Chapter 3: Review of Literature

3.1 Introduction
This chapter reviews the relevant literature relating to the role of business in climate policy and cost and competitiveness of the EI sectors as a whole and specifically in iron & steel industry, cement industry and TPP. Almost all the literature originated in the industrialised countries since they were the first to be affected and they had put in place cap and trade policies and market structures for emissions trading such as the EU ETS. Industries in the developed countries were more worried about the policies impacting profits and competitiveness since the policies were not implemented uniformly around the globe. Because of the differential treatment for non-Annex I countries negotiated in the UNFCCC, developing countries were exempt from taking any emission reduction commitments. Therefore, for almost a quarter of a century, climate policy was not a major concern for the Indian businesses and industry.

While reviewing the different aspects of the climate policy and its relation with business, industries, and competitiveness position, the literature review undertaken has been segregated into the following themes discussed below:

- Business and Climate Policy
- Cost and competitiveness in Energy-intensive Sectors:
  - Cost and competitiveness in iron & steel industry
  - Cost and competitiveness in cement industry
  - Cost and competitiveness of thermal power plants

3.2 Business and Climate Policy
As the majority of the world industrial emissions originate from privately owned operations, the decision-making process in abatement investments lies outside the public governance. This means that the governments are dependent on the industry, as well as other societal sectors to accomplish their climate agendas. Moreover, industries
play an important role not only as investors in abetment measures but also as providers of goods and technologies. The role that industry plays as abetment decision-makers that they have factual information on how different obstacles affect investments in emissions reductions. Many studies have analysed how businesses view climate change within the corporate agenda. In Sweden, 81 per cent of the companies said they would include climate change on their CSR agenda. Climate change was of the fifth most important issue to the European business community CSR agendas (Stigson, 2009).

Renukappa et al. (2013) investigate the key carbon emissions reduction initiatives implemented in the UK industrial sectors to improve their competitiveness. They studied four industry sectors — energy and utilities, transportation, construction, and not-for-profit organisations (NPOs). In order to conduct this study, mixed research methodology was used. They sent questionnaires to 1559 respondents out of which 214 fully completed questionnaires were received for quantitative analysis and conducted semi-structured interviews for qualitative analysis. They found that carbon emissions reduction strategies within the UK industrial sectors were fairly “low” and varies significantly across the four sectors, with relatively high uptake in the energy and utilities sector, and low uptake in the construction sector. The level of implementation of change management initiatives to deal with carbon emissions reduction initiatives was also relatively “low”. They called for the need for cross-sector collaboration to capture and share best practices on low carbon strategies.

Buhr (2012) explored the expectations of the climate policy community for business to act on climate change when expectations of a new global climate agreement were low. The study built on research that suggested that the perceived roles and responsibilities of various actors to address climate change may have changed after the Copenhagen summit in 2009 and that expectations could be an important driving force for corporate behaviour. Questionnaires were given to an elite sample of 205 participants at the Cancun climate conference in 2010, when expectations of a breakthrough for a climate deal were very low. The results suggested that anticipations from businesses in 2010 did not decrease as compared to the previous year when expectation for a breakthrough were high. Forty per cent of the respondents noted that their hopes had increased. In fact, businesses themselves had better expectations than other actors.
Ru et al. (2012) studied the relationship between CO\textsubscript{2} emissions and economic development in China based on dematerialization theory. They divided the period of study from 1960 to 2008 into five 10-year periods and explored the relationship among GDP per capita, carbon emissions and their intensity. They found that dematerialization occurred in 1960-69 and materialization occurred in 1970-79. Relative dematerialization occurred in the rest of the sub-time periods. Over the entire study period, when economic development changed one per cent, carbon emissions, carbon emission intensity and environmental pressure changed 0.59 per cent, -0.34 per cent, and 0.84 per cent, respectively. The results were seen as a proof of relative decoupling of economic expansion from carbon emissions.

Pinkse and Kolk (2010) explored challenges to innovating for climate change to see if any trade-offs have been made by companies. They think that a more systemic solution is needed to address climate change which can be provided by technological innovations. This cannot be delivered by a single company. The problem is how far the companies are willing to take responsibility when they require response from others to achieve positive outcomes. There is a trade-off between optimal level of cooperation and safeguarding future competitiveness by appropriation of products of innovation.

Xu et al. (2010) investigated Chinese policy instruments for mitigation of climate change. These policy instruments were divided into three categories — regulations, technological improvement and economic instruments. Regulations covered setting of national targets, targets to provinces, and a system of penalty to ensure compliance. A China national target was to decrease energy consumption per unit of GDP (EC/GDP) by 20% from 2005 to 2010. For punishment system, Energy-Saving and Emission Reduction Program was introduced. Under the technology improvement regulation, ‘Energy Saving Technology Policy’ was launched. Economic instruments were tax, flexible pricing, subsidies, and funding for climate mitigation actions. Firstly, the national EC/GDP from 2005 to 2010 was calculated to find out if the policy instruments were effective in improving energy efficiency. Then, different categories of policy instruments were compared for their effects. Lastly, trends in EC/GDP in all provinces were analysed in conjunction with instruments adopted. For the energy consumption, data on different types of energy was collected converted into standard coal equivalent (SCE) for comparison. The results presented a declining trend in EC/GDP from 2006 to 2008 on both national and provincial levels. Technology regulations played the greatest
role in reducing EC/GDP, followed by administrative regulations and economic instruments. Different provinces developed policy instruments specifically suited to their condition.

