Innovation for green industrialisation: An empirical assessment of innovation in Ethiopia’s cement, leather and textile sectors

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An empirical assessment of innovation in Ethiopia’s cement, leather and textile sectors

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Abstract

The Federal Government of Ethiopia has committed to an ambitious economic transformation and industrialisation strategy, but also to a low-carbon development trajectory as set out in the Climate Resilient Green Economy Strategy (CRGE). The international development literature highlights innovation as a critical driver and enabler of industrialisation, while the literature on green growth and sustainable development also places a large emphasis on the role of ‘green’ innovations as a key mechanism for achieving improvements in resource productivity and reductions in wastes and emissions, including greenhouse gases. Using a mixed method involving semi-structured interviews and survey questionnaires, this paper assesses the strengths and weaknesses of the emerging sectoral systems of innovation in three key manufacturing sectors in Ethiopia – the cement, leather and textile sectors – with a view to establishing the extent to which they are geared toward supporting green innovation and hence green industrialisation. Results reveal that the extent of product and process innovation is generally rather low, and green innovation is even less common. The rates of both product and process innovation were less than 20 per cent amongst cement and textile enterprises. In the leather sector, 65 per cent of firms reported product innovation, but only 28 per cent engaged in process innovation. The extent of green innovation, defined as innovations that aimed to reduce energy, water and material inputs or solid, liquid and gaseous wastes, was substantially lower: only 12 per cent of firms reported green product innovations, and 15 per cent engaged in green process innovation. Increasing market share and reducing unit costs were cited as important drivers of innovation, while meeting environmental regulations were not. Knowledge transfer links between research institutions and firms are weak, although industry development institutes are playing a key role in promoting innovation. The key policy recommendations are to enhance the inter-ministerial coordination of innovation policies and support activities, to build capacity to monitor and enforce environmental regulations, to provide financial incentives for firms to introduce green innovations, and to incentivise universities to commercialise research findings.

Keywords: green innovation, sectoral systems of innovation, Ethiopia, green industrialisation

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1 Introduction

Ethiopia is a low-income country that has aspirations of becoming middle-income country within the coming decade, thereby lifting tens of millions of its people out of poverty. To give effect to this goal, the Ethiopian government adopted a five-year Growth and Transformation Plan (GTP) in 2010 (Federal Democratic Republic of Ethiopia [FDRE] 2010). At the same time, however, the Ethiopian government recognises the risks posed by climate change and has committed the country to a low-carbon development trajectory within a Climate Resilient Green Economy Strategy (CRGE) (FDRE 2011). The second phase of the Growth and Transformation Plan (GTP-II) largely stresses the facilitation of structural transformation through developing a dynamic domestic industrial sector. In contrast to its predecessor, the GTP-II explicitly incorporates targets for the implementation of the CRGE strategy in industry and other sectors through leapfrogging to modern and energy-efficient technologies.

A large body of academic literature spanning nearly a century since the seminal work of Joseph Schumpeter (1934) has established a strong theoretical foundation that identifies innovation – defined as the introduction and diffusion of new knowledge, techniques and products into an economy – as central to the socio-economic development of countries (Dosi et al. 1988; Verspagen 2005). This notion that innovation and technical progress is key to both economic growth and industrialisation is well supported empirically (Freeman 1987; Hulten and Isaksson 2007; Organisation for Economic Cooperation and Development (OECD) 2012, World Bank 2010). Furthermore, innovation features prominently within the more recent and rapidly expanding literatures on societal transitions to sustainability (Jacobsson and Bergek 2011) and the green economy (OECD 2011; UNEP 2011a; UNEP 2011b; UN 2011; World Bank 2012).

Given the importance of innovation in the literature and the green industrialisation agenda of the Ethiopian government, this study examines innovation systems and activities in three prominent industrial sectors in Ethiopia, namely cement, leather and textiles. These sectors were selected because they have been identified as significant growth industries for Ethiopia in the GTPs, and because of their relatively large contribution to greenhouse gas emissions and/or other pollutants. For example, the cement industry is responsible for roughly half of the industry sector’s CO₂ emissions (UNDP Ethiopia 2011), while the textiles and leather sectors are responsible for significant levels of water pollution in addition to greenhouse gas emissions. The overall aim of the paper is to assess the robustness and performance – based on a survey designed to gauge the extent of innovation activities and the strength of innovation system linkages – of the sectoral systems of innovation in the cement, leather and textile industries, and how well they support the Ethiopian government’s green industrialisation agenda. The main novelty of the paper lies in its analysis of innovation within the context of green industrialisation in a low-income country context. To date, the vast majority of studies on green innovation focus on advanced economies or middle-income countries.

The paper is organised as follows. Section 2 provides the conceptual background concerning innovation and innovations systems, and briefly reviews the available literature on innovation in Ethiopia’s industrial sector. Section 3 describes the empirical methodology and data collection process. Section 4 analyses the structure of the selected sectoral innovation systems.
by mapping their major elements and the strength of network linkages. Section 5 analyses quantitative data on innovation activities drawn from a survey of enterprises in the cement, leather and textile industries. It analyses the extent of innovation in general, and green innovation in particular, and also identifies the key drivers and inhibitors of innovation. The final section presents the main conclusions and suggests policies that could be introduced to foster green innovations by improving knowledge transfers and overcoming obstacles to innovation.

2 Conceptual Background and Literature Review

This section begins by elucidating the concepts and technical definitions that underpin the subsequent empirical analysis in sections 4 and 5. The terms innovation, green innovation, and innovation system are defined more precisely, and the key drivers and inhibitors of innovation are identified. Thereafter, the existing literature on innovation in the manufacturing sector in Ethiopia is reviewed.

2.1 Definition of key concepts

2.1.1 Innovation

Broadly speaking, innovation pertains to the introduction of new knowledge, technologies and practices, or new combinations of existing knowledge, and their diffusion (i.e. dissemination and use) within an economy (Edquist and Johnson 1997:42; World Bank 2010:4). A more technical definition that is widely used internationally is provided by the Organisation for Economic Cooperation and Development’s Oslo Manual: “An innovation is the implementation of a new or significantly improved product (good or service), a new marketing method, or a new organisational method in business practices, workplace organisation or external relations” (OECD/Eurostat 2005:46). Four distinct types of innovation can be specified. A product innovation is the introduction of a good or service that is new or significantly improved with respect to its characteristics or intended uses, such as technical specifications, components and materials, software, user friendliness or other functional characteristics. A process innovation is the implementation of a new or significantly improved production or delivery method, which could include significant changes in techniques, equipment and/or software. An organisational innovation is the implementation of a new organisational method in the enterprise’s business practices, workplace organisation or relations with suppliers and customers. A marketing innovation is the implementation of a new marketing method which involves significant changes in product design or packaging, product placement, product promotion or pricing.

Changes that do not qualify as innovations include capital replacement or extension (where the machinery is of the same type as before), changes resulting from changes in factor prices, routine upgrades, customization of products, regular seasonal and other cyclical changes (e.g. a new fashion in the clothing industry), new pricing methods involving discrimination among customer groups, and trading of new or significantly improved products (e.g. in wholesale and retail distribution, transport and storage (TIPP 2013). This study focuses on product and process innovations.
To be defined as such, an innovation must have been implemented. In a developing country context, innovation is often something that is not new to the world, but is new to the society in question and can deliver significant economic, social, or environmental change (World Bank 2010). Innovation does not have to involve advanced technologies; in fact, development of low-technology industries and the exploitation of indigenous knowledge can yield substantial gains in economic growth and welfare (von Tunzelmann and Acha 2005; World Bank 2010). Both private and public actors have important roles to play in driving innovation. For example, while it is commonly believed that innovation is generally driven by entrepreneurs and implemented by business enterprises, Mazzucato (2013) argues forcefully that private sector companies often invest after innovations have already progressed significantly within government-sponsored programmes of exploratory basic research.

