Chapter 1: Introduction

1.1 Introduction

Climate change is today a major global challenge and all countries, rich or poor, have committed to reduce emissions of greenhouse gases (GHGs) that cause global warming. A major GHG is carbon dioxide (CO$_2$) which is released when fuels are burned, but there are five other category of gases whose global warming potential (GWP) is several times more. The gases are methane (CH$_4$), nitrous oxide (N$_2$O), hydrofluorocarbons (HFCs), tetrafluoromethane (CF$_4$), hexafluoroethane (C$_2$F$_6$), and sulphur hexafluoride (SF$_6$) with GWP of 21, 310, 1300-11700, 6500, 9200 and 23900, respectively (MoEF, 2012). By multiplying emissions of all GHGs with their GWP, the final figure is presented in terms of CO$_2$ equivalent, or CO$_2$eq.

An alarm was raised by top scientists in the 1980s that the CO$_2$ concentrations in the atmosphere reached such alarming levels that it could lead to irreversible global warming with attendant risks like sea level rise leading to large-scale climate migration, and increasing severity of natural disasters such as storms and draughts. A top scientist of the National Aeronautical and Space Administration (NASA) James Hansen testified in the US Senate in 1988 that the earth was warmer than the previous three decades and it was caused by human activities (Hansen, 1989). The same year, Intergovernmental Panel on Climate Change (IPCC) was established to assess climate change related scientific information and formulate realistic response strategies. In its Fifth Assessment Report (AR5), the IPCC announced that the warming of the climate system is unequivocal, ice caps are melting and sea levels are rising (IPCC, 2013). The latest World Meteorological Organization report has announced that the global average temperatures set a new record of 1.1° C above pre-industrial period and the sea ice extent dropped more than 4 million km$^2$ below average in 2016 and sea levels have risen by 20 cm since the start of the twentieth century (WMO, 2017).
In 1992, the United Nations organised a world summit in Rio de Janeiro, popularly known as the Rio Earth Summit, which adopted, among other agreements, the United Nations Framework Convention on Climate Change (UNFCCC). This legally binding convention declared that since the largest share of historical global emissions of GHGs originated in developed countries, they must lead in fighting climate change. Bearing the higher burden of reducing emissions, 37 developed countries were put in the Annex I list, who accepted legally binding commitments to reduce the six GHGs by 5.2 per cent from their 1990 levels and the rest of the world did not have any commitments under the Kyoto Protocol, signed in 1997 in Kyoto, Japan.

Since the global emissions kept on increasing, it was decided that all countries must take commitments. The 21st Conference of Parties (COP 21) to the UNFCCC, held in Paris in 2015, took the landmark decision where all Parties took emission commitments under the Intended Nationally Determined Contributions (INDCs). Before this, non-Annex I Parties to the Convention took voluntary commitments in 2009 at the Copenhagen Summit, where India committed to reduce by 20-25 per cent the emission intensity of its GDP by 2020 compared to its 2005 levels (India, 2010). In the Paris Agreement, India took more commitments through its INDC to reduce the emissions intensity of its GDP by 33 to 35 per cent from 2005 levels by 2030. Additionally, India has set a targets of achieving 40 per cent electric power installed capacity from renewable energy (RE) resources, and plant more trees and forests to create carbon sink of 2.5 to 3 billion tonnes of CO$_2$eq (India, 2015).

1.1.1 Climate policy in India

The Indian Constitution was probably the first national constitution in the world to contain specific provisions for environmental protection (Jaswal, 2003). The 42nd Amendment to the Constitution in 1976 added Article 48-A under the Directive Principles of State Policy to protect India’s environment and preserve its wildlife and forests.

The first major law to combat climate change, the Energy Conservation Act, was enacted by Parliament in 2001 to provide a legal framework and regulatory mechanism for energy efficiency. Five major provisions of the law are Designated Consumers (DCs), standards and labelling for appliances, Building Codes for energy conservation, creation of an institutional framework in the form of BEE and establishment of Energy

Just before the Copenhagen Summit in 2009, where India took voluntary emission intensity targets, the then Prime Minister, Dr Manmohan Singh, announced the NAPCC, which has eight missions designed to deal with different aspects of climate change (Prime Minister’s Council on Climate Change, 2008). The implementation of this document was predicted to give a directional shift to India’s development pathway. One of the eight missions is the NAPCC. To give effect to this mission, The Energy Conservation Act, 2001, was amended in 2010 which allowed the Central Government to issue energy savings certificates (ESCerts), enhanced the penalty for specified offences under the original Act to INR 10 lakh from INR 10,000, made the rules for energy audit more stringent and obliged the DCs to submit information on consumption of energy.

