

## GREEN MANUFACTURING FROM INDUSTRY AND CONSUMER PERSPECTIVE

**Mr. Yogesh Shamrao Bhusari**

**BBA Department, Indira College of Commerce & Science, Pune.**

**Email: yogesh.bhusari@iccs.ac.in**

**Mr. Ranjeet More**

**BBA Department, Indira College of Commerce & Science, Pune.**

**Email: ranjeet.more@iccs.ac.in**

**Mr. Vikrant Sanjay Soman**

**BBA Department, Indira College of Commerce & Science, Pune.**

**Email: vikrant.soman@iccs.ac.in**

### **Abstract**

The Government of India would like the manufacturing sector to play a bigger role in the country's economy. The Ministry of Commerce and Industry, in its discussion paper on the growth strategy for manufacturing, has set a target to increase the sector's contribution to the GDP to 25 percent, from the current level of about 16 percent. While this growth is necessary, the country's environmental concerns need to be mitigated — the manufacturing sector must use energy and resources efficiently, and minimize generation of waste. It is estimated that even if every factory, power plant, car and aero plane is shut down, the average global temperature would still increase by 0.6°C in this century. 'Green Manufacturing' or sustainable industrial activity is now the need of the hour and no more an empty slogan. Green manufacturing involves transformation of industrial operations in three ways: (1) using Green energy, (2) developing and selling Green products and (3) employing Green processes in business operations. Manufacturing companies that adopt Green practices benefit not only through long-term cost savings, but equally importantly, from brand enhancement with customers, better regulatory traction, greater ability to attract talent and higher investor interest. However, these benefits require a long term commitment and making tradeoffs against short term objectives, as the economics of Green manufacturing is still evolving and not well understood as yet. Steel manufacturers have adopted Green initiatives to stabilize rising energy costs, while automobile companies have seen it as an opportunity to launch electric and hybrid cars to meet increasingly stringent emission regulations. The impact of Green initiatives also varies by the industry sector. The impact of Green initiatives also varies by the industry sector. For example, Green initiatives in the power sector have the maximum impact on reducing CO<sub>2</sub> emissions followed by transportation and then the industrial sector. Consumers are increasingly adopting Green products and habits. Many consumers also indicated their growing willingness to pay a premium for Green. However, the survey also revealed that there is still a huge gap in consumer awareness that Green companies must strive to bridge. Green manufacturing in India is at the take-off stage. While there has been significant policy development and adoption by the manufacturing industry in the area of Green energy, there is substantial scope on both the policy front and its adoption in the areas of Green products and Green processes. Successful transformation into Green manufacturing will bring tremendous benefits, both tangible and intangible, for the nation and the business community.

**Keywords:** Green Manufacturing, GHG, E-waste, Emissions, Sustainability.

## Objectives

- 1) To study Green Manufacturing from the perspectives of Industry & consumer.
- 2) To know the forces driving Green Manufacturing.
- 3) To know the barriers to higher green consumption & find out ways to overcome them.

## Introduction

Green Manufacturing is also known by plethora of different names: Clean manufacturing, environmentally conscious manufacturing, environmentally benign manufacturing, environmentally responsible manufacturing and Sustainable manufacturing. Irrespective of the various acronyms, the primary goal remains the same - designing and delivering products that minimize negative effects on the environment through their production, use, and disposal.

Green manufacturing is a term used to describe manufacturing practices that do not harm the environment during any part of the manufacturing process. It emphasizes the use of processes that do not pollute the environment or harm consumers, employees, or other members of the community. Green manufacturing addresses a number of manufacturing matters, including recycling, conservation, waste management, water supply, environmental protection, regulatory compliance, pollution control, and a variety of other related issues.

## Green Manufacturing and Global Warming

Owing to increased concern about global warming and the ramifications of pollutive industries for the global environment, manufacturers are seeking practical solutions that can be implemented to sustain green manufacturing practices. Consumers assume that the products they consume are safe and do not harm the environment. However, manufacturers and consumers need to take a closer look at manufacturing practices. There is a growing need to understand that certain products and their related manufacturing practices can endanger the environment.

