatives based on both, economic and strategic assessments of the choices they identify. In a broad framework, (Exhibit 3) following are the three elements for identifying sustainability related opportunities:

1. Incremental efficiencies: Conduct business in a more efficient and a more effective way.

2. Change in operating model: Adapt operating model in order to do things differently; for example, use collaboration / partnerships, etc. Here the main focus is on changes of the value chain / processes, the cost model or the organization structure.

3. Change in value proposition: Changing which customers are served or in which way. Here the focus is on changes of the target segments, the product / service offering or the revenue model.

Exhibit 3: Business model to identify opportunities related to sustainability



In addition, incremental changes are important levers as well even if they don't change a company's business model itself

Key Obstacles / Challenges in Embracing Sustainability

Companies face challenges on various fronts, most critically in providing leadership. Companies also have to transition from approaching green as limited, often isolated initiatives to a more holistic approach. This calls for a major transformation which to succeed, requires a systematic approach and a framework. Three principal impediments companies often face are as follows:

- Companies don't fully understand drivers and issues relevant for their industries, and what sustainability means to them.

- Companies face difficulties in modelling the business case for sustainability. Often the economics are not well understood as technologies and costs are still evolving. According to our survey, ~55% of the companies are either not able to develop a clear business case or find it difficult to develop after having tried due to following key reasons:
  - Competing priorities
  - Difficulty quantifying intangible effects of sustainability strategies (for example, brand reputation, employee hiring, retention and productivity)
  - Difficulty capturing comprehensive metrics about sustainability impact of operations

- Difficulty quantifying sustainability–related risks.

Companies adopting green initiatives perform these activities as peripheral to their core business and not integrated into their corporate strategy. Hence the execution is flawed and they often fail in realizing the full benefits.

MAKING SUSTAINABILITY WORK

Sustainability on Management Agenda

Despite economic uncertainty, price volatility and limited success in international negotiations, businesses have continued to increase commitment to sustainability. As per the latest BCG-MIT survey 68% companies indicated that their organization's commitment to sustainability in terms of management attention and investment has 'Somewhat / Significantly' increased' while 26% indicated 'Business as usual / no changes'.

Sustainability has become a permanent item on the management agenda as per 70% of the surveyed organizations. In addition, the ones that have it permanently on the agenda also plan to increase commitment. Only 1% of the organizations plan to cut back commitment to sustainability in the following year.

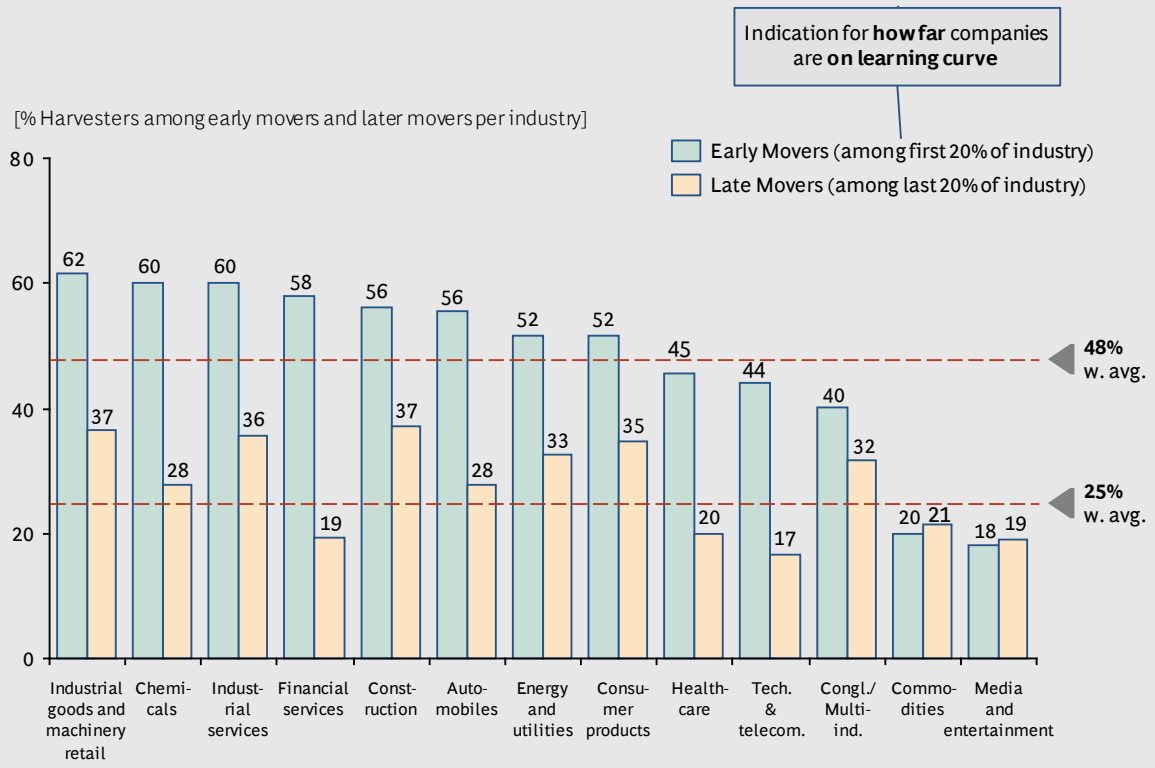
Some companies started to work with sustainability early. The industries with the highest direct impact on their surroundings both environmentally and socially are typically the industries starting to focus on sustainability first. Industries like mining, automotives and energy / utilities have a significant environmental footprint. These industries are therefore "mature" in sustainability and a sustainability strategy is already a prerequisite - a must have to stay in business - and the best firms are able to capitalize on their activities beyond pure compliance. For others, like media and entertainment, healthcare, the need is less urgent, although the shift towards sustainability is happening. Across all industries, 75% of the surveyed organizations have plans to increase organization's commitment to sustainability. That also applies to the relatively late moving industries like financial services & media and entertainment.

Leaders in Sustainability: Key Lessons

"Early movers" are likely to profit more across industries and therefore it is critical to start early and take the lead. Exhibit 4 indicates profitability of "early movers" vs. "late movers" across different industries. It is evident that even though it is well possible to profit when moving in late, the advantages are way higher after having taken a lead role in shaping the sustainability agenda early on. Additionally, industry sustainability "maturity" doesn't decrease chances for a new player to profit as this trend is seen across all industries - mature ones and others. There is a learning curve; and companies need to learn fast how to succeed in sustainability.

Exhibit 4: Early movers on sustainability likely to profit across all industries

Early movers see on average twice as often profit than late movers



Source: 2011 BCG-MIT SMR Sustainability and Innovation Survey
Note: Early / Late movers defined as companies that are at least among the first / last 20% or earlier / later entering S; Commercial-specific survey data only – does not include Academic, Governmental or Non-profit categories; Excluded "always on agenda" – not necessarily among early movers since company might have entered late.

Amongst the leaders, sustainability is changing from a corporate communication and public relations issue to a core strategic topic, closely linked with operations. “Early movers” are embedding it in their vision, organisational set-up, governance model and stakeholder management and collaborations / partnerships.

