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Energy management practices in Bangladesh's iron and steel industries

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ABSTRACT

The aim of this paper was to study energy management and improved energy efficiency among large iron and steel mills in Bangladesh. The results show that there are some barriers to energy management practices among large steel mills, the most important barriers being the perceived absence of cost-effective technical measures, high perceived risks due to uncertain future energy costs and poor information quality. However, this study has shown that the reduction in energy costs due to improved energy efficiency constitutes the most important driver for energy efficiency in the studied steel mills. The results also show that most of the steel mills have not had any technical energy efficiency improvement measures implemented in the production process. Moreover, the steel mills seem unfamiliar with the concept of including energy service companies, and the lack of information or awareness seems to be the main reason behind this. The paper also finds that energy efficiency is perceived to be able to be improved by 6%–8% through energy management practices.

1. Introduction

Bangladesh is an emerging economy with a rising level of industrialization. The country has experienced a steady increase in the industrial index over the past two decades [1]. Thus energy management in industry is becoming an important issue in the country's future competitive edge as well as climate change mitigation activities. Energy management in industry is important from both governmental and business perspectives. From the governmental point of view, energy management would mean increased efficiency and demand side management of CO_2 reduction; for business owners, energy management means higher productivity and competitiveness [2]. Cheap electricity has been a key to Bangladesh's development and the electricity generation in the country is substantially subsidized, albeit the price has doubled over the last 10 years [3]. Considering the factors mentioned above, it seems crucial for the country to have strong energy management incentives in the industrial sector. From a global perspective, research on energy efficiency improvements in the industrial sectors is a growing field of research, with some examples being [4], [5]. There is however a need for an expansion of industry-specific energy management and improvement studies, not least in developing countries such as Bangladesh.

According to a governmental study, the steel industry in the country uses around 2.25% of the total primary energy consumed[1] [6]. Along with the projected growth of Bangladesh as an industrial economy, the steel industry itself is expected to grow by more than 15% [7], and as this is an energy-intensive industry, energy management practices will be even more important in the near future. Bangladesh's steel industry is an oligopoly in nature; even though there are 400 active companies operating in the market, the big three steel manufacturers Bangladesh Steel Re-Rolling Mills (BSRM), Abul Khair Steel (AKS) and KSRM supply more than 50% of the country's annual demand for finished steel products [7]. These manufacturers also supply 90% of the semi-finished steel (billet) demand [7]. Thus, in this study, these three – along with a few other major players in the industry – have been studied in terms of their energy management practices. These manufacturers are the market leaders with the highest production capacity for both final steel products and billet.

Energy efficiency terminology refers to managing and restraining the growth in energy consumption [8]. "*Energy efficiency is the most promising means to reduce greenhouse gases in the short term*" said Yvo de Boer (Executive Secretary of the United Nations Framework Convention on Climate Change) in 2007. Later on, in the World Energy Outlook 2013, Executive Director of the International Energy Agency Maria van der Hoeven also aligned herself with the statement that "*Energy efficiency is the only fuel that simultaneously meets economic, energy security*

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[1] Even though the thermodynamic laws state that energy cannot be consumed or produced, this is the term used in, e.g. the ISO 50001 Energy Management Standard, and it is also used throughout this paper.

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and environmental objectives" [9], [10]. Industrial energy efficiency is the key anchor in the transition towards more carbon-neutral energy systems. While the energy efficiency potential area is quite vast, there are many barriers to energy efficiency which hinder the implementation of energy-efficient measures and the transition to a sustainable future [11–13].

The aim of this paper was to study energy management and energy efficiency among large iron and steel mills in Bangladesh. The aim of this study is divided into four major research questions:

- What is the energy efficiency potential in Bangladesh's large iron and steel mills?
- On what system levels are energy efficiency technologies and measures currently implemented in these mills?
- Do the mills have any existing long-term energy strategy?
- What are the barriers to implementing the energy efficiency measures?

Similar studies of energy management practices and energy efficiency have been conducted in other countries, for example studies on the Swedish iron and steel industries and Ghana's largest industrial area [14], [15]. Also, there have been studies on foundries by accumulating results from industries of a few different European countries [16], [17].

However, to the author's knowledge, there have not been any previous studies regarding the energy management and efficiency practices of the steel industry in Bangladesh. There is thus a lack of research looking at ways of improving the current practice in the industry.