2.1.2 Green innovation
Innovations that result in improved environmental performance have variously been referred to as environmental innovations, green innovations, ecological innovations (or eco-innovations), and sustainable innovations (Schiederig et al. 2012). Building on the Oslo Manual definition of innovation quoted above, the OECD (2009) defines eco-innovation as “the creation or implementation of new, or significantly improved, products (goods and services), processes, marketing methods, organizational structures and institutional arrangements which – with or without intent – lead to environmental improvements compared to relevant alternatives” (italics added). Environmental improvements include reductions in resource inputs (such as energy, water and materials) and reductions in solid, liquid and gaseous waste products, including carbon emissions. Based on a review of alternative definitions, Schiederig et al. (2012) determine that the concepts of green, ecological and environmental innovation are generally used synonymously in the literature, while the notion of ‘sustainable innovations’ also encompasses a social aspect (i.e. greater equality or social inclusiveness). In the remainder of this report, the terms green/environmental/ecological innovation are used interchangeably.

2.1.3 Innovation systems
The analysis of ‘innovation systems’ or ‘national systems of innovation’ dates back to seminal works by authors such as Freeman (1987) and Lundvall (1992). Freeman (1987: 1) defined an innovation system (IS) as “the network of institutions in the public and private sector whose activities and interactions initiate, import, modify and diffuse new technologies”. Pioneering studies analysed the structure of innovation systems, which are comprised of networks of actors from the public sector (government agencies, regulators and policies), Higher Education Institutes (HEIs), Public Research Institutions (PRIs), industry (firms), financial organisations, network and support organizations, and consumers (Edquist 2005). The flows of knowledge, information and technology among the various elements of an innovation system are key to the innovative process. Thus the interactions among these actors, including firms and other organisations, and the ways they share information, are critical for the transmission and diffusion of innovations in an economy (Edquist 2005).

Innovation systems can be defined and analysed at four different levels: a national system of innovation (NSI), regional systems of innovation (RSI), sectoral systems of innovation (SSI) and technological systems of innovation (TSI). While an NSI is located within the boundaries of a nation state (Lundvall 1992), an RSI restricts the geographical scope of the innovation system to a specific region within a country (Cooke, Uranga and Etxebarria 1997). A sectoral
system of innovation and production has been defined as “a set of new and established products for specific uses and the set of agents carrying out market and non-market interactions for the creation, production and sale of those products” (Malerba 2002:250). Thus sectoral-level studies are restricted to innovation occurring within a particular sector (or subset) of the economy. Unlike national and regional innovation systems, the sectoral innovation system may have local, national, and/or global dimensions, which often coexist in a sector (Malerba and Orsenigo, 1997). Technological Innovation Systems (TIS), on the other hand, focuses on the development, diffusion and use of a particular technology (in terms of knowledge, product or both) (Bergek, et al., 2008a). A TIS may be a sub-system of a sectoral system (when the focus is one of the sector’s products or a knowledge field that is exclusive to the sector) or may cut across several sectors (when the focus is a more “generic” knowledge field that several sectors make use of. TISs may have a geographical dimension, but are often international in nature (Bergek, et al., 2008b). Given the focus in the present study on three industrial sectors (cement, leather and textiles), an SSI approach is appropriate.

2.1.4 Drivers and inhibitors of innovation

The Oslo Manual (OECD/Eurostat 2005) provides details of factors that motivate and inhibit innovation among firms, which were used to formulate questions in the firm survey that is reported on in section 5. The major motivations for innovation at the enterprise level are to improve firm performance and boost competitiveness, either through addressing demand/competition factors (e.g. increasing the range of goods or services on offer, expanding market share, entering new markets), or by targeting production/cost aspects (e.g. increasing production capacity, boosting efficiency and reducing unit costs). Firms may also innovate in order to comply with environmental regulations, to reduce environmental impacts such as use of scarce resources and pollution, and to improve health and safety standards. A number of issues may inhibit (either prevent or retard) innovation amongst firms. These include cost factors (lack of funds, lack of access to finance and high costs of innovation), market factors (uncertain demand, barriers to entry and competition), knowledge factors (lack of skilled personnel, inadequate information about new technologies, and a dearth of market information) and institutional factors (weak property rights, high costs of doing business as a result of the regulatory environment, and a lack of reliable infrastructure).

2.2 Review of Ethiopian literature on innovation in industry

Several studies have been published that analyse innovation in Ethiopia’s industrial or manufacturing sector. Gebreeyesus (2011) examines the factors that encourage and inhibit innovation among small enterprises in Ethiopia’s manufacturing, trade and services sectors. His analysis, based on a survey of nearly 1000 microenterprises, shows that larger firms and those in the manufacturing sector are more likely to engage in innovative activities. Vocational training is also found to be a significant determinant of innovation activity. Furthermore, the results demonstrate that innovating firms tend to grow more rapidly than non-innovating enterprises. Gebreeyesus and Mohnen (2013) investigate innovation in a cluster of informal shoemaking firms in Ethiopia’s leather sector, and find that firms display varying behaviours and performance levels in spite of their geographical proximity and social homogeneity. Specifically, statistical analysis shows that local network position and absorptive capacity have a significant and positive effect on innovation performance. In a study of the Ethiopian garment industry, Legesse and Singh (2014) show that the introduction of lean manufacturing processes can bring significant savings in terms of resource inputs and
waste outputs, as well as boosting productivity. According to the definitions discussed earlier, such interventions can be regarded as green process innovations. Talegeta (2014) analyses data from a sample of small and medium enterprises (SMEs) in Addis Ababa, and finds that there is a low level of technological innovation. Among the main obstacles to technological innovation found by this author are: a dearth of government policy and regulation; insufficient technological and market information; inadequate research and development; high costs of innovation; lack of skilled personnel; insufficient finance; and a lack of cooperation.

Kuriakose et al. (2015) analyse results from the World Bank Enterprise Survey on Ethiopia, which found that 68% of large firms, 49% of medium enterprises and 42% of small enterprises reported product or process innovation. Innovation is found to be positively associated with firm performance. Innovation is more likely among manufacturing firms than service enterprises, and among large as opposed to small firms. However, compared to China, Kenya and a group of other low-income developing countries, Ethiopia’s innovation performance is relatively poor (Kuriakose et al. 2015). Based on survey data collected from leather and textile product manufacturing firms in Ethiopia, Beyene, Shi and Wu (2016a) find that innovation activities are hampered by cultural factors (such as power, collectivism, masculinity and avoidance of uncertainty), and this relationship is further affected by the type of firm ownership. In a related paper, Beyene et al. (2016b) show that product innovation performance is positively affected by innovation strategy, but this impact is tempered by firm size and ownership type.

In 2015 the Science and Technology Information Centre (STIC) based in Addis Ababa conducted a national innovation survey of 1200 small, medium and large-scale firms in four economic sectors, namely mining and quarrying, construction, manufacturing and services (STIC 2015). Overall, 60% of firms reported that they had undertaken innovations in the three-year period 2012-2014. The highest sectoral rate of innovation (including all four types of innovation) took place within the manufacturing sector (68%). Within this sector, marketing innovation was the most commonly implemented type of innovation (81.3%), while product innovation, undertaken by 42.8% of firms, was the least common. Some 60.3% of manufacturing enterprises undertook organizational innovation, and 53.8% of enterprises reportedly engaged in process innovation. The major driver of innovation was the desire to enhance product quality, and the most common mechanism used by firms was the acquisition of machinery and software, as opposed to performing R&D. The most frequently cited hindrances to innovation were lack of funds and high costs of innovation.