“Early movers” look beyond brand and perception as benefits from sustainability. According to the joint BCG-MIT survey, no more than 14% of the ones that entered to benefit from perception aspects, see any profit. Brand value is more an outcome of sustainability oriented actions. They focus more on the following key aspects:

- Increased competitive advantage
- Better innovation of product / service
- Better innovation of business models and processes
- Access to new markets
- Increased margins or market share due to sustainability positioning

Successful businesses are among the ones which develop a clear business case or proven value proposition for addressing sustainability. As many as 57% "Profiteers" have a clear business case as opposed to only 18% having a business case amongst "non-profiteers".

"Profiteers" also undertake profound changes in business models to incorporate sustainability. According to the survey, as many as 60% of "profiteers" had changed their business model as a result of greater sustainability focus, compared to only 30% "non–profiteers" who had changed their business model. In addition, "profiteers" also have a clear and tighter governance structure with higher number of companies having:

- Clear communication of responsibility of sustainability
- Company / operational KPIs related to sustainability
- Personal KPIs related to sustainability
- Link between sustainable performance and financial incentives

"Profiteers" also have more sustainability attuned organizational set-ups as compared to others. Higher number of "profiteer" companies reported the following:

- Strong CEO commitment to sustainability
- Separate sustainability reporting
- A separate function for sustainability
- Responsible person for sustainability per business unit

"Profiteers" also work together with different stakeholders to find better solutions, for example, working with suppliers to set sustainability related standards.

Sustainability Champions—Case Studies

According to a recently conducted, joint BCG and WEF study; 16 emerging market based companies were identified as "New Sustainability Champions". These companies provide inspiring examples for any corporation around the world interested in tackling the challenges of performance, growth, innovation and sustainability. They managed to:

- Proactively turn constraints into opportunities
- Embed sustainability into their corporate culture
- Actively shape their business environments

We capture here two examples of manufacturing companies from India and China, namely 'Jain Irrigation' and 'Broad Group' respectively, which are amongst the 16 leading sustainability champions.

Case Study—Jain Irrigation Systems (India)

Indian small–scale farmers often use flood irrigation due to poor access to financing and limited knowledge that is required to operate modern irrigation systems. Jain Irrigation Systems developed a drip irrigation system designed specifically for farmers with small land holdings. The company teaches "precision farming" in order to enable farmers to optimize the balance between fertilizers, pesticides, water and energy leading to an increase in agricultural output. The company teaches the benefits of sustainable farming to farmers even if they are not current customers. It also runs training programs for stakeholders such as government and lenders to promote micro–irrigation.

Given the high percentage of farmers with small land holding in India, the company's impact has been far-reaching. Those using products of Jain Irrigation Systems have recorded increases in yield between 30% - 200%, with water savings of the order of 50% at the same time compared to when they were using flood irrigation based systems. Crops are healthier and mature more quickly, generating higher and faster returns on investment and also savings of ~30% due to fertilizer efficiency. In addition, previously barren ~1,000 acres of terrain is now under cultivation due to the company's products.

Case Study—Broad Group (China)

Broad Group is one of world's leading producers of non-electric air–conditioning equipment. It has invested heavily in non–electric air conditioning technology, adapting it to local challenges over the years. Its non-electric coolers use natural gas and other heat sources to produce the same cooling effect. The chillers it manufactures are almost twice as energy efficient as compared to conventional electric units. More so, the company has diversified into other sustainable technologies such as, for example, air filters that reduce indoor air pollution. It has also pioneered sustainable building technologies such as customizable pre–fabricated construction modules that can reduce electricity consumption in buildings by up to 80%. One device developed by the company to measure air pollution has even been miniaturized to fit inside a mobile phone. The company also has a R&D facility dedicated for research on building low cost, globally relevant, energy efficiency products and solutions.

By developing, manufacturing and promoting environment friendly products, the company has accelerated a change in attitude towards the environment. Domestic demand for energy efficient products has remained strong owing to heightened awareness about the need for energy efficiency.

GREENING THE SUPPLY CHAIN

Green Supply Chain Strategy

Green supply chain strategy is integrating environment thinking into supply chain management. This includes product design, material sourcing and selection, manufacturing processes, delivery of the final product to the consumers, and end–of–life management of the product after its useful life.

A few key examples of quick win improvements of supply chain initiatives include:

- Waste reduction (raw materials, product packaging, etc.)
- Freight optimization
- Increase in energy efficiency in buildings, transportation
- Increase in renewable energy use
- Use of environmentally friendly raw materials (for example, no toxic chemicals)

A few examples of fundamental shifts in Supply Chain involve:

- Retirement of less efficient production facilities
- Re–design of network to reduce transportation needs

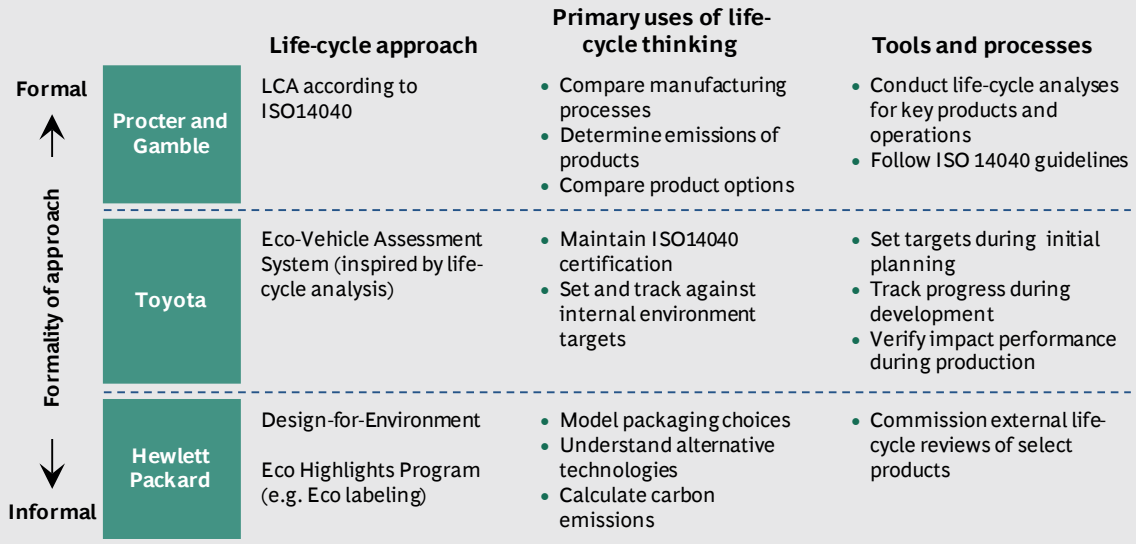
Critical Supply Chain Levers for Green

Some of the critical supply chain levers for Green are as follows:

Life–Cycle Analysis

Life cycle analysis involves considering the holistic environmental impact of enterprise, from sourcing to post–use. Cradle-to-Grave approach from material acquisition to recycling process is considered to be most environmentally ideal. Life-cycle integrity approach is generally best applied at various points throughout the product development process. Several life–cycle approaches used are depicted in the exhibit 5 below:

Exhibit 5: Range of life-cycle approaches being leveraged



Source: Proctor and Gamble website and Annual Sustainability Report; Toyota website and 2008 North America Environmental Report; Hewlett Packard website and white paper: "The Environmental Product Life Cycle: Environmentally Friendly Design"

Reverse Logistics

Reverse logistics is the handling of reverse flows of products at the end of useful life and requires players in the supply chain to address the following:

- Return of items that are defective, damaged or unsold
- Return of items at the end of their lifetime for optimal recycling and proper disposal
- Return of item packaging for proper disposal

Historically, companies have optimized supply chains but placed less emphasis on planning return flows mainly because it was viewed as a cost rather than a revenue opportunity. Lately, the return rates are increasing because of lax return policies at retailers to provide high levels of customer service. Pressure on margins and the recent focus on sustainability have forced companies to revisit this issue once again. Manufacturers are discovering that value can be captured from such returns by refurbishing and reselling. In addition, laws are also forcing companies to develop programs to promote recycling and ensure better end of life product disposal.

