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Improving the electricity efficiency in South Africa through a benchmark-and-trade system

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ABSTRACT

The improvement of energy efficiency is considered internationally as one of the ways to ensure energy security of supply, reduce greenhouse gas (GHG) emissions and mitigate the negative consequences of the climate change. In this paper, we propose a benchmark-and-trade system to improve the electricity intensity in South Africa in an effort towards the reduction of the country's emissions.

This theoretical system is then used into a calculative application, as a simplistic example, with 2006 being the base year. The results show that the majority of the economic sectors will benefit by participating in the system. Also, the system has the ability to decrease the electricity intensity of the country without affecting its economic output. The findings indicate that, compared to the implementation of a carbon tax, this system gives the participants' stronger incentives to change their behaviour.

Contents

1. Introduction

South Africa has undergone major political, social and economic changes during the past two decades. Partially, as a result of these, the country has begun to experience serious electricity supply shortages [1] and critical energy predicaments. The electricity crisis in 2008 was, among others, attributed to the mismatch between the supply and the demand for electricity and affected the whole economy considerably [2].

The South African policy makers make efforts to bring the demand and supply in a certain equilibrium by not only, boosting the electricity generation in the country (two new power plants to be operative in 2015), but also promoting Demand-Side Management (DSM) initiatives through Eskom—the national supplier. In this paper, we wish to explore another DSM method that will give incentives for more efficient use of electricity to all the economic sectors of the country. This system will particularly encourage electricity-intensive sectors to save electricity in order to avoid the cost-related and environmental consequences resulting from the use of electricity.

A cap- (or our chosen term, benchmark-[1]) and-trade system as used internationally has a primary objective to steadily improve the environmental performance of a country by decreasing its emissions

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[1] The only difference between the two terms is the manner of determination of the maximum amount of the targeted indicator which the participants are allowed to emit. In a cap-and-trade system, the cap is determined based on a number of factors such as previous performance or more usually the country's overall performance goal. On the other hand, in a benchmark-and-trade system, the amount is determined by comparing ("benchmarking") the country or participant to other countries or participants.

Table 1
Main cap-(benchmark)-and-trade systems since the 1980s.
Sources: [4–11].

Programme	Year	Place	Focus	Goal
Leaded Gasoline Phasedown Program	1980s	United States	Gasoline	Production of gasoline with a lower lead content
US Clean Air Act Amendments	1990	United States	SO_2 and NO_2	Reducing SO_2 to 50% of 1980 by 2000
Regional Clean Air Incentives Market (RECLAIM)	1994	Los Angeles air basin	NO_x and SO_x	Reducing emissions by 70% by 2003
Acid rain program—US SO_2 Trading Program	1995	United States	SO_2	Reducing SO_2-emissions by 50% of 1980 by 2000
North-eastern NO_x Budget Program	1999	USA: 12 north-eastern states and the District of Columbia	NO_X	Reducing emissions to 25% of 1990
European Emissions Trading System	1998	30 European countries	GHG emissions	Reducing EU's GHG emissions (each EU member sets its own target, subject to review by the European Commission)
NO_x Budget Program (SIP)	2003	USA: 22 states	NO_x	Reducing the transport of ozone pollution over broad geographic regions

in a cost-effective manner [3]. As such the concept of cap-and-trade is neither recent nor new. This type of system has been used for different types of emission such as SO_2 and CO_2 as well as for greenhouse gas emissions (GHG) in general at a global level. Table 1 summarises the information on the most important applications of cap-and-trade systems around the world since the 1980s.

These systems have three main elements: (a) the cap, (b) the tradable allowances, and (c) the formula for distributing the allowances [12]. The regulator of the system sets the total amount of emissions the participants are allowed to release, the "cap", for a specific time period. Then, it allocates credits ("permits" or "allowances"), to the participants usually equal to the size of the cap. One way of doing this is to estimate the allowances relative to contributions to total emissions in a selected base year and then freely distribute them. Alternatively, the participants receive allowances based on their historical emissions adjusted for the specific system's commitment [10]. The allowed emissions can remain constant or be updated frequently [13]. Another way to allocate credits is *auctioning*. It is mainly preferred to other ways because the price of credits acts as a motivation for consumers to reduce their energy usage [14].

The regulated entities can then either use their allowances or trade it among themselves [6]. The participants that emit less than their allowance can sell their credits (permits or allowances) to those that are not able to easily cut their emissions in the short-run or for those that the cost for reduction of emissions varies [3]. The system thus rewards the participants that were already doing better than their cap and the ones that managed to improve their emissions. From an economic viewpoint, the aim of a cap-and-trade system is to internalise the externality of the emissions by creating a market that puts a price on the emissions [15].

Choosing the target indicator is the most important aspect of any cap-and-trade system as it defines both the character and the objective of such a system. As indicated above, there are various systems that target CO_2, SO_2 or other GHG emissions. With these indicators targeted, the systems deal with the harmful atmospheric results of fossil fuel-based energy consumption. While these systems do have merit, we developed a system based on the principles and practices of cap-and trade systems but focused on the cause, and not on the effect, which is primarily the combustion of coal, with specific reference to electricity consumption in South Africa [16].

Taking this into account, the proposed system aspires towards the reduction of electricity consumption without ignoring the decisions regarding the participants' economic output. Hence, the system's main objective is the reduction of electricity intensity of the South African industrial sectors, with electricity intensity being defined as the ratio between the electricity consumption of the sector and its output. In the proposed system, the benchmark chosen is the average electricity intensity of the OECD members for each industrial sector. The group of OECD countries is selected as they comprise some of South Africa's most important trade partners and they represent a pool of countries that aspire towards applying international 'best practices'. Moreover, the South African electricity sector resembles that of advanced economies and, hence, needs to be compared against the OECD countries given their level of industrialisation and sophistication within this sector.

This paper is structured as follows: the next section presents and discusses thoroughly the proposed system and its design. Following, a primitive application of the system is presented using South African data for 2006 and a comparison of the results with the implementation of a carbon tax. The last section gives a conclusion.

2. Proposed benchmark-and-trade system

Taking into account the important and desirable principles of administration ease and transparency, the proposed system suggests a straightforward method to determine the credits to be traded, after having identified the targeted indicator to be the electricity intensity of the participants (as discussed in the introduction). Using a *grand-fathering* method, the regulator allocates credits to each sector per phase[2] based on their performance during the previous phase. Although, Hahn and Stavins [17] have supported independence between the initial and final allocation of allowances, they also show that in particular programmes such as the one proposed here in practice, independence is not supported and past performance is taken into consideration. For every percentage of difference between the South African and the benchmark's electricity intensity, one credit is assigned (either to be supplied or demanded by the sector).

Based on the traditional decision-making tree for benchmark-and-trade systems [18], Fig. 1 presents a diagrammatic representation of the decisions which a participant in the proposed system faces. The first question to be answered is of strategic importance because it classifies the sector as a 'buyer' or 'seller' of credits. In case the electricity intensity is above (below) target, which means that South Africa is worse (better) off, the sector will act as a buyer (seller) in the trade.

Next, the participant, either a buyer or a seller, faces a question about its potential to reduce its electricity intensity further in the

[2] A phase is defined as a predetermined time period at the end of which a participant's performance is evaluated.