The society's rising concern for Green can be grouped into three broad categories:

### 1) Rising emissions and associated climate change

Greenhouse gas (GHG) emissions have increased rapidly in the recent past and their growth is further accelerating. Global temperatures have increased by 0.74°C over the last century<sup>1</sup> —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<sup>2</sup>. This unprecedented change is expected to have a grave impact on the global ecosystem, hydrological system, sea level and crop production and related activities.

### 2) Fast depletion of scarce natural resources

With ever increasing population and industrialization, the consumption of natural resources (example: wood, coal, oil, food, water, etc.) is rapidly on the rise, while their availability is shrinking. This has led to periodic mismatches in demand–supply and highly fluctuating prices, impacting both corporate margins and consumer spend. There is an urgent need to (a) adequately manage the use of these resources and (b) find and develop alternatives which are less scarce (example: wind, sun).

### 3) Growing waste generation and pollution

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.

## Transformation to Green Manufacturing

Manufacturing companies can address these concerns by focusing on three areas:

### 1) Green energy

Green energy involves production and use of cleaner energy. This is the first and most obvious step given the dependence of industry on energy. Green energy includes both deploying renewable energy sources like CNG, wind, solar and biomass, and achieving higher energy efficiency in operations.

### **2) Green products**

Developing greener products is the second step in this transformation. ‘Recycled’, ‘Low carbon footprint’, ‘Organic’ and ‘Natural’ are becoming popular buzz-words which 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.

### **3) Green processes in business operations**

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 footprint and conserving water. Employing Green processes improves operational efficiency and lowers costs.

### **Forces Driving Green Manufacturing**

A number of companies have started adopting Green initiatives as an integral part of their operations. These initiatives are driven by five factors:

a) Rising energy and input costs b) Growing consumer pull for Green products c) Increasing regulatory pressures as policy makers introduce new and stricter environmental and waste management laws d) Technological advances which open up new attractive business opportunities

The need to enhance competitive differentiation, particularly for first movers or those who are able to break the compromise between short-term higher costs and numerous benefits (example: brand premium, new customer segments) Green has moved from being perceived as a ‘necessary evil’ to being seen as ‘good business’.

Companies that undertake Green initiatives stand to be advantaged on brand enhancement, political traction and regulatory compliance, greater ability to attract and retain talent, enhanced customer retention and potential cost savings. However, these benefits require a long term commitment and making trade-offs against short term objectives, as the economics of Green manufacturing are not well understood yet.

### **Industry Perspective**

#### **Green as an Integral Part of Business**

Over the past decade, climate change from GHG has moved from being a topic of general discussion to becoming an important factor contributing to the financial performance for manufacturing companies. In a recently conducted BCG survey<sup>3</sup>, executives of nearly all the companies interviewed said that sustainability-related issues have or will soon have a material impact on their businesses. Many executives also felt such issues will shape the strategic direction of their businesses in future. The survey revealed that 92 percent of the companies are already engaging in Green initiatives in some way. Improved company image was the most important reason for adopting Green, followed by cost savings, maintaining competitive advantage and increasing employee morale

Fewer than 25 percent of the respondents said that their companies had pulled back on their commitment to Green during the recent economic downturn – a fact that clearly indicates that sustainability measures are here to stay. In fact, many sectors like automotive and media even increased their commitment during the downturn, to cope with fluctuating and increasing energy and commodity prices.

#### **Green in Traditional Industries**

As observed earlier, different industries have varying degrees of exposure to different sustainability concerns. Green energy is an issue which is common to all but the relative impact and performance vary significantly, depending on the energy intensity and carbon footprint of the industry segment. As exhibit 6 indicates, power generation is the highest emitter of GHG, followed by transportation and manufacturing. It is, therefore, not surprising that these three sectors have the most to gain from Green initiatives.