3 Methodology and Data

A mixed-method approach was adopted to analyse the three sectoral systems of innovation in the cement, leather and textile industries. The first research method entailed a survey of innovation activities amongst a sample of enterprises in the cement, leather and textile sectors. The survey questions were based mainly on OECD/Eurostat’s (2005) Oslo Manual: Guidelines for Collecting and Interpreting Innovation Data, although some sections were omitted (such as questions relating to organisational and marketing innovation) and extra questions were added about green innovation. The purpose of the survey was to gather data on the extent of product and process innovation (and green innovation), the factors that motivate and discourage innovation, and the sources of information and partnerships that firms rely on
to assist their innovation activities. The survey was carried out in March and April of 2016, and involved enumerators conducting site visits to enterprises and gathering answers to the survey questions from one or more representatives of each company. The same questions pertaining to innovation were used for each of the three sectors.

The enterprise sampling selection was stratified in the first instance according to sector (cement, leather and textiles) and geography. Within this scope, 141 firms were identified as candidates for the survey. In the cement sector, a census of firms was conducted. Within the leather sector, a census of tanneries was conducted, and a random sample was selected of downstream leather producers, including shoe manufacturers and firms making other finished leather products. In the textiles sector, all integrated textile facilities were included in the survey, as well as a sample of garment manufacturers. Of the 141 firms surveyed, 11 refused to participate in the survey and a further 13 provided incomplete responses, resulting in a response rate of 82%. The final sample of 117 firms comprised 15 firms in the cement sector, 40 in the leather sector and 62 in the textile sector.

The second research method consisted in a set of semi-structured interviews with key non-firm role-players in the sectoral innovation systems, including a prime ministerial advisor, senior technical officials in the ministries of environment and industry, officials in government agencies such as the Ethiopian Investment Commission, representatives of industry development institutes and industry associations in the cement, leather and textile sectors, and leaders of think tanks. Nine interviews were conducted in June and July 2016, each lasting between 60 and 90 minutes. As all interviews were conducted in English, there was no need for interpretation. The identities and job titles of the interviewees are withheld for confidentiality reasons. The purpose of the interviews was to identify the relevant innovation actors, establish the existing linkages and communication channels among these actors, gather qualitative information about innovation processes, and identify the strengths, weaknesses, challenges and opportunities within the sectoral systems of innovation. The information gathered was used to map the actors and networks in the respective SSIs, especially the non-firm actors. This enabled an exploration of (especially qualitative) issues that were not within the scope of the firm survey.

4 Sectoral Systems of Innovation and the Greening Agenda

This section analyses the sectoral systems of innovation in the cement, leather and textile industries from the perspective of the green industrialisation agenda, drawing on policy documents and interviews with prominent actors in the SSIs. It begins with the government ministries and agencies that are common elements of all three SSIs, before focusing on sector-specific actors and innovation processes. Figure 1 illustrates the structure of the sectoral systems of innovation, drawing on Malerba’s (2005) concept of “building blocks” of an SSI, namely knowledge and technologies, actors and networks, and institutions.
Several national ministries and agencies are important actors in the sectoral innovation systems, including the Ministry of Environment, Forestry and Climate Change (MEFCC), the Ministry of Industry (MoI), the Ministry of Science and Technology (MoST), the Ministry of Finance and Economic Cooperation (MoFEC) and the Ethiopian Investment Agency (EIA).

The MEFCC plays a critical role in the implementation of environmental policy in general and the CRGE in particular. As part of its role in implementing CRGE, the MEFCC has introduced several national proclamations and regulations to control pollution emanating from various industrial sources, including an Environmental Impact Assessment (EIA)
proclamation, a solid waste control proclamation, a pollution control proclamation, and industrial pollution control regulations. Furthermore, the MEFCC provides technical support both to strengthen regional agencies that enforce environmental regulations and to assist other stakeholders (particularly enterprises) to comply with environmental standards and regulations. The MEFCC is therefore an important actor in both the national and sectoral systems of innovation, especially with regard to providing information and stimulus (by way of regulatory enforcement) for green innovation.

The Ministry of Industry is responsible for ensuring the implementation of the CRGE and environmental policies within the industrial sectors of the economy. Although the MoI is active in the national and sectoral systems of innovation in general, its involvement in supporting green innovation specifically appears to be somewhat limited. The MoI has limited instruments at its disposal to foster innovation. For example, it does not administer grants or provide tax breaks or loan guarantees. Furthermore, there are no specific industrial sector policies and laws aimed at encouraging eco-innovations, as this is seen as falling under the wider remit of the MEFCC. The main route that the MoI uses to promote innovation is to gather information on best practices and forward recommendations to the CRGE Facility, a fund that supports CRGE implementation projects. The CRGE Facility then dispenses funding to firms to help them to meet the targets of the CRGE strategy (especially with regard to clean energy and energy efficiency). So far, according to the interviewed official, the MoI has submitted eight projects to the Facility, only three of which have been approved. According to the official in the MoI, “the MoI is still working to develop a sectoral policy for implementation of the CRGE strategy. For the MoI, the priority is building and expanding industry, not the environment.” This could explain its limited role in fostering green innovation.

The MoI does play a role in the innovation ecosystem, although it is somewhat limited. The interviewed official in the MoI described the connections among the main innovation system actors as follows:

There are quarterly forums of the ministerial committee comprising the six line ministries involved in implementing the CRGE and a technical steering committee, which are co-chaired by the Ministries of Finance and Environment… The MoI has regular communication with MEFCC and MoFED, but also irregular meetings with other ministries, such as Education. There are university-industry linkages, some with memorandums of agreement. There are some communications between the MoI and the MoST, but they are not very regular… The MoI gives support and direction to Industry Development Institutes, but responsibility for implementation and for liaising with universities is decentralised to the industry institutes. The institutes do not have much interaction with the MoST.

Nevertheless, all of the industry development institutes are part of the national STI programme, which includes guidelines on how the institutes must collaborate with universities and firms. The institutes have facilitated some memorandums of agreement between universities and firms.

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2 Source: Interview with an official in the MEFCC. See also the FDRE’s (1997) *Environmental Policy of Ethiopia*.

3 Source: Interview with an official in the MoI who is responsible for environment and climate change issues.
The environmental impact and performance of new entrants into the manufacturing industry in Ethiopia comes under considerable scrutiny, in contrast to established firms. Investors wanting to build new manufacturing facilities have to apply for an investment licence at the Ethiopian Investment Commission (EIC). If the licence is granted, the firm approaches the regional authorities in the region in which it intends to set up operations. It then has to undertake an EIA, and submit this to the regional authority. The regional authority forwards its recommendation to the EIC, which then decides whether to grant a business licence after checking compliance with environmental and social regulations.

According to officials in the EIC, many new industrial investments, especially by foreign companies, are being channelled into industrial parks, where centralised facilities are provided to clusters of similar firms to optimise environmental performance (e.g. through the provision of clean energy and wastewater treatment plants). This recognises the fact that the major environmental challenge facing firms in these sectors relates to water pollution, while effluent treatment plants are prohibitively expensive for most firms to set up on their own. Thus, it appears as if the government’s primary strategy for achieving greening in the textiles and leather sectors is to direct its attention and resources towards the establishment of the industrial parks, rather than supporting (green) innovation per se. Firms located in the industrial parks are forced to comply with environmental regulations, including EIAs, whereas established firms are not always subject to the same level of environmental scrutiny and thus have less incentive to adopt greener processes and products.