Under NMEEE, the BEE announced the PAT scheme for incentivising energy efficiency. Under this scheme, specific energy reduction targets have been given to DCs in eight energy-intensive (EI) sectors collectively accounting for 25 per cent of India’s GDP and 45 per cent of its commercial energy use. BEE will issue tradable ESCerts to the DCs based on Specific Energy Consumption (SEC). These certificates will be tradable so that the units that outperform will be able to earn money by selling them and those that cannot achieve the desired efficiency will have to buy them to fulfil their obligation.

In the PAT Cycle I, operational from 2012 to 2015, 478 DCs in eight EI sectors, accounting for 36 per cent share in total energy consumption, were identified. Out of these, 14 closed and 18 did not register, and 446 registered. Thermal power pants (TPP) sector had 144 DCs having an energy consumption share of 63.38 per cent, Iron & Steel 67 DCs with a share of 15.35 per cent, and Cement 85 DCs with a share of 9.10 per cent. At the end of the cycle, 46 DCs achieved targets in the Power sector, 41 in Cement, and 22 in Iron & Steel. Among the better performers 25 in Power sector, 15 in Cement and five in Iron & Steel. The performance of 62 in the TPP, 27 in Cement sector and 14 in the Iron & Steel sector deteriorated (Ranjan, 2015). In the PAT Cycle II (2016-2019), 900-950 DC accounting for 50 per cent of total energy consumption in 11 sectors were identified.
1.1.1.1 Finance requirements

India’s INDC has estimated that USD 2500 billion would be required to meet the country’s climate change actions between 2015 and 2030 (India, 2015). For implementing adaptation actions in agriculture, fisheries, water resources and ecosystems, India needs USD 206 billion. Additional investments will be required for strengthening resilience and disaster management. A study by the Asian Development Bank (ADB) has estimated that economic loss and damage from climate change will be approximately 1.8 per cent of GDP. To achieve 40 per cent electricity installed capacity from RE sources in the next 15 years will require transfer of technology and low interest international finance from Green Climate Fund (GCF) and other sources (India, 2015; Kanchan & Kumarankandath, 2015).

Ahn & Graczyk (2012) estimate that the new policies scenario in India shows that carbon emissions in India will grow at a compound annual growth rate (CAGR) of 3.2 per cent, to reach 3535 Million tonnes (Mt) CO₂ in 2035, which is 8 per cent of global emissions. Emissions from coal combustion would be 2227 MtCO₂, or 63 per cent of India’s total emissions. At CAGR of 1.3 per cent, India’s emission growth would slow to 2159 MtCO₂ in 2035. But Akashi et al. (2011) predict that the largest potential of savings in emissions for EI industries remains in China and India. McKinsey found that the energy-saving potential is largest for iron & steel, chemicals and cement. The United Nations Industrial Development Organization (UNIDO) evaluated the potential based on application of best available technologies (BAT). The potential mitigation values are higher in developing countries at 30 to 35 per cent compared to developed countries, which lower at 15 per cent (Fischedick et al., 2014). According to UNFCCC estimates, annual incremental investment requirements for India will be USD 6.2 billion. McKinsey estimated the annual incremental investment around €13 billion up to 2020, and then €23 billion annually up to 2030 (Atteridge et al., 2009).

1.1.2 Top emitters

Industry’s contribution to the economic growth in India is considerable and coal accounted for over half of primary energy consumption. Energy intensity in the industry declined gradually from 1990 to 2000. This can be attributed to adoption of new technologies and expansion of non-energy-intensive industries (MoEF, 2004). Electricity generation and industry are the largest CO₂ emitting sectors in India and
together account for 54.31 per cent of emissions (MoEF, 2015). Another major emitting sector is agriculture because of methane and N₂O emissions which have very high GWP. Power sector is the largest consumer of primary energy, followed by industry. Top energy consuming industries in India are iron & steel, cement, aluminium, fertilizer, paper & pulp, and glass, which consume around 40 per cent of total industrial fuel (Bhattacharya & Cropper, 2010).