Brännlund et.al (2010) studied the impact of carbon tax on the profitability of Swedish industry. They used company-level data from 1990 to 2004 to test the validity of the Porter hypothesis which states that environmental regulations lead to enhanced efficiency and productivity which finally offset the cost increases resulting from such regulations. For the study CO\textsubscript{2} tax was a dependent variables and profit, production labour, capital, fuel, electricity were act as an independent variables. Using a factor-demand modelling approach mean price elasticities & mean of independent variables and t-vales of energy-intensive & non-energy intensive sectors of Swedish industry were calculated. The result showed that profits were negatively affected the carbon tax. A “reversed” Porter Effect was visible in most industrial sectors, especially EI sectors.

McKinsey (2009) used its proprietary model to forecast India’s emissions in 2030 under two scenarios — reference case or business as usual and abatement case. It suggested ways in which India could use the opportunities for reducing emission intensity and lower its emissions by 2030 by 30 to 50 per cent. These opportunities could reduce India’s coal and oil imports and result in reduction of coal use by 45 per cent. The required changes for bringing about reduction in energy intensity would require incremental investment of the order of 600 to 750 billion euros in the two decades between 2010 and 2030.

Eberlein et.al (2009) studied responses of businesses to climate regulation in Canada and Germany. The two countries were chosen for comparison because they were the two extremes or the “most different systems.” They used the relative case study method with five scenarios to find relationship between business ethics and regulation. The five scenarios were “Business ethics as surrogate regulation”, “Business ethics as regulation”, “Business ethics as orchestrated by regulation”, “Business ethics as preceding regulation”, and “Business ethics as implicit in regulation”. They also analysed the role of big MNC’s. The study showed that the two countries represented opposite extremes on their approach to the problem. Canadian companies saw regulation as good for national competitiveness and the German companies saw it as an opportunity for successful new technologies and markets.
Jeswani, et al. (2008) studied corporate response to climate change, which is not uniform but varies from country to country and across sectors within the same country. Companies respond to emission reduction policies by modifying input factors, products or production processes. The authors selected nine most EI sectors in two diverse countries — the UK and Pakistan — one Annex I and one non-Annex I country according to the UNFCCC classification. These countries differ significantly in economic development, GHG emissions and climate policies. The sectors chosen were power, oil and gas, steel, cement, chemicals, textiles, paper, automobile, and food & drink. Questionnaires were sent to 1478 companies (1028 in the UK and 450 in Pakistan). In all, 180 companies responded (108 from UK and 72 from Pakistan). Factor analyses were applied to the data and cluster analysis was conducted on the resulting factors. The clusters were grouped into four categories — indifferent, beginner, emerging and active. In the UK, businesses have adopted ‘emerging’ or ‘active’ strategies, while most companies in Pakistan were in either ‘indifferent’ or ‘beginner’ phase. The response of the firms were depend on the location, sector, size and type of ownership, the drivers and barriers for taking actions, size and specific type of the industrial operations. For the promotion of the effective energy efficiency policies, industries needed a clear and integrated policy with other policies. And mandatory energy-efficiency standards were help in increasing the efficiency and reduction of wastage through new technology.

Clarkson, Li, Richardson, & Vasvari (2008) studied the relation between EP and the level of environmental disclosure. He focused on environmental disclosures of 191 firms drawn from five industries. Through the content analysis, voluntary environmental disclosure scores were calculated. Other variables for the study were EP, a percentage of toxic or waste processed in the production, J–F coefficient, debt-equity ratio, TOBIN-Q, stock price volatility, Return on assets (ROA), leverage, size, asset newness ratio measured by dividing the net properties, plant and equipment of current year by those of the previous year. Multivariate regression model was used to analyse the relationship of EP and voluntary disclosures. Results showed a positive association between EP and discretionary disclosures.

Kolk and Pinkse (2007) explored the MNCs response towards the emission trading. They sent questionnaire to 500 largest firms and received 331 completed questionnaires. The questionnaire covered a wide variety of corporate activities. To
analyse the data QSR NVivo 7 software package was used. In the findings, MNCs were categorised into four scenarios — “institutional conformist”, “institutional evader”, “institutional entrepreneur” and “institutional arbitrageur”. The study revealed the constraints and opportunities of EU ETS.

Egenhofer (2007) describes the EU ETS scheme and investigates whether it has been successful as a tool to reduce GHG emissions. He concludes that EU will continue to depend on EU ETS for global action but it can face competition from US schemes. Therefore, uncertainty will remain. The analysis was conducted on the basis of the data from the fourth questionnaire of the CDP. The raw data was analysed using the QSR NVivo 7 software package. The author concluded that EU ETS was the most prominent scheme and a large number of MNC’s were engaged in emissions trading.

Levy (2006) studied the business responses to climate change, political economy of corporate strategies and US perspective in abatement of climate change. According to him, the nature of international environmental agreements is such that even the most powerful nations are not able to impose an agreement on the international community, but they are able to block it for some time. Therefore, businesses have no direct role in determining state policies. The consent to a particular climate change regime by countries and companies both depends on whether the policies present economic threats or opportunities. Threat to the markets of an industry in from of regulation, environmental NGOs, or technological innovation was also seen as an economic threat and a challenge to stability. Corporate responses to such threats were R&D, mergers, and or lobbying, at both economic and political levels. Perceptions of threats and opportunities depend on locations of firms and their capacity to compete in new markets. Emissions trading can offer attractive incentives to firms having appropriate capabilities.