Some of the supply chain considerations for the reverse logistics include:

- Centralized Return Centres (CRC) - for example, Amazon uses separate DC for reverse logistics
- Outsourced reverse logistics - 3PLs offer comprehensive range of services from remanufacturing to remarketing and liquidation
- Use of secondary reselling channels

- Secure destruction services
- Reduced incidence of unsellables by identifying root causes for creation of such stock, addressing the same jointly with retailers

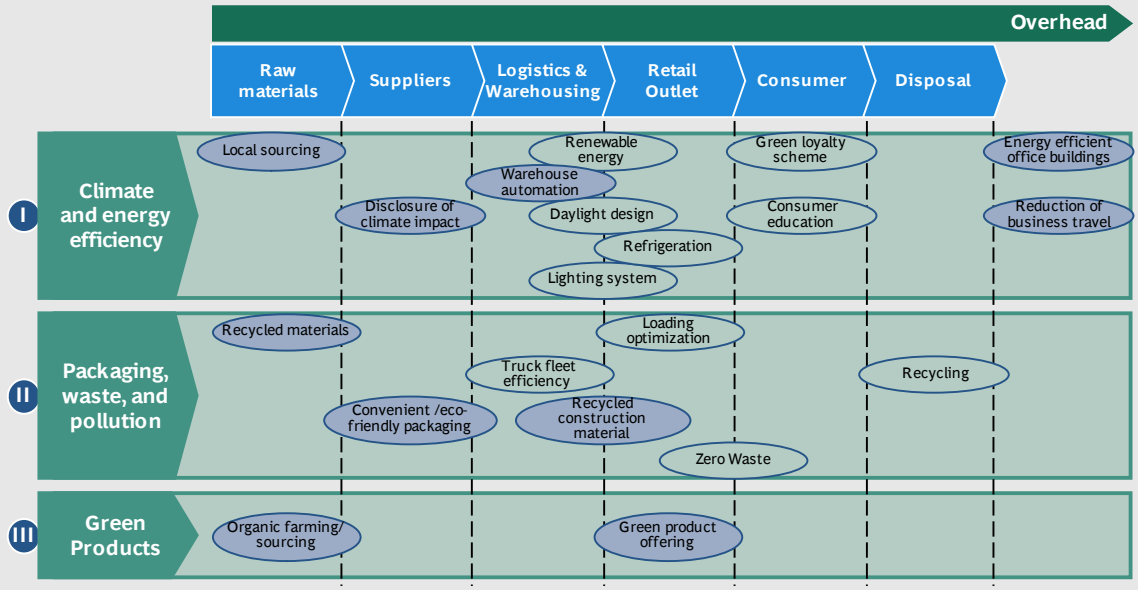
External Partnerships

Sustainability can also be viewed through a wider lens of external partnerships with several stakeholders such as suppliers, third parties, government / NGOs, etc. Examples of joint–action with different stakeholders to achieve sustainability are as follows:

- Key trade partners: Share knowledge and set joint objectives with trade partners to drive consumer awareness, demand and loyalty
- Government / NGOs: Engage government and NGOs as allies and advisors as well as regulators
- Community / Employees: Create sustainability dialogue with communities and employees to maximize local impact and participate in ideation and execution
- Suppliers / Industry: Reinforce leadership through cooperative industry action and promotion of common initiatives

Exhibit 6 outlines a range of initiative options for companies to improve environmental impact along the value chain.

Exhibit 6: Initiative options for sustainability goals along value chain



Source: BCG project experience

GREEN MANUFACTURING

KEY ENABLERS: TECHNOLOGY AND INNOVATION

Key Emerging Technologies for Green Manufacturing

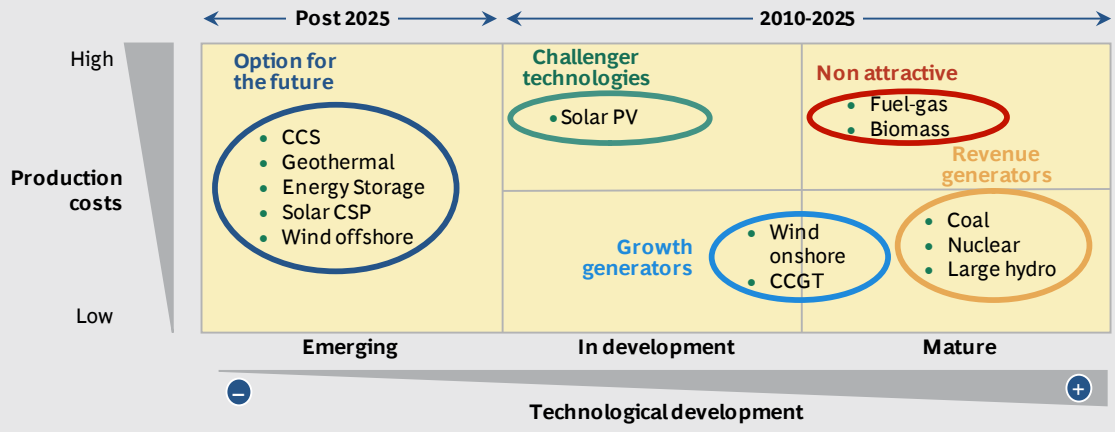
Today, there are a range of new and emerging technologies that aid in both, making the traditional businesses greener, as well as creating new ones. For example, technologies for reducing GHG can be classified into five broad categories.

Carbon Sinks

This category consists of emergent technologies related to Carbon Capture and Storage (CCS) that enable capturing and storing CO2 in ways such that it does not enter the atmosphere. For example, CO2 from fossil fuels is trapped and stored in underground wells under intense pressure which keeps it in liquefied form.

CCS is perceived to be a relatively unattractive technology in the short term due to uncertain regulation and market developments. CCS growth is highly dependent on government support but there has been no regulatory framework developed for CCS in the last 3–4 years - renewable and energy efficiency regulations and targets are more developed than those for carbon markets and CCS. Most countries have adopted official plans and targets for future renewable development. Also there are substantial technological challenges in carbon capture and storage in the absence of a dominant technology. CCS is seen as an option for the future (post 2025) by utilities and technological companies. Power generation technological portfolio is covered from technological development stand–point and production costs in Exhibit 7.

Exhibit 7: Power generation technological portfolio



Efficient Fuels

This category encompasses a class of technologies that lead to cleaner power. Examples include biomass, hydro power, Integrated Gas Combined Cycle (IGCC / CCGT), etc. The landscape of technological development and production costs is indicated in Exhibit 7.

Supercritical and ultra–supercritical thermal power plants can, for example, achieve efficiencies as high as ~40% and ~45% respectively, compared to about 35% achieved by subcritical plants.