1.1. Use of energy in Bangladesh

Bangladesh is one of the most densely populated countries in the world with 162 million people in an area of 147,570 km^2 [18], and the population is expected to increase even more in the future [18]. The total GDP on purchasing power parity (PPP) in 2014 was 499 million USD [19], and given stable conditions this is projected to increase to 3367 million USD in 2050 [20]. In different studies it has been shown that growth in GDP has a positive causal relationship with the growth in energy consumption [21–23], which with the population growth indicates a sharp increase in energy demand in Bangladesh in the future. Subsequently, the future GDP growth is also dependent on the availability of energy for the growing industrial sectors. The installed capacity of Bangladesh's electricity system in August 2016 was 12,780 MW including 600 MW power imported from India [3]. The installed capacity increased rapidly over the course of a few years due to favorable governmental policies to invite private investment and independent power producers (IPP). These companies are now producing 46% of the total power in Bangladesh [3]. The government is committed to supplying electricity to all citizens by 2021. Presently, only half of the total population has access to electricity, and the supply is far from reliable [24].

A significant portion of the total energy consumption (55%) is supplied by traditional biomass fuel such as fire wood, dung and crop residues. The rest is supplied by natural gas, imported oil and coal, as well as hydroelectricity [6]. Fig. 1 [6] shows the primary energy supply by sources in Bangladesh.

Electricity production is heavily dependent on natural gas, and around 80% of the electricity is generated from natural gas, 7% from coal, 6% from oil and rest from other sources [6], [24]. The pie chart in Fig. 2 [6] shows energy and electricity production by sources in Bangladesh.

Disregarding biomass sources used mainly in rural areas, gas and petroleum are the most important primary energy sources in Bangladesh. The use of gas and petroleum products in different sectors is illustrated in Table 1 [6].

The largest energy consuming sectors in Bangladesh are industry, transportation, commercial and residential as shown in Fig. 3, where total primary energy consumption by different sectors is shown [6].

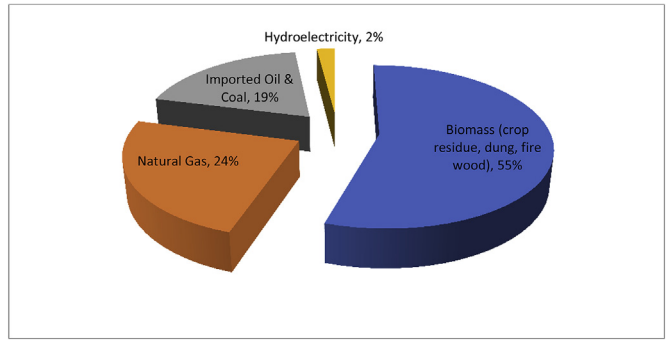

Fig. 1. Primary energy supply by sources [6].

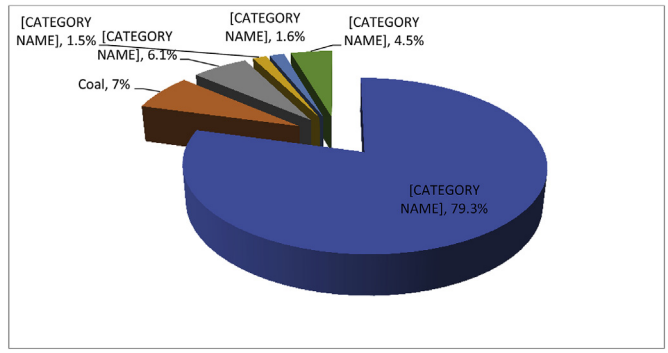

Fig. 2. Percentage of electricity production by fuels [6].

Table 1
Gas and petroleum consumption by sector in Bangladesh [6].

	Industry	Transport	Residence	Commercial	Agriculture
Gas	69.2%	8.2%	20.7%	1.8%	0.2%
Petroleum (Oil)	4.9%	59.8%	9.0%	0.5%	25.8%

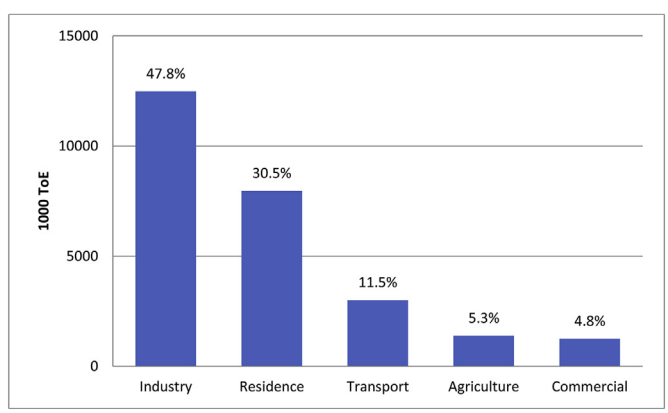

Fig. 3. Primary energy consumption by sector [6]
Note: primary energy basis, excluding biomass. Electricity: 2867 kcal/kWh (thermal efficiency 30% basis).

1.2. Steel industry in Bangladesh

The steel industry in Bangladesh is an established and growing industry; the industry produces for the domestic market as well as exports abroad. Compared to 2012, the production capacity of Bangladesh's steel industry has more than tripled during the financial years 2014–15, and actual production is expected to double by 2022 [25]. The