Hoffman (2005) described how companies have benefitted from voluntary GHG emissions reductions and business logic for adopting voluntary GHG emissions reductions strategy in U.S. companies. He categorised corporate strategies into “operational improvement”, “anticipating and influencing climate change regulations”, “accessing new sources of capital”, “improving risk management”, “identifying new market opportunities”, and “enhancing human resource management”. He finds that responses to climate change have a strong potential to be strategic in nature. The companies considering operational changes are more likely to incorporate emission
reductions in their decision-making than companies with operating assets that are new. He concludes that more sophisticated strategic plans need to be crafted.

Wagner (2005) studied the relationship of economic and environmental performance in the European paper industry. SO$_2$ emissions, NOx emissions, Chemical Oxygen Demand, energy input, and total water input were used as a measure of EP. Economic performance was measured by Return on Sales (ROS), Return on Capital Employed (ROCE), and Return on Equity (ROE). Additionally, Asset Turnover Ratio, the Debt-to-Equity Ratio and firm size were used as control variables. Panel data model was used for analysis. The results confirm the inverse U-shaped relationship between environmental and economic performance. Corporate strategies on sustainability had moderating effect on the relationship. He suggested that the paper industry should not adopt only those strategies which are related to improvements in the undesired outputs.

Dunn (2002) gave an overview of emerging business strategies to address climate change. He explained the role business in international negotiations, potential of evolving technologies and economics, business engagement with flexible mechanism, risk of sectoral & regional differentiation and corporate leaders in the climate change policy. Results showed that early business responses to climate change were hampered by the prevailing pessimistic economic models as well as limited understanding of the potential of new technologies to lower mitigation cost. Models, however, have been refined and new technologies have entered the market. Consensus among the economists was that emissions trading between countries would help in reducing the costs by 0.1–1.1 per cent. In terms of risk, American firms anticipated more risk than competitors in Europe and Asia. DuPont, BP and Shell were considered to be corporate leader in the mitigating climate change.

Mahadevan (2001) conducted a study on the GHG emissions in the Indian aluminium industry. The entire Indian aluminium capacity is owned by five companies — Balco, Hindalco, Indal, Malco, and Nalco. He took all these companies and analysed their potential for reducing emissions. He also compared emission intensities of Indian plants with world average. He found that CO$_2$ emissions per tonne of alumina were between 1.6 and 1.9 tonnes and for aluminium they were between 21.8 and 25.6 tonnes per tonne of metal. He calculated that with hydropower not available to aluminium plants, their emissions cannot go below one tonne for every tonne of alumina and 19 tonnes for every tonne of aluminium. He also suggested measures which can reduce
emissions to 1.45 tonnes per tonne of alumina and 19.8 tonnes per tonne of aluminium, equivalent to 18 per cent reduction from the 2001 levels.

3.3 Cost and competitiveness in Energy-intensive sectors

By imposing a price on GHG emissions, the climate policy can negatively impact EI industries which compete with other, foreign or domestic, producers. “Industrial competitiveness is a controversial and multi-faceted notion. It depends on a number of factors including primary factor and other input costs, the availability of a skilled labour, company’s ability to compete on quality as well as cost and to generate product innovations” (Reinaud, 2005). Giving a wakeup call at the Climate Leadership Summit in New York, World Bank Group Vice President Rachel Kyte noted that “The science is clear. The economics are compelling. We are seeing a shift toward the economic architecture that will be necessary to avoid a 2-degree-warmer world, an architecture that supports green growth, jobs and competitiveness” (World Bank, 2014). Porter and Van der Linde (1995) elaborated the famous Porter hypothesis that pollution is often a waste of resources and stricter enforcement of environmental standards will enhance efficiency and competitiveness of companies. Michael Porter first gave his theory in 1991, which was against the conventional economic wisdom at that time, in a one-page article in Scientific American (Porter, 1991).

3.3.1 Competitiveness defined

According to Dechezleprêtre & Sato (2014), “competitiveness is synonymous with a firm’s long-run profit performance and refers to its ability to compensate its employees and provide adequate returns to its owners. It can then be interpreted as firm’s ‘ability to sell’, which reflects the capacity to increase market share and may be measured by trade volumes or domestic market share. Or it can be seen as the ‘ability to earn’, the capacity to increase profit measured by turnover, value added or market value.”

Lanzi et al. (2013) consider competitiveness a comparative concept, “aimed at describing the ability of a firm, economy or other aggregation to supply a certain market. It is not measured directly. A loss in competitiveness can be defined as a loss in international market share and/or a loss in profit. Competitiveness concerns arise from the variation among countries’ climate change policies and measures (PAMs). At the simplest level, when one country’s policy results in a cost for carbon and another
country’s does not, the first country may lose competitiveness in the international marketplace.”

Competitiveness is a multidimensional concept. It can be viewed from the perspective a country, an industry, and a company. As comparisons between nations and industry are seen from collective assessments, the firm level comparison gives the clearest idea of competitiveness. In today’s context, the term portrays the economic strength of an entity with in comparison to its competitors in the global and local markets (Ajitabh & Momaya, 2004; Reinaud, 2005).