Integrated gasification combined cycle technology (IGCC / CCGT) can make coal–based power generation 10% more efficient. For every 1% rise in efficiency, there is a 2% decrease in CO2 release. In addition, there is a substantial reduction in NOx emissions.

Natural gas based power generation is also cleaner than coal–based generation as CO2 emissions are only 50% compared to coal.

Biomass is a key renewable alternate option for power generation through straight biomass combustion or biomass gasification. Biomass based power technologies avoid problems associated with ash disposal from coal based plants and the ash here can be used for improving productivity in agriculture.

Consumer Green

This involves using clean and efficient fuels at the user end and solutions covering demand side management. For example, off–grid solar power applications like solar water heating and building insulation are included in this category.

Green Transportation

Electric vehicles, fuel cells, and bio–diesel are some examples of this category.

Wide range of technology under development in Electric Vehicles (EV) market is as below:

- Battery Electric vehicle (EV or BEV): These use electric motors for propulsion and batteries are used as energy sources.

- Hybrid Electric Vehicle (HEV): It has conventional internal combustion engine (ICE) propulsion system with an electric propulsion system. HEVs are usually categorized as mild hybrids or strong hybrids, depending on the degree of usage of the electric propulsion system.

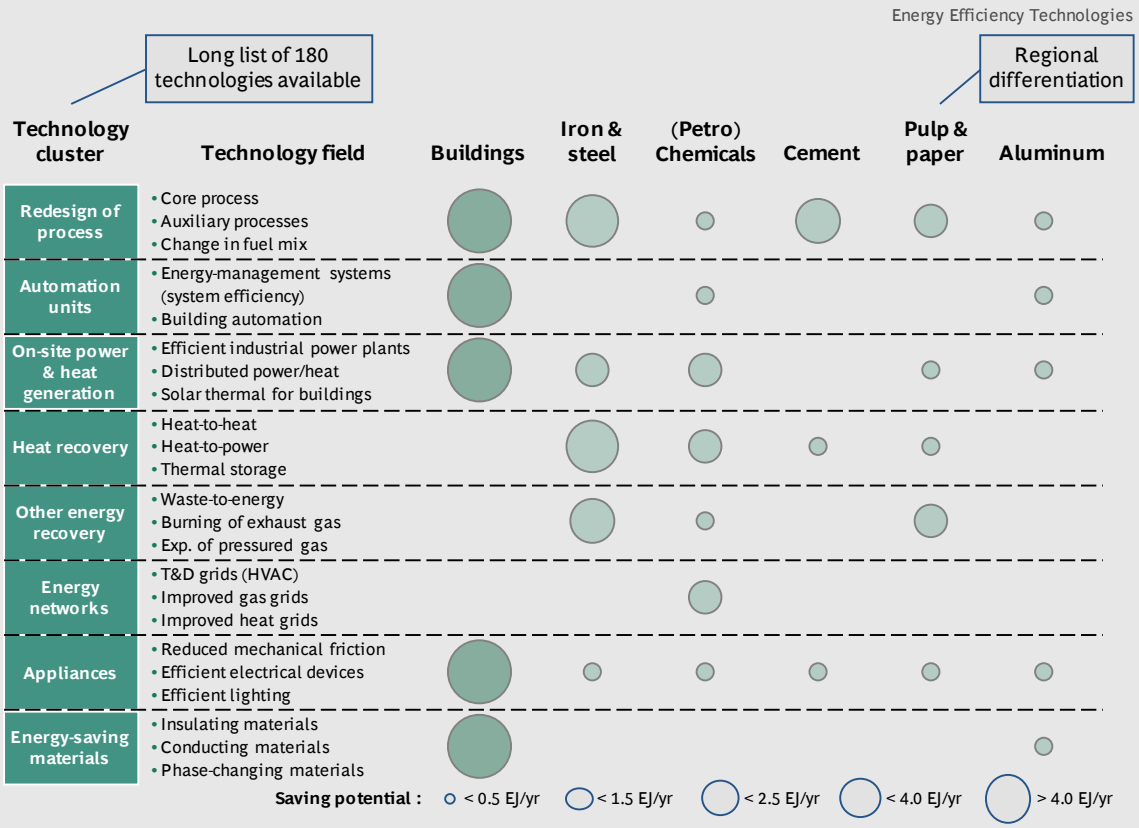
- Fuel–Cell Vehicle (FCV): They are a special type of EV that uses a fuel cell as an energy source and for storage. Fuel cells create electricity to power an electric motor using hydrogen and oxygen from the air.

Industry efficiency

This category refers to the use of green production methods and technologies in traditional industries such as iron and steel, cement, refining, chemicals, etc. Multiple technologies are emerging in each of these industries. Exhibit 8 indicates the technologies and the potential savings they could create in different industries.

Exhibit 8: Efficiency Technologies across sectors

Energy savings potential by technology cluster and application area



Source: IEA, BCG analysis

Each technology within these five categories mentioned above can be further characterized on two dimensions - maturity (nascent versus established) and availability (local versus global). While some technologies such as biomass, hydro and off–grid solar score higher in terms of their relative technological and commercial maturity, there are others like tidal waves, wind offshore and concentrated solar power which are relatively nascent. Similarly, while technologies such as IGCC and CCS are globally available for use, others such as geo–thermal and waste to energy are available only in select geographies.

ICT: An Enabler for Green Manufacturing

Role of ICT in several key resource intensive sectors to reduce emissions and increase efficiencies is presented below:

Power Sector

ICT can play a role in reducing inefficiencies in power sector and dependence on fossil fuels through following sub-levers:

- Facilitating integration of renewable - Integration of renewable in power generation, virtual power plant (Roof top solar, MicroCHP, micro–wind, etc.) and integration of off–grid renewable.
- Enabling smart grid - Smart grid is an electrical grid that uses ICT to gather and act on information such as data behaviors of suppliers and consumers to act in a manner that optimizes production and distribution.

Transportation Sector

Adoption of ICT in transportation has been driven by many factors, such as reducing price, reducing size and weight of equipment, emergence of smart–phones and cloud services for data analysis. Examples of some of the key applications include:

- Consumer based Telematics: Honda's Fit Electrical Vehicle (EV) used IT to enhance EV experience.
- Wireless fleet management: Optimization of pick–up route based on the end–coordinate requirement, for example, wireless signals from full waste containers used in planning route for pick–up trucks.
- Location based fleet management: Trucking with GPS tools make distribution more efficient by helping truck drivers navigate to their destinations, avoiding traffic and cutting fuel use.

Manufacturing Sector

Key ICT related sub-levers to achieve efficiency through ICT in this sector are as follows:

- Automation of industrial processes - Involves modernizing plants which will be controlled by ICT devices. Higher level of control of equipment will help reduce and optimize energy use for a given manufacturing process.
- Optimization of variable speed motor systems - Traditional motor systems are designed to operate at continuous rate and do not account for strain placed on them by varying loads. Having motors operate at constant rate is inefficient and thus a waste of electricity. Variable speed motor systems controlled through ICT tools can overcome this limitation.
- 3D manufacturing or 3D printing - Object is created by laying down successive layers of raw materials through an additive process. 3D printing thus has the potential to be disruptive to entire manufacturing process and could reduce the amount of raw material required and transport of end–products.