### Technologies for Green Manufacturing

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

#### 1) Carbon sinks:

This category consists of emergent technologies related to Carbon Capture and Storage (CCS) being developed for use in power plants that are fired by fossil fuels such as coal. These technologies enable capturing and storing CO<sub>2</sub> in ways such that it does not enter the atmosphere. For example, CO<sub>2</sub> from fossil fuels is trapped and stored in underground wells under intense pressure which keeps it in liquefied form.

#### 2) Efficient fuels:

This category encompasses a class of technologies that use cleaner fuels for generating power. Examples include biomass, hydro power, Integrated Gas Combined Cycle (IGCC), etc.

#### 3) 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.

#### 4) Green transportation:

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

#### 5) 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 such technologies are emerging in each of these industries.

Each technology within these five categories can be further characterized on two dimensions – maturity (nascent versus established) and availability (local versus global). A mapping of Green energy technologies is shown in Exhibit 10. 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.

Categorizing technologies on these two dimensions provides guidance in making business model choices. It also helps strike a balance between opportunistically harnessing the revenue pools of today and proactively positioning for capturing future revenue pools. Depending on their appetite for resource commitment, companies can make fundamentally different choices.

### Consumer Perspective

A. Green Awareness: Green manufacturing is imperative, not just due to tightening regulations or cost benefits, but also because consumers are demanding it. In a recently concluded survey about two-thirds of the participants expressed the belief that the environment is in a poor shape and that environmental problems are a primary threat to the society. Not only are consumers becoming increasingly aware and conversant with Green, they are also adopting Green habits and buying Green products. The continuing expansion of Green consciousness around the world presents a huge opportunity for smart companies. Consumers believe that as individuals, they can and should contribute to sustainability by adopting Green products, they also hold companies to a higher standard when it comes to being Green.

The term Green is recognized the world over as shorthand for environmental consciousness. However, when asked to define Green and their expectation from Green products, consumers had a range of responses depending on where they lived and the type of products they bought. It is, therefore, critical for companies to discover how their target consumer segments feel about Green, what they expect from Green products and what prices they are willing to pay for them. Another finding of the survey was that about 50 percent of these consumers purchased Green products. The survey also indicated that consumers greatly value the direct benefits that Green products offer, such as – superior freshness and taste, the promise of safety and health, and savings on energy costs. They are willing to pay higher

prices for Green products that have better quality perception. While shopping for Green is becoming common in many countries, shopping habits vary considerably by product category. Certain Green product categories like paper, food products, disposable home products, consumer durables and beauty products are more popular than others and are purchased more often.

### **Barriers to Higher Green Consumption**

As mentioned earlier, many consumers, particularly in developed countries, are willing to pay a premium for Green. Their willingness to pay more depends on a product's category and perceived benefits, and is highest for food and consumer durables. The findings of the survey establish clearly that price is not a significant obstacle for many buyers. In fact, price ranks much lower as a barrier to Green purchasing than lack of awareness of Green alternatives or a perceived lack of choice.

Quite clearly, awareness is a critical lever for increasing sales of Green products. It is estimated that companies lose, on an average, nearly 20 percent of potential purchasers when consumers are not adequately informed about the sustainability aspect of their offerings. Companies need to carefully plan and invest in their customer awareness programmes and work with their retailers to provide adequate shelf space and visibility to ensure their Green efforts are fully leveraged.

### **Green Manufacturing Agenda for India**

#### **India's Green Challenge**

"Global fossil CO<sub>2</sub> emissions are expected to rise by 1% in 2022 (range: 0.1-1.9%), driven by increased oil consumption, reaching 36.6 gigatonnes." The report stated that "projected 2022 emissions decrease in China and the European Union, but increase in the United States, India, and the rest of the world."

The total global emission in 2019 was 36.3 Gt, which was reduced to 34.5 Gt in 2020 and increased to 36.3 Gt in 2021.