The firm level competitiveness is “the ability of a firm to design, produce and or market products superior to those offered by competitors, considering the price and non-price qualities. Competitiveness processes are those processes, which help identify the importance and current performance of core processes such as strategic management processes, human resources processes, operations management processes and technology management processes. The competitiveness process can be viewed as a balancing process that complements traditional functional processes such as operations management and human resources management. It enhances the ability of an organisation to compete more effectively” (Liargovas & Skandalis, 2010).

3.3.2 Impact of CO$_2$ and energy pricing

Wooders et al. (2009) addressed competitiveness and leakage issue for options to policy-makers by structured and objective approach. The analysis showed short-term and long-term option for the policy makers. In the short run, there is limited opportunity to improve the competitiveness through the trade intensity. The best option is to increase production from existing plants, build new plants and refurbish the existing ones.

Bassi et al. (2009) examined the impacts of changes in energy prices due to carbon-pricing policies on the competitiveness of US, EI industries, the response of the industry, and opportunities for mitigation of impacts. Five EI manufacturing industries: iron and steel and ferroalloy products, aluminium, paper and paperboard mills, petrochemicals & alkalis and chlorine were studied through the HRS-MI model. EI manufacturing sectors in US show that investment in technology can mitigate cost increases due to policy, improve energy efficiency, and ultimately enhance their performance. The Model shows that all industries suffer losses in domestic market
shares, ranging from 4.5 to 11.9 per cent, but iron & steel industry could suffer the largest cost increases i.e., 2.5 to 10 per cent by 2020 and 6 to 18 per cent over BAU.

Yudken & Bassi (2009) made an attempt to examine how low-carbon technology investments mitigate the cost impacts, achieve energy savings and cut GHG emissions and how do energy price changes due to CO₂ pricing policies impact the competitiveness of five most EI sectors in the US economy. The Vensim modelling (HRS-MI), Dynamix model and climate policy model (II-CPM) were used to develop the production cost model on the variables like production process and technologies, industrial organisations and structure, markets and trade flows, economic and financial trends. They explored a range of energy-saving technologies for the short run, mid run and long run. They found financial, technological, and other limitations in short to mid run. To improve competitiveness in the long term, the only sustainable option is a carbon-constrained world. In conclusion total production cost increases and operating surpluses & margins decline when there is an increase in energy price because of climate policy in EI industries.

Houser (2008) wanted to find answers to questions like (1) how to prevent a decline in output in the face of higher costs, (2) how to guard against “emissions leakage” and (3) how to create incentives for other countries to reduce emissions. He took five emission intensive industries in the United States which account for more than half of all CO₂ emissions from the manufacturing sector. He found that under a cap-and-trade or carbon tax regime, these industries could face a decline in output and lose market share to foreign competitors if they are unable to reduce emissions.

Morgenstern et al. (2007) studied the impact of CO₂ pricing on competitiveness of US industry. He found that auctioning of 50 per cent of allocations would lead to a 3 per cent loss in profitability of the steel sector. Smale et al. (2006) examined the impact of the EU ETS on the competitiveness of UK companies and addressed the potential changes in the prices, volume of sales and profits. The Cournot Oligopoly model was used to represent the market cost structure, flexibility to incorporate profit-maximizing and sales-maximizing objectives. EI companies facing the greatest international competition have a significant impact of policies.
3.3.3 Sectoral competitiveness

Château et al. (2013) examined the macroeconomic and sectoral competitiveness under different mitigation policy scenarios and policies to find solution to competitiveness and carbon leakage. They took the levels of linkages and coverage and strictness of pricing policies for carbon. Competitiveness and carbon leakage were the major concerns in the framing of climate policies. For analysis, they used CGE model. These concerns assume more importance when there are multiple carbon markets as policy differences could impact the competitiveness in countries where the policies are more stringent and production could shift to countries will where there are less stringent policies, known as carbon leakage. The results showed that multiple carbon markets could impact on the competitiveness and lead to carbon leakage. Such an impact could be reduced when climate policies are harmonised across countries and carbon markets are linked.

Chan et al. (2013) assessed the impact of regulation on three variables, viz. unit material costs, employment and revenue on power, cement, and iron & steel sectors using 5873 firms in ten EU members for the period of 2001–2009. Four regression models were developed: regression in from Ordinary Least Square (OLS) without controlling for firm fixed effects (FE) and time effects, regression including firm FE, regression on both firm FE & country-year FE, and regression of interaction terms between programme participation dummy with permit allocation and usage variables. The results of OLS and FE show a positive relationship between EU ETS and firms’ turnover. Emission trading program has different impacts on different sectors. In cement and iron & steel industries, no impacts were found on any of the three variables but industries are vulnerable to carbon leakage and cannot pass increased energy costs to consumers without suffering a loss in market share. Power sector is the most heavily affected by carbon regulation which affect both material costs and revenue.