Buildings Sector

Energy use in buildings is a major source of emissions. Energy waste is usually high due to inefficient heating, cooling, lighting or power systems. ICT could play a key role in reduction of energy consumption. An important sub–lever is therefore building management systems. These computer based systems control and monitor buildings' mechanical and electrical equipment including ventilation, lighting, power systems, fire systems and security systems.

- Cisco Connected Real Estate (CCRE) is an example of merging ICT and building control systems into one infrastructure. The system thus integrates building automation functions and optimizes power management.

TAKING GREEN PRODUCTS TO MARKET

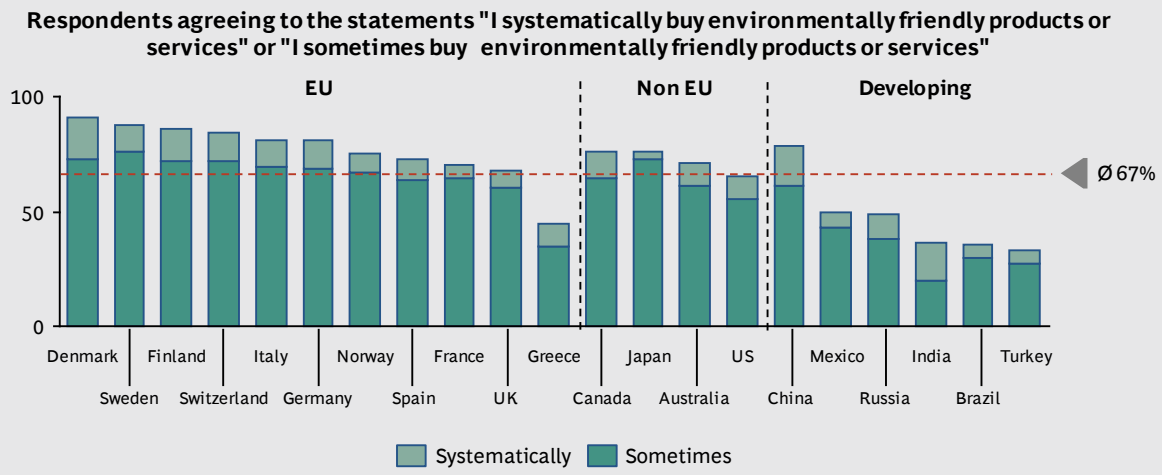
Consumer Demand for Green: Trends, Drivers, Barriers

Consumer habits are turning to more sustainable products and services. They are demanding sustainability proofs from the products and services that they buy. The economic crisis has also not dulled consumer commitment to environment friendly products.

Increasing number of consumers indicate that they systematically buy environmentally friendly products and services. Exhibit 9 indicates the regional trends in systematically and occasionally buying green. In developed countries, the number of customers buying green is relatively high. Among developing nations, willingness is currently on the lower side (except China). In India, 16% respondents indicated buying green products systematically while 20% indicated buying them 'sometimes'.

Exhibit 9: Green has become a consumer reality

Significant customer demand linked to sustainability

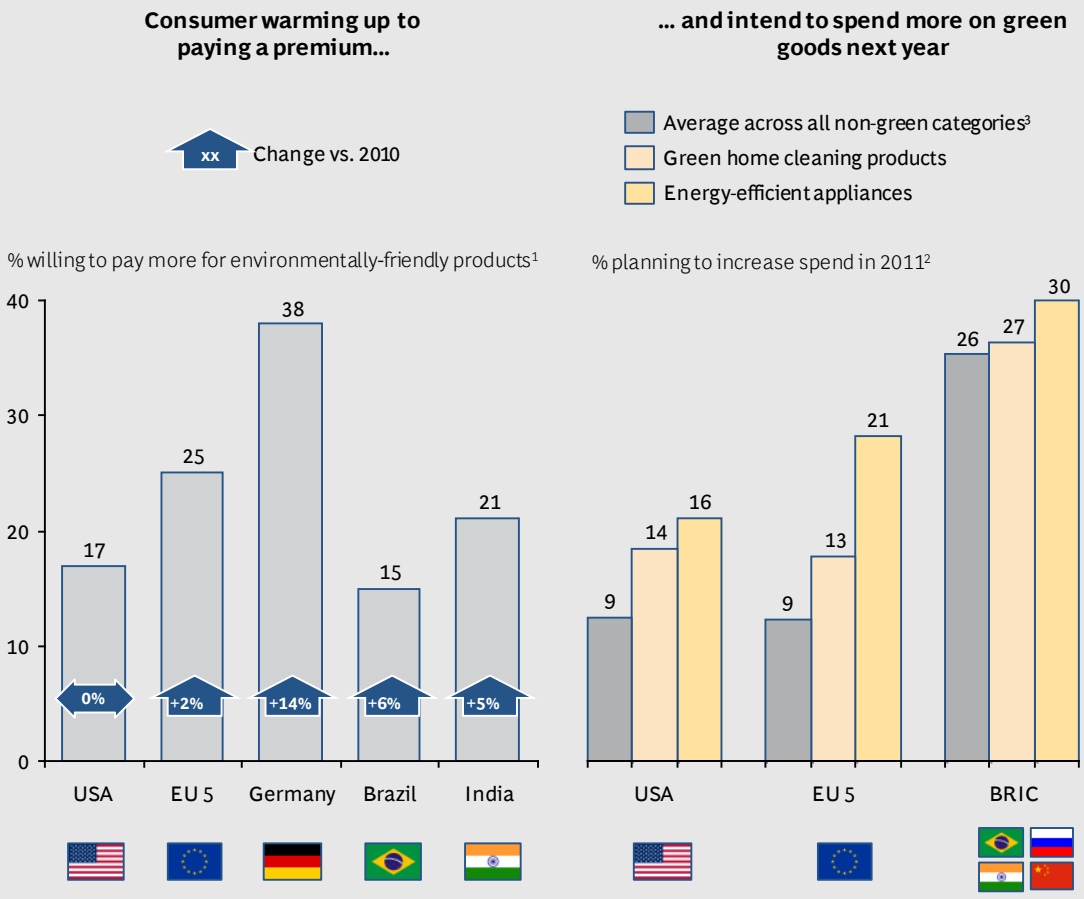


Source: BCG Global consumer sentiment survey 2011

There is an increasing willingness among consumers to pay a premium to buy green products. In India, 21% survey respondents were willing to pay a premium for environmentally friendly products.

There is increasing propensity to spend on environmentally friendly products with 6% more respondents willing to spend as against previous year's survey. Exhibit 10 outlines this in detail.