Innovation, however, is arguably more important in established firms that typically use older processes and equipment, rather than new entrants that build factories from scratch, often using more state-of-the-art equipment. Existing manufacturing facilities tend to be spread out geographically, which makes it more difficult and costly for them to deal with wastes and effluents. In some cases, existing firms (e.g. tanneries) have been encouraged to relocate to industrial parks. However, the EIC official stated that many domestic firms face a cost barrier to enter these industrial parks, as they cannot afford the rentals. Hence, many such firms cannot take advantage of the opportunities for process innovations that industrial parks and their facilities make possible. Furthermore, there does not seem to be any mandatory EIA process for incumbent firms. Enforcement of compliance with existing environmental regulations has been weak partly due to a lack of capacity and motivation of the regulatory bodies. According to the EIC official, there is a proposal for EIAs to be required for the expansion of existing manufacturing facilities, but this has not yet been approved. Therefore, from the environmental regulatory perspective, the incentives for green innovation amongst existing firms are somewhat limited.

A key challenge of the sectoral innovation systems is the lack of strong links between the relevant manufacturing sector development institutes and research institutions in order to foster innovation and the diffusion of new technologies (STIC 2015). The Science, Technology and Innovation (STI) policy document recognized this challenge and proposed strategies to create effective linkages amongst relevant actors (FDRE 2012). The proposed strategies include establishing a system to integrate and synergize technology transfer issues between universities, research institutes and industry, creating a conducive environment for

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4 Source: Interview with officials in the Ethiopian Investment Commission.
university academics and students to engage in technology transfer activities in industries, creating strong links among universities, research institutes and industry addressing technology adaptation, and enabling universities to take on an advisory role for industry with regards to technology transfer. As the following subsections show, some progress has been made in strengthening institutional linkages and cooperation, but more remains to be done.

4.1.1 Cement sector innovation system

As mentioned above, enforcement of environmental requirements is ultimately the responsibility of the MEFCC, but the MoI is responsible for implementing the CRGE within industrial sectors, including cement manufacturing. The MoI oversees the activities of the Chemical and Construction Inputs Industry Development Institute (CCIIDI), which is responsible for assisting the cement industry to meet the CO₂ emission reduction targets contained in the CRGE. According to a leading official in the CCIIDI,

Every new entrant into industry must meet various environmental criteria, but especially CO₂ emissions in the case of cement. An Environmental and Social Impact Analysis (E&SIA) must be undertaken before a firm can obtain a manufacturing licence. Enforcement of environmental requirements is ultimately the responsibility of the MEFCC, but in the case of the cement industry this is delegated to the MoI since it is an industrial sector. The MoI, in turn, delegates to the CCIIDI.

The CCIIDI plays a coordinating role within the network of innovation actors in the cement SSI, in accordance with the national STI Policy. This role is described as follows by an interviewee:

There is a tripartite relationship between the CCIIDI, academia and industry. Research is demand-led, according to the industry’s problems and needs. Regular meetings or workshops involving all partners are held every three months. These are organised on a geographical basis, linking universities and firms within specific areas. CCIIDI also generates research agendas, along with the firms in its constituency. CCIIDI has an advisory board involving professionals who advise on the research agenda, although this is still in a start-up phase. The CRGE strategy takes account of local people’s needs, and how they can benefit from the programmes that are adopted to meet the targets (e.g. the biomass programme). This requires diversified knowledge from experts in a wide range of fields, including economists, sociologists and natural scientists (e.g. on the plant issues and chemical processes). The CCIIDI, along with other Development Institutes, therefore engages with academics from diverse fields.

The cement industry is acknowledged as having a significant impact on CO₂ emissions as the result of the calcination of raw materials and the energy used to make cement. The key mitigation effort within the cement industry involves reducing emissions from energy use, because the industry cannot at this point take action to reduce calcium carbonate inputs, which is more technically demanding and costly. Since Ethiopia does not produce any coal-fired electricity, it lacks fly ash for use in alumino-silicate cement, the main alternative to Portland (calcium-silicate) cement. There are two key process innovations for reducing energy-related emissions: improving efficiency and fuel switching. According to the CCIIDI official:

Each firm must analyse its energy efficiency potential. For example, some firms are using hot gas emissions to capture heat for use in the industrial processes. A two-stage programme of fuel switching
has been undertaken by the cement industry, with assistance from the CCIIDI. Planning began in 2010 to switch from the use of heavy fuel oil to coal, imported from South Africa. Implementation took place largely in 2014/5. Energy inputs accounted for about 60 per cent of costs before the switch, but this was reduced to about 40-45 per cent with coal. This cost saving has allowed firms to exploit efficiency gains by investing in new equipment. Use of heavy fuel oil was highly inefficient, so it was bad for emissions. All cement firms are now using coal.

The second stage of fuel switching will involve the partial substitution of biomass energy for coal. An invasive plant, *Prosopis juliflora*, is a significant problem for farmers in Afar state, having invaded 1.2 million hectares by 2013 and subsequently spreading to other areas. Research conducted with the Global Climate Fund (GCF) has shown that *Prosopis* has a relatively high calorific value for biomass, so it is useful as a source of biomass energy for cement production. Technology is available for harvesting the plant, and a German company has developed technology to convert the plant to energy. According to the CCIIDI official:

> The plan is to migrate all cement firms to biomass (40 per cent of their energy, with the balance being coal) over the next few years, starting in 2016/17. Mosobo is taking the lead, showing the way for other firms. By 2020, CCIIDI expects most cement firms to have adopted this measure. It is estimated that this project can meet the whole CO₂ reduction commitment for the cement industry stipulated within the CRGE.

### 4.1.2 Leather sector innovation system

The main actors in the leather sector innovation system are firms operating along the leather product supply chain (including livestock producers, slaughterhouses, suppliers of hides and skins, leather processing enterprises and leather product manufacturers), along with the Leather Industry Development Institute (LIDI) and the Ethiopian Leather Industries Association (ELIA).

The LIDI has primary responsibility for assisting firms in the leather industry supply chain to meet the goals and targets of the CRGE and other environmental regulations. To achieve its mandate, the LIDI collaborates with relevant government ministries, domestic and foreign universities and research institutes, and local firms in the leather sector. According to a senior LIDI official,

> LIDI is playing crucial role in CRGE implementation in leather industry sector. Among others, we provide support to industries to use less emission technologies and monitor their activities. We have a checklist of indicators to monitor the CRGE implementation. Our institute has environmental laboratory for testing. We do have model treatment plant facility. Moreover, the institute has established the CRGE unit and other relevant department such as environmental technology which work for issues related with CRGE implementation.

The LIDI holds regular meetings with the MEFCC and MoI. The LIDI is collaborating with universities to build capacity in the leather sector, for example by establishing degree programmes in leather processing technology at Addis Ababa University, a course in Footwear Engineering at Addis Ababa Science and Technology University, and a teaching and research programme in leather and garment technologies at Bahir Dar University. The LIDI also has links with universities and research organizations in India and the UK.
The ELIA represents tanneries as well as enterprises manufacturing leather products such as footwear and gloves. An ELIA official stated his organisation’s functions as follows:

Basically, as an association we provide services like market information, promotion of products to international market, and we work on the policy advocacy on the challenges of common interests… Our market information includes international promotion. There is specialized marketing information office in Geneva, which provides as marketing information… The other promotion activities we use is trade missions. Moreover, we are also organizing All Africa Leather Fair, in Addis Ababa which we have reached eighth round this year.

The ELIA official recognized that one of its significant challenges is to help improve the environmental performance of constituent firms, especially tanneries. The Association states that as yet green certification for leather products has not yet been secured, and that this will require concerted efforts from other stakeholders including government ministries and export promotion agencies. While foreign direct investment (FDI) has been attracted from seven countries into the leather sector, technology transfers are somewhat limited because such ventures remain fully-owned by foreign interests.