Ambec et al. (2013) reviewed the studies supporting or opposing Porter Hypothesis which says that environmental regulation will enhance efficiency and competitiveness rather than restricting them and reducing their profits. Twenty-eight major studies were reviewed and the results could be explained either way by conflicting and alternative theories. The version of the hypothesis that says that innovation is the result of strict regulations is well established. The results are mixed for the version that says that “stricter regulation enhances business performance.”
A study by Bassi et al. (2012) attempted to answer the questions if (i) investing in resource efficiency will lead to more sustainable manufacturing industry, (ii) would it reduce global emissions? and (iii) how would it impact the economic performance of industries? Chemicals and petrochemicals, iron & steel, and paper & pulp sectors ranked 1st, 2nd, and 4th in global energy consumption. The study used the system dynamics (SD) modelling through Vensim platform. Results show that under the BAU scenario profitability declines because of exposure to fuel price and in the alternative scenario investing in the resource efficiency help in reducing the energy demand and emission but also lead to positive return on investment (ROI) and reduction in the energy expenditure.

Narayanan and Sahu (2012) studied CO$_2$ emissions intensity of metal industries in India to find out firm level differences. They computed the firm level emissions on the basis of IPCC reference approach. Data was obtained from the PROWESS database and conversion factors from IPCC & IEA were used. The sample size was 400 firms. The study found that intensity of technology import and R&D were negatively correlated with emission intensity, meaning that firms importing more technology and spending more on R&D emitted less. It found that large very small firms emitted less but the medium firms emitted more. The capital intensity was positively related and labour intensity was negatively related with emission intensity, meaning that labour intensive firms emitted less and capital intensive firms emitted more.

García-Sánchez et.al (2012) studied the relationship between the GHG Emission control practices (GHGE) and financial performance (FP) of companies. They took a sample of 81 USA S&P 500 companies from CDP 2005. The industries belonged to different industrial sectors from EI industry to pharmaceuticals, transport and utilities. Taking GHGE & Innovation as independent variable and FP as dependent variable, the study applied different regression models on the data. It found that GHGE control practices had a negative effect on FP and market performance. This is because the emission control practices were motivated by legal pressures and were not a business mechanism aimed at competitive advantage.

A CDP (2012) report found that investments on carbon reduction activities generated an average 33 per cent internal rate of return (IRR), a payback of three years. High-emitting units which set absolute emission targets reported double the reduction rate and 10 per cent higher profits than those that did not set targets. Sixty-three per cent
of the projects generated more than 30 per cent ROI and 88 per cent exceeded firm-level return on invested capital (ROIC). The report warned that the companies that have not yet invested in emission reduction activities will miss the opportunities for high returns. It analysed 860 emissions reduction activities on a sample of 256 companies.

Rivers (2010) studied the impacts on sectoral competitiveness in Canada through dynamic CGE model to see if emission mitigation targets could be met and evaluated design mechanisms which could be used to reduce the negative impact on competitiveness. Several sectors showed competitiveness challenges under the scenario where emission permits were handed out in lump sum.

Barker et al. (2007) studied United Kingdom’s climate agreements and energy efficiency policies. MDM-E3 was used to model interactions between production, consumption, investment, employment, trade, prices and wages. They estimated the effects of the policies on inflation, growth, energy demand, and CO₂ emissions. Energy reduction was estimated at 4.2 mtoe and CO₂ reduction at 3.3 per cent. They estimated more reductions in energy demand and CO₂ emissions if stronger targets were put in place.

Wagner & Schaltegger (2004) analysed the influence of corporate strategy and EP on competitiveness of companies in manufacturing sector in Germany and the United Kingdom. The approach of Environmental Shareholder Value (ESV) was used to identify their influence on shareholder value creation. Through the OLS, regressions relationship between the dependent and independent variables was conducted. It was found that environmental impact reduction index had a positive influence on environmental competitiveness dimensions.

Holling et.al (1998) studied the impact of international climate policies on the competitiveness of Canadian industry. The study investigated the economic cost of limiting the GHG emissions under the six different scenarios. Results showed that greater constraints on CO₂ emissions imposed greater costs due to foregone production. These costs varied with mechanisms chosen and assumption made. In one scenario, initially the GDP reduced from BAU projections by two per cent but recovered to BAU after a decade. Transition costs to the economy increased under all scenarios in the short to medium term but productive capacity was not affected in the long run.
3.3.4 Cost and competitiveness in iron & steel industry

India was the 3rd largest producer of crude steel in 2015 against its 4th position in 2014 in the world (Ministry of Steel, 2016). Production of crude steel grew at eight per cent annually from 2006 to 2012 (Ministry of Steel, 2013). But in 2015 the growth came down to 0.9 per cent. The sector’s contribution to GDP was approximately two per cent but its contribution to GHG emissions was 6.2 per cent in 2007 (INCCA, 2010). Its contribution to India’s GHG emissions came down to 4.49 per cent in 2010 (MoEF, 2015). IEA projections estimate a strong growth of between 85 and 122 per cent between 2006 and 2050 (IEA, 2009). In 2011, one billion tonnes of iron & steel was produced which resulted in 5 per cent increase in global atmospheric CO₂ (Fray, 2013). Emissions of industry sector are estimated to increase by 50–150 per cent in 2050, unless energy efficiency improvements are accelerated significantly.

Morrow III et al. (2013) assessed the energy saving potential in the Indian steel industry and also estimated its cost. Energy saving, cost, lifetime, and technology (used outside the India) were obtained from Lawrence Berkeley National Laboratory (LBNL) reports. The Conservation Supply Curve (CSC) was used as a tool for analysis. They estimated the plant-level electricity savings potential in the industry at 66 Twh and the CO₂ emissions reduction at 65 MtCO₂ between the 2010 and 2030. Under the sensitivity analysis, twelve energy-efficiency measures out of seventeen fell below average fuel price.