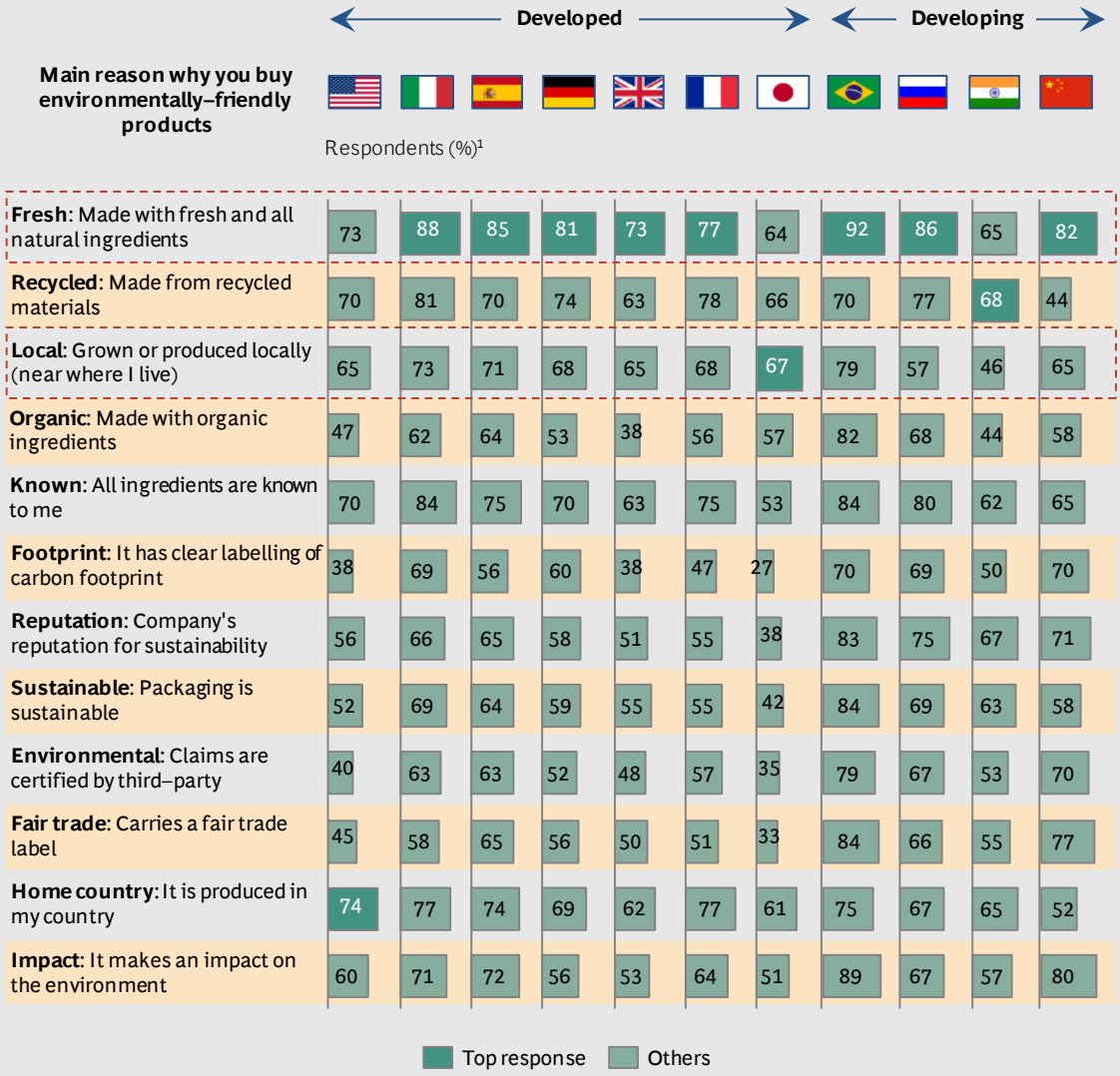
Exhibit 10: Consumers are increasing their spending on green goods, the BRICs are leading the way



Source: BCG Global consumer sentiment survey 2011.
Note: Bottom income quartile cut and sample reweighed to represent real income distribution in each country. EU5 includes EU Big5 (Germany, UK, Spain, Italy and France).
[1]Survey question: Are you willing to pay more for environmentally friendly products? Response options include: Willing to pay more / understandable but not willing to pay more / willing to purchase but at the same price / not interested. Shown are % of respondents willing to pay more for environmentally friendly products.
[2]Survey question: For each of the following categories, please indicate if you plan to change your spending in the next 12 months. Response options: A) I plan to decrease spending in this category, B) I plan to spend the same in this category, C) I plan to increase spend in this category, D) I don't buy this category. Respondents who selected "D" excluded. Category list includes 42 products / services ranging from groceries, clothing, entertainment, accessories, and personal health products.
[3]Weighted average includes all categories except green home cleaning products and energy-efficient appliances.

Exhibit 11 indicates the key motivators for buying green across different countries. Product being 'Fresh', 'Recycled' or 'Local' is amongst the key reasons for buying green across different countries. In India the top–most response for buying green was products being "Made from recycled materials". Importance of criteria varies by country as shown in the Exhibit 11 below.