The top two emitting industries are cement and iron & steel, which accounted for 41.44 per cent and 31.93 per cent of industry sector emissions of 300.62 Mt of CO₂eq in 2012 (MoEF, 2015). Electricity generation, and energy consumption in six EI industries— iron & steel, aluminium, cement, fertilizer, refining, and pulp and paper — and fuel used in road transport covered 75 percent of emissions from energy use in India (Gaba, Cormier, & Rogers, 2011). Globally, aluminium, cement, and iron and steel contribute more than 10 per cent to global GHG load and are growing rapidly in China, India and other emerging economies (Baron, Reinaud, Genasci, & Philibert, 2007). The share of electricity generated by coal in India is estimated to increase from 73 per cent in 2007 to 78 per cent in 2031 (World Bank, 2009).

UNFCCC estimates that clean technologies for fossil fuel power generation can reduce emissions by 1.6 Gigatonnes (Gt) CO₂eq by 2030. This can be done by improving or replacing with advanced technologies the existing facilities generating power from coal. It will not only bring about considerable CO₂ mitigation but also ensure that power demands are met. As much as 40 per cent of coal in India has high ash content, low calorific value and low volatile matter. Gasification of these low grade coals and adoption of integrated gasification combined cycle (IGCC) technologies can resolve these problems. IGCC technology is suitable for India because of significant cost advantages and long expected life cycles. Five-year plans also prioritise the adoption of larger TPP based on supercritical technology. For old TPP there are modernisation and live extension schemes for efficiency improvement. Central Electricity Regulatory Commission (CERC) has approved a national tariff mechanism that will promote energy efficiency. This is based on heat rate and auxiliary power consumption (AUX). India is making bilateral cooperation arrangements with the EU, the US, Germany, and Japan to improve efficiency of TPP and build operation and maintenance (O&M) personnel capacity (MEF, 2009).
Climate Modelling Forum, India (2009) reviewed the results of five modelling studies done independently using different models and assumptions on India’s future emissions. The institutions which conducted the studies with the support of the Ministry of Environment and Forests (MoEF) are the National Council of Applied Economic Research (NCAER), The Energy and Resources Institute (TERI), Integrated Research and Action for Development (IRADe), and Jadavpur University. McKinsey and Company has done a separate report. The five models gave vastly different picture of India’s GHG emissions in 2030-31, from 4 Bt to 7.3 Bt of CO$_2$eq, but all predicted fall in emission intensity per unit of GDP.

A report by Industry apex body FICCI has warned of a severe drop in the output of EI sectors and a fall in GDP growth (FICCI, 2007). The United Nations Environment Programme (UNEP) has acknowledged that India is on track to achieve its voluntary pledges (UNEP, 2014).

1.2 Linkage between business and climate policy

The Paris Agreement provides a momentum for a resource-efficient and low-carbon global economy. It encouraged corporate leaders to contribute in the discussions during the conference of parties (COP). Corporations are now pushing the climate agenda instead of blocking the climate action as their past record shows. They are demanding clear and strong policies. Nations now have a new objective which will form the basis for policy instruments for development and investment. The Agreement provides an opportunity to achieve “net zero” climate impact.

The key to climate change mitigation depends on the private sector because big multinational corporations (MNC’s) are responsible for nearly half of global GHG emissions. Private companies need to initiate investments and innovation essential for a low-carbon economy. The governments also a role to play in bringing regulations, whether market-based or conventional, and facilitate the agenda through public-private partnerships (Stavins et al., 2014).

1.2.1 Paris Business and Climate Summit

The top 1,000 GHG emitting companies are responsible for annual emission of 10 GtCO$_2$eq, which is about 20 per cent of the world's annual GHG emissions (UNEP, 2015). At the 2015 Paris Business and Climate Summit, business representatives urged the governments to achieve net zero emissions before the end of the century. CEOs
from around the world called on G7 finance ministers to make political commitment on long-term policy to give investors policy certainty and clear direction (Allen, Isabel Bottoms, James, & Yamin, 2015).

Luis Neves, Chairman, Global e-Sustainability Initiative (GeSI) (2015), expressed “strong support for a new climate agreement from the Information and Communication Technology (ICT) industry, reporting that action in the industry could reduce global carbon emissions by 20 per cent by 2030, while generating US$ 11 trillion in revenues and cost savings”. And Ulrich Spiesshofer, CEO, ASEA Brown Boveri (2015), highlighted his company’s commitment to improve energy efficiency by 20 per cent by 2020 in all operations, and underscored several investment initiatives in environmentally-friendly and low-loss power grid technology, including solar and wind, as well as micro-grid projects, to bring electricity to one billion people in Africa (Brewer, 2007). Due to climate change policy there is a transition in a strategic positioning of a company that requires a successful assessment of emission reductions. But some companies see opportunities in this transition that will deliver winners and losers in the economy (Hoffman, 2005).