Hasanbeigi et al. (2013) conducted a study to analyse the 23 energy efficiency technologies by using a bottom-up electricity CSC model to estimate the technical potential for efficiency improvements and emission reduction in China’s iron & steel industry. Results showed that the electricity saving potential was 251 Twh and associated with emission reduction 139 Mt CO₂.

Tian et al. (2013) described the major factors of GHG emission growth in Chinese iron & steel industry by using the data on direct fuel consumption in which 20 fuel types were taken. Emissions were calculated as per the Tier 1 method of IPCC. They found that production scale effect was the driving force for emission increase.

He et al. (2013) examined the change in energy efficiency and productivity in 50 enterprises in iron & steel industry in China for the period 2001 to 2008. They found that environmental regulation had positive impact on technical change, and that average
energy efficiency of plants was 61.1 per cent and productivity growth rate was 7.96 per cent.

Arens et al. (2012) analysed the SEC in the German steel sector for the period 1991 to 2007. The results showed that SEC declined by 0.4 per cent per year and the decrease in BF was 0.2 per cent per year. EAF and sinter plants increased by 9 per cent and BOF increased was 60 per cent between 1991 and 2007. Energy efficiency improvement accounted for 25 per cent of the observed change in SEC (0.1 per cent/year).

Demailly & Quirion (2008) studied the impact of EU ETS on production and profitability of the iron & steel industry. For the study the world was divided into EU 15 and the Rest of the World. In results it clearly visible that the emissions dropped by 12 per cent and emission intensity declined by 91 per cent in the iron & steel industry. The loss to competitiveness was small in ETS first phase, hence opposition to stringency of the ETS held no ground.

Gielen & Moriguchi (2002) described the strategies for reducing CO₂ emissions in the life cycle of iron & steel in Japan. They studied the current Japanese CO₂ emissions in the iron and steel life cycle, characteristics of emission reduction options, the optimal mix of emission reduction options and how will Japanese CO₂ policies affect foreign trade and foreign CO₂ emissions. For the development of strategies through the systems life cycle approach, tracking of the flows of energy and materials in the economy, and an analysis of the systems response to different policy was done. Steel Environmental Assessment Program (STEAP) model covers a materials category ‘from cradle to grave’ for the whole world and provides new insights into the trade effects and carbon leakage. By encouraging recycling and adopting a global tax equivalent to USD 41 per tonne of CO₂ a further emission reduction can be achieved in the industry.

Kim & Worrell (2002) analysed the iron & steel industry in seven countries through in-depth decomposition analysis for finding the trends in CO₂ emissions by using physical indicators. To establish a possible link between the energy intensity to technology change, decomposition analysis was employed. Calculation of the carbon intensity index (CII) was done which is the ratio of the actual CO₂ intensity to a reference CO₂ intensity to compare CO₂ emissions across countries. CII can be used as a
tool in benchmarking one country’s performance against the other. Production was the main contributor while energy-efficiency was the main factor in reducing emission intensities. Substantial differences in energy efficiency were found in all countries. South Korea and Mexico showed a shift to less CO$_2$ intensive product mix, upward trend in the share of EAF. Brazil, China, India and the US showed a shift to a more CO$_2$-intensive product mix.

Ozawa (2002) assessed the trends in energy use and CO$_2$ emissions for a period of 26 years started from 1970 to 1996 of the Iron & steel industry in Mexico. By using the decomposition analysis the technical score was calculated. Production as output variable and energy consumption & CO$_2$ emissions were taken as an input variable. There was an increase in the production of iron & steel at an annual growth rate of 4.8 per cent and primary energy consumption and CO$_2$ emissions increased by 3.8 per cent in and 9 per cent. But energy intensity decreased because of technological changes, use of natural gas instead of coke, substitution of OHF by BOF and use of new technologies. Despite the decline of energy intensity, the iron and steel industry had a large technical potential in comparison to other countries.

3.3.5 Cost and competitiveness in cement industry
The CO$_2$ issue for cement companies is mainly focused on the production process. The issue has not resulted in the companies’ global strategy being called into question for the time being. Most energy efficient units are being installed in almost every sector and seven Indian cement plants are at the frontier of energy efficiency (Eberlein & Matten, 2009).

Arjaliès et al. (2016) conducted a comparative study of CO$_2$ reduction strategies in the cement and chemical industries to find i) the dependence of the production process on natural resources, ii) the ability to leverage the business portfolio, and the resulting role of R&D, and iii) the structure of the downstream sector. Twenty-three member companies of the Cement Sustainability Initiative (CSI), a global effort by leading cement produces in 100 countries, were selected. The study showed that the freedom of companies to adopt an approach to sustainable development is constrained by the features of the sector, in terms of its dependence on natural resources, flexibility in the composition of the business portfolio, and the structure of the downstream sector.
Neuhoff et al. (2014) examined the influence of the EU ETS and other policy instruments on the investment and operational choices at the company level in the cement sector. Secondary data was obtained from sources like the European Union Transaction Log (EUTL), Eurostat, World Business Council for Sustainable Development, Cement Sustainability Initiative (WBCSD-CSI), annual reports, and primary survey conducted through interviews of the executives about the influence of the EU ETS system, energy & CO$_2$ intensity, trade flows, competitiveness, investments and innovation on short, medium and long term. EU ETS is considered the main driver in the CO$_2$ emission reductions in the cement companies. The decrease was from 7 per cent to 5.6 per cent between 2008 and 2012.