According to the interviewees, the impetus to undertake green innovations in the leather sector emanates from both external and internal sources. As the LIDI official put it, “There is also pushing factor (pressure) from the buyers themselves. Buyers require compliance to environmental standards and social issues including child labor and safety.” Domestically, tanneries were initially given a five-year grace period in which to comply with new environmental regulations that came into effect in 2009, but this period expired in 2014. Since then, leather makers have come under increasing pressure from environmental regulators, with several tanneries having been forced to close, although some were able to reopen after making improvements. The LIDI official described some of the key initiatives that are supported by the government and private firms:

Currently, we are taking high initiative to establish leather city with common effluent treatment plant in Modjo town. The feasibility study has been completed and given to Central Leather Research Institute for verification and adjustment of the standards into the Ethiopian context. Concerning the financing, promising negotiations with European Investment Bank are ongoing. Given substantial importance of clustering and building effluent treatment facility for leather industries particularly tanneries to greening the sector, the government is encouraging and support private sector to build their own industrial parks. In response to this, some private industrial groups are being involved in building their own facilities. These are the George Shoe Industry Zone in Modjo (which employ 250,000 workers) and the Huajan Industry Zone.

The ELIA regards the scale of investment and management required to create an effluent treatment plant to cater to so many firms as a significant challenge, but one in which it will be a major stakeholder. The leather city is envisaged as a joint undertaking between the private sector and government, although precise roles and contributions have yet to be determined. At this stage, according to the ELIA, tanneries will have to relocate to Modjo at their own cost, but they have the alternative of building their own waste treatment plants. However, the LIDI reports that promising negotiations on funding are underway with the European Investment Bank.
Green innovation in the leather industry faces a number of challenges. One factor is the mindset of private sector businesses, while incentives and enforcement of regulations are also lacking. As related by the LIDI official:

As you may know, enforcing environmental regulations is of high challenge. One of the challenges comes from the private business sector. Private investors / industry owners become less responsible to environmental protection. They sometimes fail to comply to the environmental standards and focus only on making profit. Most of the private businesses consider greening (cleaner production) activity as an expense and ignore future benefits pertaining to green industrialization. All the time, industries become reluctant and need push from the regulatory (coordinating) body… Adoption of environmental standards and technologies needs capacity and experience. Hence, taking standards from somewhere and experimenting it in different context is also challenging. Another challenge is the lack of strong market incentives for the environment particularly for the establishment of effluent treatment facilities. There are no separate incentives for those who developed their own effluent treatment plants.

Established enterprises can be especially reluctant to engage in innovation to comply with environmental regulations and require more capital to implement environmental innovations. According to the ELIA, enterprises face financial constraints as banks are reluctant to lend money for greening activities, forcing firms to use their own resources. However, some firms are benefitting from the Ethiopian Competitive Facility (ECF), a fund administered by the United Kingdom Department for International Development to support activities such as ISO standardization and improved environmental performance.

Newer firms, particularly those resulting from FDI, are taking the lead in terms of environmental compliance, with the support of the LIDI. The institute’s environmental technology department is providing training to firms on effluent treatment, handling and recovery (recycling). The LIDI plays a pivotal role in the implementation of innovations designed to achieve the CRGE emission reduction goals in the leather industry. For example, the LIDI supports firms to use less emission-intensive technologies and helps firms to monitor their activities. The institute has an accredited environmental laboratory for testing and a model treatment facility.

4.1.3 Textiles sector innovation system

In the textile sector innovation system, the main actors include the suppliers of inputs for cotton production, cotton plantation farms, various industries involved in the processing and production of textile products and garments, the Textile Industry Development Institute (TIDI), and the Ethiopian Textile and Garment Manufacturers Association (ETGAMA).

According to a senior official in ETGAMA, the organisation has 85 member firms and represents their interests in capacity building, creating market linkages, investment promotion and policy advocacy. The ETGAMA works closely with the Ethiopian Textile Industry Development Institute (TIDI), which was established under the Ministry of Industry to support the sector’s development. The official stated that:

We collaborate with TIDI in provision of the training to build technical capacity. Another area we collaborate is market linkages and development through organizing and taking our
member to abroad to participate in international trade fairs. We also work with TIDI in our role of policy advocacy to address policy gaps related to finance, customs, logistics and other.

Another area of collaboration is the formation of market linkages and development through organising trips abroad for members to participate in international trade fairs. Two recent international conferences on sustainability helped raise awareness and created opportunities for links to be made with other stakeholders so as to improve competitiveness of member firms in the international market. The association also holds quarterly meetings with the MEFCC to discuss issues of environmental compliance. Consumers, through the market mechanism and via global retailers who monitor compliance, are exerting pressure on factories to comply with environmental standards. The ETGAMA monitors the activities of its members and supports their compliance with international standards pertaining to environmental sustainability and social issues.

The ETGAMA official described some of the government initiatives towards greening of the textiles sector as follows:

> Government has set several incentives including tax holidays for more than ten years and building the industrial zones having sheds for ‘plug and play’ type of industrial establishments which is important for attracting investment. In addition to attracting investment, industrial zones help to ensure greener production and environmental sustainability. Previously all the factories were scattered all over the country and this make compliance to the environmental standards challenging. This is because effluent treatment plant requires high investment which is costly to establish own effluent treatment plant.

In pursuit of capacity building, the ETGAMA collaborates with various development partners like the Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) and the Embassy of the Kingdom of Netherlands. According to the interviewee, the ETGAMA initiated a three-year project, funded by the Dutch government, which has engaged a consultant (‘Solidar Dag’) to assess the sustainability gap in the sector, including social and environmental compliance in the case of more than 20 factories. After identifying the sustainability gap, the project will support the firms to address issues of cleaner production, environmental and social aspects, health and safety.

## 5 Empirical Analysis of Sectoral Innovation Activities

This section investigates the extent, nature and drivers of innovation activities within the cement, leather and textiles sectors based on a survey of firms in these manufacturing sectors.\(^5\)

### 5.1 Extent and types of innovation

The survey questionnaires asked firms about the extent of product and process innovations undertaken in the preceding three years, i.e. 2013 to 2015. Table 1 displays the headline results. Of the 15 cement firms, only one (7% of the sub-sample) reported that it had undertaken product innovation, and in that case it was a single innovation. Two other cement

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\(^5\) This survey, and the authors’ calculations based on the data, are the source for all tables and figures in this section, unless otherwise stated.
firms reported process innovations; a single instance for one firm, and two new or
significantly improved production processes in the second firm. Of the 40 leather sector firms,
65% engaged in product innovation. The reported number of product innovations varied from
as few as two to as many as 90, with an average of 18 per innovating firm. Process innovation
was conducted by 28% of leather enterprises, ranging between one and five innovations per
firm and averaging 2.4. Just 11% of the 62 textile sector firms reported product innovations,
with the number of individual innovations per firm varying between one and 28, and
averaging 10 per firm. Eighteen per cent of textile firms engaged in process innovation, with
the number of such innovations varying between one and five, except for one firm which
claimed to have introduced 28 process innovations. Aggregating all firms across the three
sectors, 29% reportedly engaged in product innovation, with an average of 15 innovations per
innovating firm. Of the 117 firms surveyed, 21% reportedly engaged in process innovation,
with an average of 4 innovations per innovating firm.