With no public and political pressure on the mainstream political parties to address the environmental issues (H. Gupta, Kohli, & Ahluwalia, 2015), the politicians in power, who have to address diverse, and often contradictory, claims on resources, succumb to the lobbying by the big businesses and corporate sector.

1.3 Cost and competitiveness in energy intensive industry
Climate policy has imposed an indirect cost on the EI industrial sectors, for which energy forms a significant share of production costs, which could have a negative impact on its competitiveness vis-a-vis foreign and home producers. Research in other countries found that impacts of climate policy or the energy prices changes resulting from the CO₂-pricing policies have an impact on the competitiveness of the industry (Rivers, 2011; Yudken & Bassi, 2009). EI Industries are exposed to impacts of emissions pricing policies, and the constraints arising from national climate policies are a double-edged sword. Steel, cement, aluminium, basic chemicals and pulp & paper represent the classic sectors of industrialisation and rising living standards. But they also represent the largest sources of energy consumptions and GHG (Droege, 2013). In the climate policy context, the competitiveness concern applies to companies in the EI
Industries, which are exposed to trade and whose market is challenged by foreign competitors. Globally, aluminium, cement and iron & steel fit into this category (Baron et al., 2007).

Climate policy is not a major trade issue but there are competitiveness issues for industries which are GHG-intensive as well as trade intensive. Most of the world’s EI Industry is now situated in developing countries. In 2003, developing countries produced 78 per cent of global cement, 57 per cent of world’s nitrogenous fertilizers, 50 per cent of aluminium and 42 per cent of steel (Worrell, Bernstein, Roy, Price, & Harnisch, 2009).

Globally, industrial emissions are estimated to grow from 11.72–17.95 Gigatonnes of CO₂ (GtCO₂) in 2010, to 12.82–22.72 GtCO₂ by 2020 and to 11.35–32.24 GtCO₂ by 2050. The energy intensity of the world economy has been falling by one per cent per year. This has been brought about mainly by technology improvements which come with replacement of depreciated machines and equipment (Watson, Zinyowera, & Richard H. Moss, 1996). Globally, primary industry accounts for approximately 30 per cent of GHG emissions. Direct and indirect industry-related GHG emissions grew from the equivalent of 10.4 GtCO₂ in 1990 to 15.5 GtCO₂ in 2010, reflecting the steady growth in production trends. However, attention is currently focused on ways of improving energy efficiency in the primary industry sector. Energy intensity could be reduced by up to 25 per cent through wide-scale employment of the BAT. “Additional reductions of up to 20 per cent can be achieved through innovation before approaching technological limits in energy intensity” (Pal, Gupta, & Kapur, 2016). The potential for energy savings based on widespread application of new technologies is higher for developing countries at 30–35 per cent than developed countries at about 15 per cent (Bourgouin, 2014; Newell, Jaffe, & Stavins, 2006).

Power generation from fossil fuels resulted in over 40 per cent of world’s energy-related emissions. The International Energy Agency (IEA) indicates that over 50 per cent of the power sector’s emissions through 2030 will be come from coal-fired generation, which is a 60 per cent increase (MEF, 2009). Over half of India’s energy-related CO₂ emissions are expected to come from power (World Bank, 2008a).

Steel production constitutes about 7 per cent of global CO₂ emissions, which are estimated to be 2.6 GtCO₂ (Fischedick et al., 2014). Indian steel plants have achieved
energy consumption of 6.5–7.0 Giga calories (Gc) per tonne of crude steel against the international norm of 4.5-5.5 Gc per tonne. Steps are being taken to achieve even lower rates of energy consumption (India, 2015). In 2010, worldwide average CO₂ emissions were 1.8 tonnes for every ton of steel produced (Quader, Ahmed, Ghazilla, Ahmed, & Dahari, 2015). Iron and steel industry is the highly CO₂ emitting sector of the China’s economy which contributes 15 per cent of china total energy consumption (Karali, Xu, & Sathaye, 2016). India’s share in the world cement production is approximately 6 per cent coming from 154 large plants with an installed capacity of 230.82 Mt (Parliamentary Standing Committee, 2011).