Siew, Balatbat, & Carmichael (2013) examined the relationship between sustainability practices and FP of construction companies for the three-year period 2008-2010. The sample of 44 companies was selected from the Australian Stock Exchange. For the sustainability practices data from the non-financial reports were taken on the 68 items within nine domains such as climate change, environmental management, environmental efficiency, other environmental matters, health and safety, human capital, conduct, stakeholder engagement and governance. And FP indicators included profitability financial and equity valuation ratios i.e., ROA, ROE, ROIC, earnings before interest tax depreciation and amortisation (EBITDA) margin, and net operating profit less adjusted taxes (NOPLAT), earnings per share (EPS), dividend per share (DPS), dividend yield (DY), price to earnings ratio (PE), and enterprise value (EV). Then to measure the relationship correlation technique was use. Results showed that publicly listed construction companies achieve “excellent” levels of disclosure in non-financial reporting and high level of disclosure lead to better FP.

Mandal & Madheswaran (2009) measured the environmental efficiency of both desirable and undesirable output on a state-level data of the Indian cement industry for the years 2001 to 2005. This study covered 20 major states in terms of cement production. Further, input-output model was conceptualize by taking four input capital, energy, labour, materials and one output i.e., production. Undesirable by-product was measured by CO$_2$. By using data envelopment analysis (DEA) technique, technical efficiency scores of different sates were calculated. Empirical results showed that average environmental efficiency measured in 2005 was declined in comparison to 2001. They found that larger the availability of coal in a state, lower was the
environmental efficiency. Regulation expanded desirable output and reduced undesirable inputs.

Sheinbaum, C., & Ozawa, L. (1998) analysed the energy use and emissions trends in the Mexican cement industry between 1982 and 1994. Production of clinker and cement were taken as an output variable and fuel intensity, energy intensity, ratio of AF were taken as an input variable. Results showed that energy use increased by 10.8 per cent and CO$_2$ emissions increased by 40 per cent. Energy intensity dropped mainly due to modernization, increased production of blended cements, and use of AF.

**3.3.6 Cost and competitiveness of thermal power plants**

India accounts for nearly four per cent of global power generation capacity, and is the fifth largest in the term of over-all installed capacity. Major advancements in power generation have resulted in the compound annual growth rate (CAGR) of 5.6 per cent in the last five years between 2007 and 2012, whereas the demand has grown at a CAGR of seven per cent (Frost & Sullivan, 2012). The Indian power sector is driven by state, central and private players. The total installed capacity in the country was 271.72 GW as on 31st March 2015, with state sector accounting for 35 per cent, central sector 26.7 per cent and private producers 38.3 per cent. Targeted improvements in transmission and distribution (T&D) have led to reduction in losses from around 24 per cent of generated electricity in 2010-11 to about 23 per cent in 2012-13 (MoEF, 2015). The Twelfth Five Year Plan (2012-2017) has laid down a detailed agenda for sustainable development. The Plan emphasises on a bouquet of intervention in governance and technologies e.g. UMPP, SC technology, SEEP for superefficient fans, LED bulbs and tube lights (Planning Commission, 2013).

Emissions from the electricity sector make up 38.36 per cent of India’s total GHG emissions. Given India's low per capita electricity penetration, this share is likely to increase substantially in the future as per capita electricity consumption levels approach those of developed countries. Simultaneously achieving deep carbon emission cuts in the power sector while meeting high electricity demand will prove challenging (Shukla & Chaturvedi, 2012).

**3.3.6.1 Background of thermal Power Plants**

The history of India’s power sector can be divided by a series of major legislative markers: the Electricity Act (1948), the Electricity Act (1991), the Electricity Act
(1998), and the Electricity Act (2003), each of which made significant changes to the structure of the Indian power sector. After, India’s independence in 1947, the Electricity Act of 1948 led to the establishment of State Electricity Boards (SEBs), operating vertically-integrated generation, transmission, distribution, and retailing activities. The national and state governments shared control of the power sector, with SEBs exercising significant autonomy, but relying on the national government in the form of technical advice from the Central Electricity Authority (CEA) and financial support from the Power Finance Corporation (PFC). With no competition in any segment, the state represented the only producer and buyer of electricity.

In 1991, a financial crisis brought on by high levels of indebtedness at all levels of government triggered wide-ranging reforms of much of the economy, including the power sector. The Electricity Act of 1991 sought to ease the fiscal burden of the power sector by allowing private capital and relying on competition to bring down production costs. Under the new rules private generators known as independent power producers (IPPs) could sell electricity directly to SEBs under power purchase agreement (PPA) contracts, which ensured attractive rates of return and were guaranteed by the national government. Through the Electricity Act of 1998, attention began to shift from generation towards reforming distribution. The Electricity Act of 2003 provides open access not only in transmission, but also in distribution. These conditions include a spot market, into which an independent system operator responsible for coordinating the dispatch of electricity over network wires, open access to network wires and appropriate calculation and application of location-specific transmission charges to consumption (Talbott, 2013).