Exhibit 11: Key reasons why consumers buy environmentally friendly products

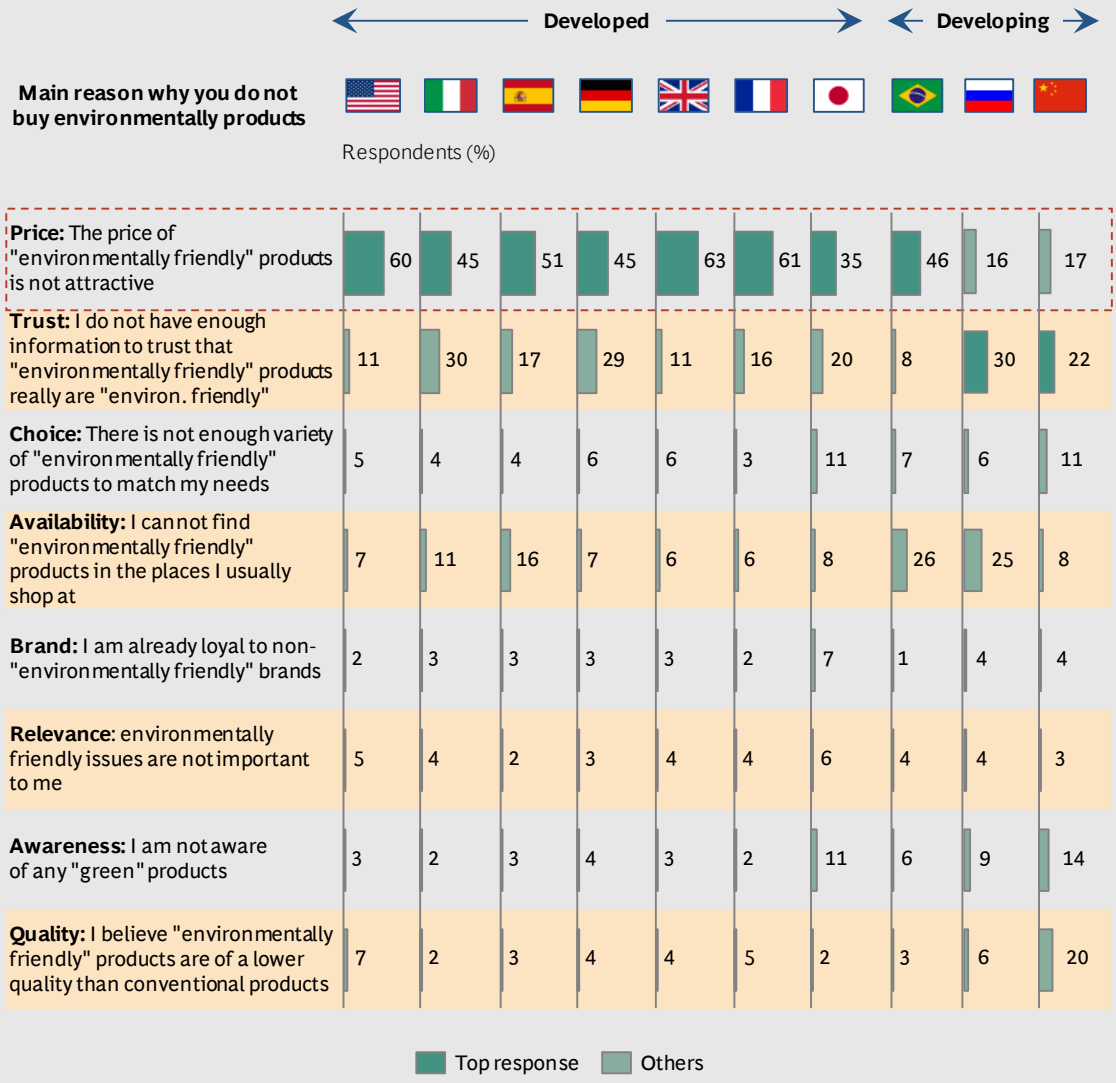


Source: BCG Global Consumer Sentiment Barometer 2012.
Note: BRIC countries include top 3 income quartiles only. India includes only urban SEC A-C.
[1]Survey question: For each of the following claims or statements, indicate how important they are in determining the products you buy / consume? Respondents who answered "very important" or "somewhat important" shown.

Many consumers, particularly in developed countries, are willing to pay a premium for green and the propensity to pay premium is increasing over time. However, price is still the key reason for not buying more green products globally. Their willingness to pay more depends on a product's category and perceived benefits. In developing markets, trust and availability of environmentally friendly products play a significant role in consumers not buying green. Exhibit 12 outlines the key barriers across different regions.

Exhibit 12: Price key reason for consumers not buying more green products

Trust and availability also factors in developing markets



Source: BCG Global Consumer Sentiment Barometer 2012.
Note: BRIC countries include top 3 income quartiles only. India includes only urban SEC A-C.
Survey question: Please indicate the main reason why you do not buy environmentally friendly products systematically. Only respondents who do not systematically purchase environmentally friendly products were asked.

In addition, consumers across the world are in state of information overload as there are too many definitions and certifications for green products. There are 300–700 eco–labels globally - only 28% of consumers are aware of the differences between various 'green' certification symbols. This acts as another key barrier in buying environmentally friendly products, due to the confusion created.

Successful Examples of Green Products: Key Lessons

Incremental Efficiencies—Key Example and Benefits

Covered below are two examples showing how companies could save on material usage by optimizing the packaging design of their products.

Aquafina product innovation - less material required: Since 2002, Aquafina had been striving to reduce the material usage for their plastic bottles. Aquafina's latest innovation on the usage of a patented spider web technology allows them to ensure that the latest bottle design uses 50% less plastic compared to the 2002 version. By constantly optimizing the bottle design, Aquafina has managed to save 75 million pounds of plastic per year.

Heinz product innovation - reduced material thickness: Heinz managed to reduce the thickness of its can ends by 10%, in co–operation with its supplier. The new easy–open can ends bring Heinz 1,400 tons of annual steel savings in the UK and operating cost savings of 400,000 pounds resulting in carbon emission savings of 585 tons.

Change in the Operating Model—Key Examples and Benefits

GE business model innovation - Sustainability turned into a core initiative: Sustainability-related products were scattered across GE's organization so much so that by 2004, GE already had many products that could be counted as sustainability initiatives. Examples included solar panels, wind turbines, water treatment offerings etc. But sustainability was not a focus of the organization as a whole and did not figure on top of the management agenda.

A CEO driven initiative was started in order to organize all sustainability initiatives under one umbrella and make it a top priority for GE. Ecomagination brand was used to market all sustainability–related business and position GE as a leader in sustainability. As a result there was huge growth in the sustainability oriented product portfolio and by 2010, Ecomagination sales grew to $18 billion accounting for 12% of total revenues.

Change in Value Proposition—Key Examples and Benefits

Product lifecycle innovation by Xerox - The closed loop system: Today, companies lease Xerox equipment for printing purposes. Since Xerox keeps ownership at all times, it manages the reverse logistics. When an equipment comes back, it is disassembled, and then sent for remanufacture and transformed into a significantly updated, next generation model. A Xerox product has 60% of its parts by weight in common with previous equipment which allows it to follow this strategy.

In 2009 alone, Xerox's manufacturing approach led to estimated savings of 106 million pounds of waste, bringing the total to over 2.2 billion pounds since 1991. Usage of parts from an end of life product generates for Xerox several hundred million dollars in cost savings each year, in addition to energy savings.

GREEN MANUFACTURING
REGULATORY FRAMEWORK

Key Government Policies

India has adopted the National Action Plan on Climate Change (NAPCC) in 2008 as part of which government has launched eight major initiatives as national 'missions' to promote green and achieve key goals in the context of climate change.

Government has also announced a goal of reducing the emission intensity of its GDP by 20–25% of the 2005 level by 2020. The plan is to achieve this through a multi–sector carbon abatement strategy. It is intended that lower GHG emission based sustainable growth will be a central element of the 12th Five Year Plan.

In addition to NAPCC, all the states have also been asked to prepare state–level action plans as extensions of eight National Missions. Some states have already taken the lead in addressing climate change by formulating and launching state level action plans, etc.

The government has set up a National Clean Energy Fund (NCEF) by imposing a cess on coal at an effective rate of Rs. 50 per tonne. The Government expects to collect Rs. 10,000 Crore by 2015 through this. It will support projects, programmes and policies that promote clean energy technologies.

National Mission for Enhanced Energy Efficiency

The National Mission for Enhanced Energy Efficiency (NMEEE), a part of NAPCC, is the key focus for government action for energy efficiency. The NMEEE is divided into four components:

- Perform Achieve and Trade (PAT) – a scheme for trading in energy efficiency certificates. This scheme is mandatory for all large industrial units and facilities in energy intensive industries (these industries account for ~60% of India's primary energy consumption) where they will have to meet certain efficiency targets.
    - Firms which achieve gains beyond their target will be rewarded with an energy saving certificate; those who fail to meet their target will be required to buy certificates to make up the shortfall or face a financial penalty.
- Energy efficiency financing platform - Creation of mechanisms that would help finance demand side management programmes by capturing future energy savings.
- Market transformation for energy efficiency - Accelerating the shift to energy efficient appliances in designated sectors through innovative measures to make the products more affordable.
- Framework for energy efficient economic development - Developing fiscal instruments to promote energy efficiency.

Power Plants

For reducing emission intensity, 60% of coal based capacity addition in the 12th Plan and 100% in the 13th Plan is planned to be achieved by deploying super critical technology. Large–scale adoption of this technology in coming years is expected to reduce the emission intensity of the power sector. Additionally, there are plans to retire old and inefficient coal–based power generating units.

Renewable Energy

The Electricity Act 2003 together with the National Electricity Policy 2005 (NEP) and the Tariff Policy (TP) mandate promotion of electricity generation from renewable sources. Integrated Energy Policy (IEP) of 2010 also underscores the importance of renewable resources. Central Electricity Regulatory Commission (CERC) has also taken initiatives ranging from determination of preferential tariff for renewable energy and creating a framework for grid connectivity through the Indian Electricity Grid Code to developing market–based instruments such as Renewable Energy Certificates (REC).