Indian cement industry is estimated to consume at 2 per cent of global primary energy, or almost 5 per cent of the global industrial energy consumption (Worrell, Price, Martin, Hendriks, & Meida, 2001). TERI Director General Ajay Mathur has noted that developing countries have a huge advantage in energy efficiency since late development of infrastructure means it used latest technology (TERI, 2016).

India’s power sector consumes 43 per cent of commercial primary energy and produces 40 per cent of the country’s CO₂ emissions. TPP in India produce 71 per cent of the country’s commercial electricity, which is estimated to go up to 78 per cent in 2031 (Bhattacharya & Cropper, 2010). India’s goal to have 60 per cent of the new coal-fired plants built during the 12th Five-Year Plan (2012-2016) using supercritical technology is appropriate, but higher steam conditions should be sought (World Bank, 2008a). In 2009, per capita electric power consumption in India averaged 734 kilowatt hours (Kwh), compared to 2,456 Kwh in China and 13,647 Kwh in the United States. While such low levels of electrification pose challenges on their own, it is the shortfall of supply relative to demand that creates the more pernicious risk of outages (Talbott, 2013). The most efficient coal-based power generation plants in developed countries achieve efficiency levels 50 per cent higher than average plants in India and China. Power generation installed capacity is expected to go up from 128 Gigawatts (GW) in 2009 to 800 GW by 2030 (A. Ghosh & Watkins, 2009).

This study is an attempt to find out the impact of climate policy on the cost and competitiveness in the EI Industry. The study will focus on three most EI sectors — TPP, Iron & Steel and Cement — which together accounted for 50.8 per cent of India’s total GHG emissions in 2007 (INCCA, 2010) and 43.23 per cent in 2010 (MoEF, 2012). Out of the eight most EI sectors chosen by BEE, these three accounted for 87.83 per
cent of annual energy consumption during PAT Cycle I. The study period is five years from Financial Year (FY) 2010, to FY 2014. Other major emitters are transport, domestic and agriculture sectors. A part of the emissions of these sectors is being covered under electricity but they are omitted from the preview of the study since they are highly diverse and spread out.

1.4  **Research objectives**

1. To find and compare climate policy variables impacting the cost and competitiveness of three industrial sectors, viz. iron & steel, cement and TPP.
2. To find the impact of climate policy variables on the competitiveness of the industrial selected sectors.
3. To find out the efficient and inefficient units and their potential in the industrial sectors.
4. To find out how companies are responding to the new challenge.
5. To offer recommendations for the policy makers and EI industry on the basis of this study.

1.5  **Need and significance of the study**

Environmental policy research is one of the thrust areas identified by the MoEF for building and validating models and generating knowledge that supports negotiations in the multilateral environmental agreements (MoEF, 2006). The importance of the issue will increase in future because industries are the driving force of economy as well as emissions. For successfully negotiating such an agreement, India needs studies based on cost-benefit analysis of its commitments. This study will help generate strategic knowledge for climate change, which is one of the national missions under the NAPCC. At the same time, industry needs to know the impact of such policies on its profitability and competitiveness.

1.6  **Scope of study**

The study is an interdisciplinary research which covers commercial, economic and environmental concerns in the upcoming scenario. It is also possible to be able to build an economic model fully applicable to the Indian industry in the context of climate change. As of now, no such model exists. A lot of uncertainty pervades this area, whether scientific or economic. Many future studies can build upon this study to reduce those uncertainties.
This study focuses on the three most EI sectors — Iron & Steel, Cement and TPP — out of the eight EI sectors as per the PAT Cycle I. So, the remaining left out industries under the PAT Cycle I and PAT Cycle II are also be covered in the scope of the future research.

1.7 Thesis outline

The objective of this study is to find the impact of climate policy on cost and competitiveness of EI industry in India. The first chapter Introduction puts the issue in perspective. The second chapter has been named Industrial Processes and Climate Policy, which attempts to describe how the CO₂ is produced during the processes studied in this investigation and how climate policy will mitigate their effect on climate without impacting the economy. In the third chapter, the literature relevant to business and climate policy and the profitability and competitiveness of EI industry are reviewed. Based on the research gaps found in literature review, the fourth chapter lays down the objectives of the study and describes the research methodology used for this investigation. The fifth chapter presents the results and analyses them in context to make their meaning clear. The sixth chapter is named Discussion, which examines the meaning and impact of the results in detail with the help of interviews with economists and experts in the field. This chapter makes a qualitative assessment of how the companies are responding to the challenge. The seventh chapter is Conclusion, which gives the conclusion of the study, future prospects, and recommendations for policy makers as well as the industry.