Table 1: Occurrence of product and process innovation by sector

<table>
<thead>
<tr>
<th>Innovation Activity</th>
<th>Cement</th>
<th>Leather</th>
<th>Textiles</th>
<th>All firms</th>
</tr>
</thead>
<tbody>
<tr>
<td>Percentage of firms engaging in product innovation</td>
<td>7%</td>
<td>65%</td>
<td>11%</td>
<td>29%</td>
</tr>
<tr>
<td>Average number of product innovations per innovating firm</td>
<td>1</td>
<td>18</td>
<td>10</td>
<td>15</td>
</tr>
<tr>
<td>Percentage of firms engaging in process innovation</td>
<td>13%</td>
<td>28%</td>
<td>18%</td>
<td>21%</td>
</tr>
<tr>
<td>Average number of process innovations per innovating firm</td>
<td>1.5</td>
<td>2.4</td>
<td>5.5</td>
<td>3.7</td>
</tr>
</tbody>
</table>

Given that the cement industry by and large produces a single homogeneous product (Portland
cement), it is not surprising to find a low rate of product innovation. By contrast, textile and
garment manufacturers deal with a much larger range of products (various types of fabrics
and numerous different garment types and styles), which also tend to change more frequently.
One would expect the leather industry to be somewhere in between these extremes. The
extensive product innovation reported in the leather sector is somewhat surprising. This could
be because of how leather and shoe producers interpreted the meaning of product innovation,
e.g. new shoe designs. One tannery reported 30 product innovations, while one shoe factory
claimed 90. Given the difficulty in precisely specifying what constitutes a product/process
innovation, and the further difficulty of communicating this to the enterprise representatives,
the data should be interpreted with caution.

Firms were also asked about the extent to which product and process innovations were
introduced in order to reduce various kinds of inputs (energy, water, chemicals and materials)
and waste products (solid, liquid and gaseous wastes). The results for ‘green product
innovations’ are reported in Table 2, which shows both the percentage of all firms in each
sector that reported at least one product innovation to reduce each type of input or waste
product, and the average number of green product innovations per innovating firm. The single
cement firm that reported one product innovation responded with “do not know” to the
question of how many innovations were adopted to reduce inputs or wastes; thus Table 2
reports no green product innovations in the cement sector. In the leather sector, just one
enterprise (3% of firms) reported product innovations intended to reduce chemical inputs and
solid wastes, while a quarter of firms said they introduced product innovations to reduce material inputs. Considerably more green innovations were reported in the textiles sector, but only between 3% and 6% of firms engaged in such innovations. In aggregate, less than 5% of firms introduced product innovations to reduce most categories of inputs and wastes, with the exception of material inputs (for which the proportion was 12%). Overall, 21% of all firms reported at least one green product innovation.

Table 2: Product innovations adopted in the last three years to reduce inputs or wastes

<table>
<thead>
<tr>
<th>Innovations to reduce:</th>
<th>Cement</th>
<th>Leather</th>
<th>Textiles</th>
<th>All firms</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Percentage of firms</td>
<td>Av. number of innovations per firm</td>
<td>Percentage of firms</td>
<td>Av. number of innovations per firm</td>
</tr>
<tr>
<td>Energy use</td>
<td>0%</td>
<td>0</td>
<td>0%</td>
<td>0</td>
</tr>
<tr>
<td>Water use</td>
<td>0%</td>
<td>0</td>
<td>0%</td>
<td>0</td>
</tr>
<tr>
<td>Chemical inputs</td>
<td>0%</td>
<td>0</td>
<td>3%</td>
<td>3.0</td>
</tr>
<tr>
<td>Solid wastes</td>
<td>0%</td>
<td>0</td>
<td>3%</td>
<td>4.0</td>
</tr>
<tr>
<td>Liquid wastes</td>
<td>0%</td>
<td>0</td>
<td>0%</td>
<td>0</td>
</tr>
<tr>
<td>Gaseous emissions</td>
<td>0%</td>
<td>0</td>
<td>25%</td>
<td>1.3</td>
</tr>
<tr>
<td>Material inputs</td>
<td>0%</td>
<td>0</td>
<td>0%</td>
<td>0</td>
</tr>
</tbody>
</table>

Table 3 shows the reported extent of ‘green process innovations’ per sector, i.e. the percentage of all firms that reported at least one process innovation to reduce each category of input or waste product, and the average number of green product innovations per innovating firm. In the cement sector, a single firm reported that it introduced green process innovations to reduce energy use, solid wastes and material inputs. In the leather sector, the percentage of firms engaging in green process innovation varied from 5% to 15%, depending on the type of input/waste. Amongst textile sector firms, green process innovations were much more numerous (averaging between 2.7 and 4.9) and somewhat more common (adopted by between 10% and 15% of firms). Overall, 15% of all firms reported at least one green process innovation.

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6 A caveat is necessary, as on close inspection some of the responses seemed unrealistic. For example, a textile firm that reported having introduced 5 process innovations in total, also said that 5 process innovations were adopted to reduce every one of the input and waste categories listed in the table. This would mean that every innovation served to reduce every type of input and waste, which seems very unlikely. The same occurred with two other textile firms, which reported 3 and 2 product innovations, respectively. Therefore, the data should be interpreted with caution.
Table 3: Process innovations adopted in the last three years to reduce inputs or wastes

<table>
<thead>
<tr>
<th>Innovations to reduce:</th>
<th>Cement</th>
<th>Leather</th>
<th>Textiles</th>
<th>All firms</th>
</tr>
</thead>
<tbody>
<tr>
<td>Energy use</td>
<td>7%</td>
<td>2</td>
<td>13%</td>
<td>13%</td>
</tr>
<tr>
<td>Water use</td>
<td>0%</td>
<td>0</td>
<td>5%</td>
<td>0</td>
</tr>
<tr>
<td>Chemical inputs</td>
<td>0%</td>
<td>0</td>
<td>13%</td>
<td>2</td>
</tr>
<tr>
<td>Solid wastes</td>
<td>7%</td>
<td>1</td>
<td>10%</td>
<td>1</td>
</tr>
<tr>
<td>Liquid wastes</td>
<td>0%</td>
<td>0</td>
<td>8%</td>
<td>1</td>
</tr>
<tr>
<td>Gaseous emissions</td>
<td>0%</td>
<td>0</td>
<td>5%</td>
<td>0</td>
</tr>
<tr>
<td>Material inputs</td>
<td>7%</td>
<td>1</td>
<td>15%</td>
<td>1.5</td>
</tr>
</tbody>
</table>

Figure 2 displays the percentage of firms that reported investing in various types of activity to support product and process innovation. In the cement sector, acquisition of machinery, equipment, software and buildings was the most common activity (73% of firms), followed by training of personnel (40%). In the leather sector, the most-cited investment activities were in training (83%) and design activities (73%). Among textile firms, the percentage engaging in investments for innovation was generally much lower, reaching just 31% of enterprises in the case of training. The proportion of firms reporting investment in all categories except acquisition of machinery etc. was highest among leather sector enterprises, which is consistent with the much higher reported rate of innovation in this sector.

Figure 2: Percentage of firms investing in activities to support innovation

![Figure 2: Percentage of firms investing in activities to support innovation](image-url)
5.2 Drivers and inhibitors of innovation

In order to assess the relative importance of potential drivers and inhibitors of innovation, firms were asked to score a number of different factors on a scale of 0 (not significant) to 4 (a very strong factor). Figure 3 reports average scores across firms in each sector and in aggregate for 11 drivers of innovation. The most striking feature of the results is that there is comparatively little variation in the averages across sectors for most of the individual drivers. One exception is “reducing costs per unit produced”, which is considerably higher for cement firms (3.9) than leather (2.8) and textile (3.1) firms. As could be expected, “expanding the range of goods or services” is not of great importance to cement manufacturers, as they produce a homogeneous product. By contrast, this factor is of considerable importance for leather producers (3.3). For both leather and textile enterprises, the most important drivers of innovation are “increasing market share” and “improving the value of goods and services”. Of course, the averages conceal variation in the scores across individual firms within each sector.

Given the central concern of this paper with green innovation, it is noteworthy that textile firms cited “reducing environmental impacts” and “meeting environmental regulatory requirements” as the two weakest drivers of innovation. For leather firms, these two factors were the second and third weakest. For cement firms, the two environment factors were the fourth and fifth weakest out of 11 drivers. For all firms taken together, only “replacing outdated products or processes” (2.5) received a lower score than the two environmental drivers. This is a clear indication that improved environmental policies, regulations and enforcement are needed to stimulate green innovations.