"Projected 2022 emissions from coal and oil are higher than in 2021, with oil accounting for the majority of total emissions growth," the report added. Oil emissions, which account for one-third of global emissions, are expected to rise by 2.2%, dominating the global increase in fossil CO<sub>2</sub> emissions. During the forecast period, 2021-2026, the India e-waste management market is expected to grow at a CAGR of 8.24% in terms of volume and 14.25% in terms of revenue. E-waste has become a major issue in India due to a lack of effective e-waste disposal mechanisms. The problem has been exacerbated by the thriving IT industry and the increasing adoption of modern technologies.

Because unrecycled electronic products are highly toxic in nature, they pose a serious health and environmental risk. Furthermore, technological advancements are expected to shorten the lifespan of products as they are replaced by new ones. This will increase the amount of e-waste generated. Furthermore, the country ranks fifth among the top e-waste producing countries. It recycles less than 2% of total e-waste produced each year. Apart from producing more than 2 million tonnes of e-waste each year, India imports large amounts of e-waste from other countries. According to an ASSOCHAM (Associated Chambers of Commerce and Industry of India) and KPMG study, computer equipment accounts for roughly 70% of e-waste. The informal sector ignores recycling, processing, transportation, and e-waste collection.

### **Setting the Agenda for Green Manufacturing**

To overcome these challenges, or at the very least to minimize their impact, the Indian manufacturing sector will need to take concerted action on all three areas.

#### **1) Green energy**

Over the past few years, both the Government and the industry have recognized the challenges posed to the country's environment by industrial growth and rapid urbanization. While India has had strict environmental protection laws for many years, the implementation has been weak at times. This scenario is changing if one goes by some of the recent high profile cases, where companies were either denied permissions or given conditional approvals and had to commit to certain sustainability conditions. To supplement the impact of these laws, the Government has launched eight major

initiatives as national ‘missions’ to promote Green, the most prominent of them being the Solar Mission to promote Green energy.

According to a new report from the Institute for Energy Economics and Financial Analysis, renewable energy investment in India reached record levels in the fiscal year 2021-22.

A total of \$14.5 billion was invested in renewable energy, a 125% increase over the fiscal year 2020-21 and a 72% increase over the pre-pandemic period of the 2019-20 fiscal year.

Similar aggressive targets have been set for hydro and nuclear power generation. The 11th Five Year Plan has set a target of increasing energy efficiency by 20 percent and the Government is also offering tax holidays, soft loans, subsidies and other incentives for renewable energy projects. The Government has set up the Indian Renewable Energy Development Agency (IREDA) as a public sector unit for market development and financing. The Bureau of Energy Efficiency (BEE) was set up to support awareness and demand creation for energy efficient products, goods and services. BEE has set up the Energy Efficiency Financing Platform (EEFP) for supporting the cost effective financing of energy efficiency project implementation and its expansion. In the Union Budget 2010–11, the Government announced setting up of National Clean Energy Fund (NCEF) for funding research and innovative projects in clean technologies.

The Central Electricity Regulatory Commission (CERC) has announced Renewable Energy Certificate (REC) norms in a bid to promote power generation from clean sources in the country.

The number of carbon credits issued for emission reduction projects in India is set to triple over the next three years to 246 million by December 2012 from 72 million in November 2009 as per estimates 14 . This will cement India's second position in the global carbon credits market, technically called Certified Emission Reduction units or CERs. The growth in CER issuance will be driven by capacity additions in the renewable energy sector and by the eligibility of more renewable energy projects to issue CERs. Consequently, the share of renewable energy projects in Indian CERs will increase to 31 percent.

While considerable progress has been made as shown above, India has still some way to go. Close to 75 percent of India's energy generation comes from coal and natural gas. In efforts to provide electricity to 40 percent of households that do not yet have it, and to sustain its industrial growth,

India can expect a six to eight-fold growth in energy production over the next 25 years. Projections suggest that the share of coal in the energy mix is unlikely to go down substantially in the next 20 years. This calls for ensuring the implementation of the aggressive targets set for Green fuels (e.g. Solar Mission) and strengthening the regulatory framework (BEE) for improving the energy efficiency.