3.3.6.2 Other Policy Instruments in thermal power plants

The Mega Power Policy was introduced in 1995 to fast-track investment by giving additional incentives to plants having more than 1000 MW capacity. Power Trading Company was set up with the aim of acting as an intermediary between the private power plants and state electricity boards (Ahn & Graczyk, 2012). The Energy Conservation Act was enacted by Parliament to promote efficient use of energy.

3.3.6.3 Thermal power and carbon pricing

Pachauri (2014) analysed changes in CO₂ emissions from the use of electricity in India between 1981 and 2011. Emissions from use of electricity were decomposed into four underlying factors:
i. Carbon intensity of electricity production (I)
ii. Electricity use per connected household (C)
iii. Share of households with access (A),
iv. Number of households (N).

Results showed that use of electricity by every connected household was growing and more households had access to electricity, which made largest contribution to increasing emissions from household electricity.

Gonzalez-Gonzalez et al. (2013) studied the strategies of organisations in response to ETS, with special reference to Heineken Spain, a company that primarily manufactures and distributes beer. The reason for studying the company was its own thermal generation capacity of over 20 MW. The strategies the company employed were “top management support”, communication, training, internal supervision, and consistency.

Shukla & Chaturvedi (2012) analysed energy technology targets for the national energy security and meeting the climate change goals in China and India through the target approach. They calculated emissions from energy and land use changes under four scenarios. The results showed that targets could have adverse impact on mitigation efforts if they are not derived from the main goal of ensuring economic efficiency. The technology targets can result in excessive subsidies because of competition and adversely affect other low carbon options which have not been chosen for subsidy.

Behera & Farooque (2010) estimated the technical and scale efficiencies of coal-fired power plants in India. They studied performance data of 74 plants over 5 years from 2004 to 2008. They considered each plant as a separate DMU different years, giving a total of 370 DMUs. They found average technical efficiency of these plants to be 83.2 per cent with 38 plants falling below the mean level. As many as 49 DMUs topped the efficiency scores defined by the operational parameters Capacity, Plant load factor (PLF), Specific Coal Consumption (SCC), AUX, Planned Maintenance (PO) and Forced Outage (FO).

Hoffmann (2007) studied the impact of EU ETS on the investment decisions of the German electricity industry. The purpose of the EU ETS, launched in 2005, was to reduce CO₂ emissions and stimulate low carbon investments. The launch of the pilot phase of the scheme raised questions whether the scheme would actually spur
innovation. But there was no sufficient empirical evidence to answer the question. This study provided initial empirical evidence by analysing corporate reactions to the EU ETS. The study investigated five companies accounting for over 80 per cent of the sector’s CO₂ emissions and more than 50 per cent of investments announced. The study relied on interviews with top management. It found that electricity companies integrated the CO₂ costs in their investment decisions but large-scale investments in power plants or in R&D were limited. It recommended that the policy makers should set long-term goals to reduce regulatory uncertainty and announce more incentives to increase efficiency.

Sijm et al. (2006) studied implications of carbon trading under the EU ETS for the price of electricity and profits of power companies in the Netherlands and Germany. It was found that to cover their costs, power companies were allocated carbon allowances for free. The companies then added the cost of carbon to the price of electricity and reaped windfall profits by selling these credits at the EU ETS. The study found that companies passed on 60 to 100 per cent of the CO₂ cost. The power companies earned profits of the order of 3-5 euro per megawatt hour (Mwh) produced and sold.

Sathaye & Phadke (2006) examined the costs and emissions of proposed coal and natural gas-fired combined cycle power plants in India and compared them with plants in the US and other OECD countries. They found that the cost of electricity for proposed plants will higher than similar units in the OECD countries. They reached the conclusion that the cost of carbon reduction could be higher in developing countries since the technology costs are higher.

3.4 Research Gap

There is a paucity of academic literature on the impact of climate change policies on the corporate sector and corporate responses to climate change in emerging economies (Pulver, 2012). Most of the studies have been carried out in OECD countries or the countries having Kyoto obligations to reduce emissions. There are some general modelling studies (Climate Modelling Forum, India, 2009) on India’s future GHG emissions. Global consultancy firm McKinsey brought out a study on India’s energy sustainability (Gupta et al., 2009), which talks about opportunities but has nothing to
say on the costs to, and readiness of, the Indian corporate sector in taking up the challenge.

Globally, few studies have attempted to examine the implications of climate policies for EI industries. Most of them are largely qualitative. An example is a report Houser (2008), which summarises the challenges faced by policymakers in drafting climate legislation that addresses competitiveness for U.S. manufacturing.

3.5 Chapter summary

In this chapter, two main aspects business and climate policy were discussed. One, the role of business in climate mitigation and policy is critical since majority of the world industrial emissions originate from privately owned operations, and the decision-making process in abatement investments lies outside the public governance. Two, the cost and competitiveness in EI sectors in the face of new domestic climate policies, especially in relation to the iron & steel, cement and TPP were reviewed. Most of the studies were carried out in the developed countries and focus on the twin goals of achieving emission reduction and at the same time remaining globally competitive. Most of the studies show that as a result of climate policies profitability and competitiveness will be reduced in the short to medium terms but efficiency and production will remain unaffected in the long term. They examined the effectiveness of a wide range of policy options in achieving overall environmental effectiveness and economic efficiency of domestic climate policy.

The next chapter is research methodology where objectives of this study in the light of research gap highlighted in this chapter will be discussed and hypotheses will be developed for meeting these objectives.