Figure 3: Relative strength of factors encouraging innovation
Figure 4 displays average scores across firms in each sector and in aggregate for 11 factors that inhibit innovation. A “high cost of new technologies” emerged as the strongest inhibitor for leather and textile firms and the second strongest for cement firms. “High cost of access to new markets” was also a major obstacle for cement and leather firms. The relatively high average score for “price competition” amongst cement firms could be due in part to product homogeneity in the cement sector. “Innovations by competitors” scored lowest for both cement (1.5) and textile (1.7) firms, while for leather firms, the least concerning inhibitors were “lack of demand” and “dominant market share held by competitors”. The cost of meeting government regulatory requirements does not appear to be an important obstacle to innovation, especially in the cement and textiles sectors. This might indicate a lack of regulations or enforcement thereof. Lack of adequate finance was ranked as the second strongest inhibitor for textile firms and of medium importance for leather firms. The major policy implication appears to be that firms need financial support to meet the high costs of new technologies and to access new markets.

**Figure 4: Relative strength of factors inhibiting innovation**
5.3 Sources of information and partnerships for innovation

The firms were asked several questions relating to the sources of information and types of partners they cooperated with in the innovation process, with a view to establishing how strong the innovation networks are and where the gaps lie. Figure 5 shows the relative importance of 10 sources of information for innovation that firms rated. Information from within the enterprise or group was considered most important for firms in the leather (3.0) and textiles (2.3) sectors, and second most important for cement firms (2.4). The top category for cement producers was suppliers of equipment, materials, services or software (2.5). For leather sector firms, an important source of information was conferences, trade fairs and exhibitions (2.9), whereas this was one of the least productive sources for cement firms. Government, public or private research institutes constituted a mediocre source of information for innovation, which clearly indicates scope for more effective implementation of innovation policies. Even more concerning are the very low scores given by firms in all sectors to higher education institutions, which has the second lowest average (1.3) across all firms. This confirms the findings of the Ethiopia National Innovation Survey (STIC 2015), and implies that much more needs to be done to strengthen linkages between HEIs and firms to foster knowledge and technology transfers.

Figure 5: Sources of information for innovation
To further assess the strength of innovation system linkages, firms were asked how many meetings they had with key innovation actors in the past year (Figure 6). The generally low number of meetings held with all of the innovation partners is striking. For firms in all three sectors, the most meetings occurred with the respective industry development institute. Meetings with financial service providers were much more common among textile firms than among cement or leather firms. At least some meetings took place with the Ministry of Industry, although there is clearly scope for more interaction. The very low number of meetings with universities and TVET institutions again highlights the need for more regular contact between HEIs and firms in order to facilitate knowledge transfers.

**Figure 6: Average number of meetings held with innovation partners in the past year**

One of the cement firms reported that it had 365 meetings with banks or other financial service providers in the past year; among the textiles firms, three firms reported 300 or more such meetings. Given that these four responses were extreme outliers and were deemed unrealistic, they were excluded.
Finally, firms were asked which their most important cooperation partners for innovation were. Figure 7 shows that for the leather and textile sectors, clients or customers from the private or public sector were cited by the largest number of firms. Among cement firms, suppliers of equipment, materials, components or software were the most common innovation partners. Government, public or private research institutes were ranked top by eight leather firms, but no cement or textile firms. Universities or other HEIs were the most important partner for just two cement firms and two textile firms. Once again, these results confirm that there is much scope for building institutional linkages between HEIs, government agencies, research institutes and firms in order to foster the transmission of knowledge and technologies for innovation. This is an essential component of building well-functioning sectoral systems of innovation, and will help to address disintegration among the actors in the SSIs, missing actors and a lack of soft institutions.

**Figure 7: Most important cooperation partners for innovation**

![Figure 7: Most important cooperation partners for innovation](image_url)
6 Conclusions and Recommendations

The Federal Government of Ethiopia has committed the country to an ambitious economic transformation and industrialisation strategy, but also to a low-carbon development trajectory as set out in the CRGE strategy. The international development literature highlights innovation as a critical driver and enabler of industrialisation, while the literature on green growth and sustainable development also places a large emphasis on the role of ‘green’ innovations as a key mechanism for achieving improvements in resource productivity and reductions in wastes and emissions, including greenhouse gases. This paper aimed to assess the strengths and weaknesses of the emerging sectoral systems of innovation in three key manufacturing sectors in Ethiopia, with a view to establishing the extent to which they are geared toward supporting green innovation and hence green industrialisation. The major findings are summarised below, following which recommendations are made for policies to strengthen green innovation in these sectors.

6.1 Summary of main findings

Based on interviews with officials in the key ministries, it appears that green innovation is not garnering the level of attention it requires to support a full-fledged green industrialisation strategy. The MEFCC plays a critical role at the national level in the implementation of environmental policy and plays a role in the industrial SSIs mainly by providing information and regulatory stimulus for green innovation. However, the MoI has primary responsibility for implementing the CRGE in the industry SSIs, and its involvement in supporting green innovation specifically appears to be somewhat limited given its main focus on industrial development. Furthermore, links with the Ministry of Science and Technology could be strengthened. The sectoral Industry Development Institutes are playing an important role in the implementation of the CRGE strategy, and this includes facilitation of interactions and knowledge transfer among the innovation system actors. All of the IDIs are part of the national STI programme, which includes guidelines on how the institutes must collaborate with universities and firms. The major green innovation that is being adopted by cement manufacturers is the replacement of coal with biomass in order to reduce CO₂ emissions. The creation of industrial parks with centralised effluent treatment facilities is the main sectoral-level green innovation in the leather and textile industries.

The firm survey revealed that the rates of product and process innovation were low amongst cement and textile enterprises (less than 20% in each case). A large percentage of leather sector firms reported product innovation (65%), but only a moderate proportion (28%) engaged in process innovation. The extent of green innovation, defined as innovations that aimed to reduce energy, water and material inputs or solid, liquid and gaseous wastes, was substantially lower. Only 12% of firms reported green product innovations, and 15% engaged in green process innovation. However, nearly half of all process innovations were reportedly undertaken to reduce inputs or wastes.

For both leather and textiles producers, the most important drivers of innovation are increasing market share and improving the value of goods and services, while for cement firms it is reducing unit costs. Of concern is that “reducing environmental impacts” and “meeting environmental regulatory requirements” ranked amongst the least important
motivators of innovation for firms in all three sectors. This is a clear indication that improved environmental policies and/or enforcement is needed to stimulate green innovations. The most important inhibitors of innovation identified by firms were high costs of new technologies and high costs of access to new markets. Lack of adequate finance for innovation was also an issue for many firms. The cost of meeting government regulatory requirements did not feature as an important obstacle to innovation, which might indicate a lack of strong regulations or enforcement thereof.

When it comes to sources of information for innovation, firms generally relied more heavily on their own resources and their suppliers, rather than on external sources such as universities, research institutes and government agencies. This implies that much more needs to be done to strengthen the linkages between public and academic innovation actors and firms to foster knowledge and technology transfers. This is further reinforced by the finding that the number of meetings between firms and most innovation system partners – especially universities – was very low, despite the efforts of the industry development institutes.

6.2 Policy recommendations

A number of recommendations emerge from the preceding analysis for policies that could help to stimulate green innovation at the enterprise level in support of the country’s green industrialisation ambitions. Three key strategies are: (1) mainstreaming greening within the STI policy framework and promoting green innovation as a core part of the CRGE strategy; (2) enhancing the enabling environment for innovation; (3) promoting green innovation through economic incentives and improved enforcement of environmental regulations.