## **2) Green products**

Indian companies and consumers have begun accepting Green products. Companies are offering their customers a growing range of Green products, ranging from organic food products, to electric cars and solar heaters. Lighting and air-conditioning companies are introducing new-age products with energy efficiency as the key differentiating lever. Explicit energy ratings for electric appliances are a new reality and consumers are not only accepting these, but also incorporating them in their buying behaviour. Consumer consciousness about Green products is expected to grow further and companies are quickly identifying this avenue as a route to achieving competitive advantage.

Indian companies are also implementing the RoHS (Restriction of Hazardous Substances) compliance for many of their products. For example, the Godrej Group's furniture division has systematically created a range of products that provide for a Greener customer experience in terms of emitting lower Volatile Organic Compounds (VOCs), thereby making long hours of working on an office floor much better. In the automotive sector, the Society of Manufacturers of Electric Vehicles (SMEV) expects sales of electric two-wheelers to double in the coming months, spurred by an incentive scheme announced by the Ministry of New and Renewable Energy (MNRE). Compressed natural gas-powered vehicles in India also increased 30 percent over 2009, to reach 1 million in 2010<sup>15</sup>. Green buildings are catching up fast in the country. It is estimated that about 2–3 percent of all construction in India is Green, which is similar to a developed country like the US. This figure is expected to go up to about 10 percent for new constructions over the next few years<sup>16</sup>.

While some companies have made efforts to introduce Green products into the market, the efforts are still at an early stage and have to be systematically expanded to cover more of the manufacturing

sector. Manufacturing companies should evaluate their product portfolio in terms of the energy intensity of their manufacture and in-life use, recyclability and waste generation.

Here the various industry associations can play an active role on educating both their member companies and consumers, and bringing together the different stakeholders to set standards which conform to international Green norms and are customized for Indian environment.

### 3) Green processes in business operations

Indian manufacturing is catching up with the long term benefits of Green processes to improve corporate brands, reduce costs and achieve compliance at the same time. Energy intensive companies are implementing lean processes to minimize waste and enhance energy efficiency.

For example, the shortage of reasonably priced domestic high-grade coal is forcing cement engineering plant can be reduced by using more power-efficient motors and moving to Compact Fluorescent Lamp (CFL) and natural lighting in the buildings. By adopting these measures, an engineering plant was able to reduce power consumption by nearly 35 percent in a short span of time.

But there is still a long way to go in many sectors. For example, even the more advanced amongst the Indian steel producers consume more than 20 percent higher gigajoules per ton of hot metal in the iron making stage as compared to their advanced Chinese counterparts, and over 70 percent more gigajoules per ton compared to advanced western European producer. Some efforts to bridge this gap have now started to come to the fore. For example, the Essar Group has claimed that it has reduced its energy consumption very significantly and has planned three Clean Development Mechanism (CDM) projects in its upcoming blast furnace project in Hazira aimed at reducing CO<sub>2</sub> emissions.

In a bid to promote energy efficiency and reduce industrial carbon emission levels, the Government is evolving a PAT (Perform, Achieve and Trade) regime designed by the National Mission for Energy Efficiency under the Prime Minister's National Action Plan for Climate Change. Under the scheme, BEE would set energy efficiency targets for industrial units and issue them energy saving certificates or ESCerts against those targets. Units that exceed targets for energy efficiency can sell the ESCerts to units that fall short of targets. Energy audits play a critical role in improving energy efficiency and the Government has mandated the appointment of an energy auditor for industries with high energy intensity.

It is also important to address water consumption and waste generation as big levers of Green. It is possible to reduce water consumption by better control of processes, recycling water and embracing new water-saving technologies. For example, in the metal businesses which use plating as a process, water consumption is a direct function of the number of tanks used.