- Each sub–national electricity regulatory commission has set a specific 'Renewable Purchase Obligation' for their utilities so that they source electricity from renewable sources. In the first year of the scheme, FY10, the national target was set at 5%. Government plans that utilities should be procuring 15% of their electricity from renewable energy sources by 2020.
- If the utilities fail to meet their target they will have to purchase a 'Renewable Energy Certificate', which is issued to producers of renewable energy.

Nuclear Energy

A three–stage nuclear power programme has been chalked out to increase the installed nuclear power generation capacity, in order to reach 20,000 MW of installed capacity by 2020.

Transport

One of the key initiatives in transportation has been an up-gradation of vehicle emission norms progressively going to Bharat Stage II, Bharat Stage III and Bharat Stage IV over time. In addition, the Integrated Transport Policy (2001) promotes the use of ethanol–blended petrol and biodiesel. The National Urban Transport Policy emphasizes development and usage of extensive public transport facilities over personal vehicles.

National Solar Mission

National Solar Mission aims at grid parity for solar power by 2022 and has a target of setting up 20,000 MW for solar power. Solar photovoltaic and solar thermal are each expected to contribute 50% of the above target, in addition to a 2,000 MW target for off–grid solar power. Government has facilitated generous financial incentives for grid–connected solar plants in the form of feed–in tariffs valid for 25 years. The government has also incentivized state–level utilities to accelerate solar capacity addition by mandating a three per cent solar power target by 2022 (under the National Tariff Policy) and by providing opportunities for additional revenue streams through instruments such as Renewable Energy Certificates (RECs).

Government Initiatives, Interventions, Schemes, Standards, etc. to Promote Green in Manufacturing

1. Emission and Discharge standards: Government has plans to prescribe emission and discharge standards for industries. The Government will also provide continuous incentives, monetary and otherwise, to encourage reduction in releases of harmful pollutants and to ensure that the standards are complied with.

2. Green Manufacturing Committee: As per the National Manufacturing policy, the government plans to devise a system for defining and implementing Greener and Cleaner Technologies. Objective criteria will be prescribed by a Committee called the Green Manufacturing Committee (GMAC) comprising representatives from the concerned Ministries / Departments and relevant sectoral experts.

3. Technology Acquisition and Development Fund (TADF): A fund will be established for acquisition of technologies including environment friendly technologies; creation of a patent pool; and development of indigenous capabilities for manufacturing of equipments used for controlling pollution and reducing energy consumption. As part of the initiative:

    - SMEs will be given access to the patent pool and provided part reimbursement of their technology acquisition costs.
    - Incentives for production of equipment / machines for controlling pollution, reducing energy consumption and for water conservation will be provided.

The fund is also aimed at providing specific incentives for development and manufacturing:

- Equipment or technologies for producing energy from renewable resources; clean coal technology; carbon sinks.
- Equipment used in energy–conservation technologies (including energy conserving lighting technologies and smart grid technologies).
- Equipment used to refine or blend renewable fuels.
- Fuel Cells, micro–turbines or energy–storage systems for use with electric or hybrid–electric motor vehicles.

For the above incentives government plans to provide 5% interest reimbursement of the interest charged by lending agencies in addition to a 10% capital subsidy.

In addition, the fund will function as an autonomous patent pool and licensing agency. It will purchase IP rights to inventions from patent holders and provide the same to companies against a payment of royalties.

Some of the key manufacturing specific incentives or schemes as outlined in the National Manufacturing Policy include the following:

- Environmental audit through external auditors / firms (from panel of auditors approved by GMAC) will be mandatory for industrial and institutional units in NIMZs. 25% grant to SMEs for expenditure incurred on audits will be provided.

- Water conservation audit will be mandatory for industrial and institutional units in NIMZ (from panel of auditors approved by GMAC). 25% grant to SMEs for expenditure incurred on audits.

- Wastewater treatment - Government will mandate treatment of waste–water by every industry as per CPCB and PCB norms. Units practicing zero water discharge will get 10% one–time capital subsidy on the relevant equipment / systems.

- Rain Water Harvesting will be compulsory for all industrial / institutional units as per guidelines to be formulated by the GMAC.

- All buildings (>2,000 square meter built up area) in the NIMZs which obtain green rating under the Indian Green Building Council (IGBC / LEED) or GRIHA systems shall be eligible for an incentive (of up to Rs. 2 lakhs).

SETTING THE AGENDA FOR GREEN MANUFACTURING IN INDIA

Imperatives for the Industry

1. Business entities need to develop green manufacturing related strategies at the earliest and ensure these are an integral part of their overall business strategy to remain competitive. In several resource intensive industries such as those relating to Commodities, Automotive, Energy and Utilities and Construction sector, sustainability initiatives are necessary to be competitive as well as for the business entity to have a license to operate and for the acceptance of their products / services.

2. Business entities must develop a clear business case and value proposition for sustainability. This must be accompanied with clarity on necessary changes required in business models to embed sustainability into day to day business operations. Globally, firms that articulate and develop a clear business case or proven value proposition for addressing sustainability issues are the ones that profit from such efforts and are indeed leaders in their respective industries.

3. Business entities must ensure adequate focus on development of green products for customers and in ensuring due recognition of their quality / trustworthiness as green products. Particularly in developing markets, lack of trust and availability of environmentally friendly products plays a significant role in consumers not opting for buying green products in a major way.

4. Businesses must define clear governance mechanisms and supporting organizational structures to drive and ensure ownership of their sustainability agenda. Companies embracing sustainability must aim to have clear governance structures, with key elements such as, communication of responsibility for sustainability initiatives and KPIs linked to sustainability, in order to profit. They must also have strong organizational structures (adjusted for sustainability) with key elements such as, an identified team responsible for sustainability initiatives. Governance structure and organizational structure adjustment are what "profiteers" companies globally manage to do well.

5. Manufacturing strategy needs to incorporate development and leveraging of Information, Communication and Technology (ICT) tools that enable green manufacturing. Driving a comprehensive assessment of opportunities for deploying ICT tools and driving a change in established processes to integrate ICT are key requirements for making it happen.

6. Businesses need to systematically evaluate, embrace and leverage new legislations and policy measures being put in place to speed up the adoption of green technologies and focus on identifying opportunities emerging through sustainability oriented policies.

Imperatives for Policy Makers

1. Policy makers must actively drive measures to promote private sector investing in green manufacturing. This will help in overcoming the financing gap and lack of market transparency. Access to private finance is crucial for the development of a clean energy industry. For example, this can speed up the adoption of many green technologies by using levers such as PPP models.

2. Policy makers must put in place a framework to promote green products through 'Green' ratings based on criteria that recognizes green manufacturing. A central standards body needs to be created as part of a holistic policy framework to govern the same. These ratings have to be actively promoted and will provide a critical lever for companies to be able to differentiate themselves, and also enable the consumers to make more informed choices.

3. There is a strong need to strengthen policies and coordinate incentives from multiple agencies and policies to promote efficiency measures during manufacturing and production within in key energy and resource intensive industries. For example, a coordination agency (providing a single window interface across a spectrum of ministries) could accelerate the sustainability agenda, through faster application of incentives available under different policies, for efficiency measures being under taken across a broad spectrum of energy intensive industries.

4. Policy makers needs to ensure greater coordination across institutions promoting sustainability and green manufacturing to hold private companies accountable while avoiding market distortions resulting from green manufacturing incentives. The lack of clarity and overlaps in policies may result in confused action and worse in rent–seeking behaviour and market distortion.

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