6.2.1 Mainstreaming green innovation

Effective governance requires proactive leadership, policy coherence, institutional capacity building and strong implementation of policies. Interviews with several high-level government officials confirmed that the former Prime Minister Meles provided strong leadership for the formulation of the CRGE strategy around 2009-2010 and its subsequent devolution through numerous government ministries. There has been similar high-level endorsement and support for national innovation policy from the top leadership; as indicated earlier, Ethiopia has promulgated an innovation policy and constituted an innovation council, which is led by the Deputy Prime Minister. However, judging from the results of the Ethiopian national innovation survey conducted by STIC (2015a) and the survey of cement, leather and textile firms conducted in this study, there is still much to be done to fully implement the national STI policy in order to stimulate a greater extent of innovation. Moreover, greater leadership and commitment to support green innovation specifically is required to support the implementation of the CRGE. Such commitment to green innovation also needs to filter down to relevant ministries (in particular the Ministry of Industry).

Although the STI Policy does include some elements that are related to environmental policy, the need for green innovation needs to be raised in profile in order to align the policy with the desire for green industrialisation as motivated for in the CRGE. Conversely, green innovation also needs to be mainstreamed within the CRGE implementation process. However, to date innovation has not been the particular focus, for example, in quarterly forum meetings involving the six main line ministries involved in implementing the CRGE. Moreover, the greening agenda has not been mainstreamed within the education system. All government
departments that are involved in implementing the CRGE need to understand the importance of innovation as the key enabler of improving environmental performance. Mechanisms that have been created to facilitate inter-ministerial cooperation on the implementation of the CRGE should also be used to promote green innovation more explicitly. Ideally, there should be an inter-ministerial coordinating body to lead the innovation/greening industry agenda at the national level. Encouragingly, the revised Environmental Policy (a draft of which was published in December 2015) gives explicit attention to the need for policies to encourage green innovation.

At all levels, capacity building needs to occur to strengthen the ability of government departments to contribute to the green innovation agenda. Vertical policy coordination is required to ensure that different levels of government (federal, regional and local) are pulling in the same direction. In addition, horizontal policy coordination is necessary; for example, innovation policies also need to be dovetailed with other relevant policies, such as macroeconomic, trade, industrial and competition policies.

6.2.2 Enhancing the enabling environment for innovation

Although it is typically firms that bring innovations into the economy, government has a critical role to play by establishing conducive framework conditions, including the macroeconomic and business environment, large-scale infrastructure, and the broad educational and public knowledge creation systems. These structural underpinnings are important for innovation in general as well as green innovation in particular.

Stable and prudent macroeconomic policies need to be maintained in order to maintain high rates of economic growth, low and stable inflation, and manageable public debt, and thereby lay the foundation for an economic environment that is conducive to innovation. Trade policies should continue to promote international trade to facilitate inflows of technology and to incentivise both export and import competing firms to meet international product standards, including environmental standards, through product and process innovations. Ethiopia’s industrial policies are encouraging foreign direct investments, and it appears that efforts are being made to ensure that new entrants stemming from FDI are – at least in principle – forced to comply with environmental regulations. However, monitoring and compliance need to be bolstered.

The Ethiopian government has been investing heavily in infrastructure in recent years, especially for transport and energy. While such infrastructure lays a necessary foundation for an innovative economy, innovation needs to be supported by an accelerated rollout of communication infrastructure, especially to facilitate Internet connections. This will allow firms to more easily access information and to communicate more effectively with suppliers, consumers and other actors in the innovation system. Since many existing domestic firms find the cost of relocating to industrial parks prohibitive, policy-makers could consider introducing tax breaks or rental subsidies to enable firms to take advantage of the opportunities for greening their activities and technological learning from other firms.

Public investment in education and scientific research is essential to create the human capital that is required to generate, adopt and adapt new knowledge and technologies in the Ethiopian economy. Furthermore, innovation requires data and information, against which progress can
be monitored. Ethiopia is lagging behind in terms of data systems and knowledge creation. Although more than 20 new universities have been opened since 2005, these are essentially teaching universities with very little research activity. Universities can play an important role as generators and mobilisers of knowledge, but in Ethiopia’s case capacity in higher education needs to be enhanced in order to close the ingenuity gap. There should also be an emphasis on vocational education and training. The emphasis placed in the STI Policy on scientific, technical and engineering education is warranted, but in order to support green innovation, attention and resources need to be focused on the creation of environmental programmes at all levels of education. To support innovation in the manufacturing sector, more funds should be allocated for engineering and technology, perhaps diverted from the agriculture sector, which currently receives the bulk of government R&D funding.

A critical function of an innovation system is to ensure that the knowledge that is generated in education and research institutions is effectively transmitted to businesses. This requires active mechanisms to strengthen the linkages between the various actors in the national and sectoral innovation systems, including government departments and agencies, universities and TVET institutions, public research institutes, industry development institutes and associations, and enterprises. This is what can be referred as building well-functioning sectoral innovation systems, and is particularly relevant in Ethiopia given the weakness of such linkages highlighted above. While the various industry development institutes are playing a leading role in facilitating linkages, they need adequate resources to ensure they have sufficient human and institutional capacity to fulfil their mandate. Greater resources could be provided for conferences, workshops and websites, which are all useful tools for sharing information. The industry development institutes should also be directed to prioritise support for green innovation among their enterprise constituencies. So far, the development institutes’ main engagement has been in facilitation activities for investors, which are mainly non-technical. They should become proactively involved in information gathering and dissemination regarding new and relevant technologies, including more environmentally sustainable products and production methods. The information dissemination can be further enhanced by establishing Science and Technology Information Centres under each of the sectoral development institutes. Another major policy opportunity is the formation of a programme to incentivise commercialisation of research activities at universities and to support collaboration with private sector firms.

6.2.3 Implementing incentives and regulations

The government, working through the relevant ministries as well as state agencies such as the industry development institutes, should continue their efforts to educate firms about the need for green innovation. However, education is usually insufficient by itself, and needs to be supported by incentives and regulations that help to change the mindset of private businesses to internalize their negative environmental externalities.

Financial barriers to innovation such as the high costs of innovation and lack of access to finance can be addressed with financing several mechanisms, including debt financing, equity financing, government funding of R&D, co-funding by government and firms, and subsidies. Given the shallow nature of the banking sector in Ethiopia, the Ethiopian Development Bank could play a major role in providing finance for innovation. Another possibility is government co-investing to share risks, for example through public-private partnerships.
In addition to financing, various fiscal incentives can be used to stimulate R&D and innovation among firms. These can be either direct measures, such as contracts, grants and awards, or indirect incentives like R&D tax rebates, accelerated depreciation for R&D equipment, and duty exemption for imported inputs for R&D (OECD 2015; World Bank 2010). A carbon tax can provide strong incentives for firms to innovate in ways that reduce their carbon emissions (e.g. by adopting more energy efficient equipment), and at the same time the revenues generated by the tax could be directed towards greening efforts (such as subsidies for firms that innovate to reduce other environmental impacts such as pollution, or by subsidising clean energy).

The demand side is also important as a stimulus for green innovation. There is a role for policies that help create markets for greener products and to assist firms to access such markets that may already exist, including international markets. Trade policies can help to expand access to foreign markets, and can encourage Ethiopian manufacturers to innovate in order to meet environmental standards set by other countries or regions, such as the European Union. In the case of domestic markets, public procurement can be an effective policy tool to encourage green innovations. For example, state-sponsored infrastructure projects could procure cement that is produced using process innovations that reduce CO₂ emissions.

Finally, in some instances economic incentives are inadequate to reduce pollution, and environmental regulations imposing curbs on wastes and emissions are required. Ethiopia has scope for improved enforcement of environmental regulations, which in turn requires enhanced capacity-building for environmental monitoring and evaluation.

References