Therefore, a shift to plating technologies / processes with fewer tanks can save as much as 40–50 percent of water consumption in just a few years. Manufacturing plants can minimize waste generation by redesigning their press tools and machines to reduce the scrap they produce, and by improving scrap collection and recycling. For example, Godrej Locks improved scrap recycling for all brass made products such as locks, by collecting the scrap and providing it to local smelters for recasting it into brass sheets and rods. Another example of a Green process is ITC's paper plant at Bhadrachalam which has been re-designed to consume less water than the industry average and at the same time convert pulpwood into crisp white paper much faster. C. Role of Technology in Enabling Green technology is the common denominator across all the three areas of Green energy, Green products and Green processes. Companies can think about the role of these technologies in their business strategy in two different ways – building a new Green Business, and using technology to 'Green' an existing one.

For example, companies can set up Green energy businesses using technologies such as concentrated solar power or storage technologies like molten salts and ultra capacitors. Another example is building Green waste management businesses using new technologies such as aerobic composting and pyrolysis which can make products like bio-organic fertilizers, organic manure, Refuse Derived Fuel (RDF) economically viable. On the other hand, existing process intensive manufacturing industries like cement can be made Green by replacement of existing cyclones with low pressure drop cyclones or conversion of open circuit cement mills to closed circuit which significantly enhances the energy efficiency in the old plants.

Indian companies can also consider investments in emerging Green technologies as part of a broader portfolio comprising both, short term and long term plays. For example, the Tata Group, as part of their

Green portfolio is investing in Sun Catalytix Corporation, an energy storage and renewable fuels company founded by Daniel Nocera, a professor from MIT, as a longer term bet.

### **Findings & suggestions**

The Government of India has to play a key role in the transformation into 'Green Manufacturing'. To promote Green energy, both the central and state Governments have launched many initiatives with significant budgetary support (example: Solar Mission). The promotion of Green technologies has been included in the draft strategy for the manufacturing sector prepared by the Department of Industrial Policy & Promotion (DIPP), Ministry of Commerce and Industry.

However, there has not been adequate attention given to financial, regulatory and policy support to promote Green products and Green processes in on-going business operations. For example, an equivalent of ISI certification can be implemented as part of a holistic policy framework to govern Green products by giving 'Green' ratings based on criteria like product recyclability and biodegradability. These ratings have to be actively promoted and will provide a critical lever to companies to differentiate themselves, and also enable the consumers to make more informed choices.

In the area of Green processes, the current focus on one hand has been on improving energy efficiency through energy audits which are basically voluntary and on the other, the recent strictness in the implementation of laws to check industrial pollution. The scope of these efforts can be widened and integrated into a 'Green Audit' which focuses on all three – energy, water and waste. This could be done through incentivizing, through voluntary participation, or by mandating via an independent regulatory body.

Finally, the Government can speed up the adoption of many Green technologies by using levers like PPP models (e.g. such a model is proposed for development electric and hybrid transportation), creating a dedicated Green Fund to invest in emerging technologies, setting up Green science parks which promote collaboration between businesses, research institutions and universities and providing fiscal incentives for the early adopters.

### **Conclusion**

The manufacturing companies are Green pioneers. Green manufacturing is core to their competitive strategies. The transformation journey to Green manufacturing has just started. While there are a few early adopters, the industry at large needs to develop comprehensive plans to address all three areas — Green energy, Green products and Green processes. The Government has to play an effective facilitator role in this transformation with both stronger incentives on one hand and regulatory mechanisms on the other. The industry associations can bring the different stakeholders together and support the roll-out of a communication strategy.

Green manufacturing is imperative, not just due to tightening regulations or cost benefits, but also because consumers are demanding it. The continuing expansion of Green consciousness around the world presents a huge opportunity for smart companies. Consumers believe that as individuals, they can and should contribute to sustainability by adopting Green products, they also hold companies to a higher standard when it comes to being Green.

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