

Global Mechanisms to Create Energy Efficient and Low-Carbon Infrastructures : An Indian Perspective

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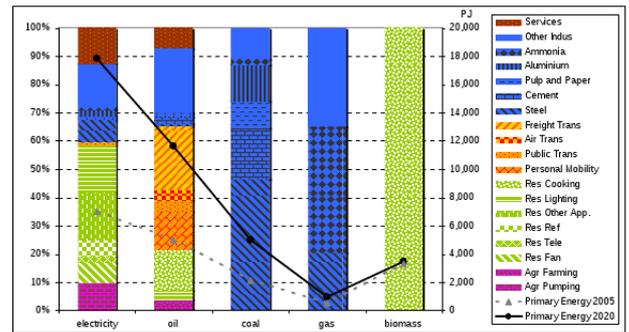
Abstract—The Bureau of Energy Efficiency (BEE) in India has proposed the Perform, Achieve and Trade mechanism to improve industrial energy efficiency. Several European countries and Australia have other energy efficiency schemes. Major developing economies like India and China are also engaged in reducing energy consumption, lowering energy intensity in a manner that would be technically feasible and economically viable. This paper compares some energy efficiency schemes which are being implemented or already implemented in countries. We will draw lessons from these schemes in the design of Perform, Achieve and Trade (PAT) mechanism for India. This paper also discusses design and operational features of white certificate schemes mainly in terms of obliged parties, size of target, eligible customers etc. Most of the schemes discussed are based on quantified energy savings obligations imposed on energy distributors or suppliers, coupled with a certification of the energy savings (via white certificates), and a possibility to trade certificates. These market based instruments help countries to encourage investments in energy efficiency improvement and achieve national energy saving targets. The paper looks at several issues that may arise during/after implementation of PAT mechanism.

I. INTRODUCTION

The gap between the energy supply and demand is constantly increasing. World energy consumption is expected to increase by 49% in 2035 as compared to 2007. The share of world marketed energy consumption by non-OECD countries is expected to increase by 84% as compared to only 14% by Organisation for Economic Co-operation and Development (OECD) countries [1]. Countries are analysing the use of energy in different sectors to arrive at ways to use energy in more efficiently. Fig. 1 shows the projected energy consumption in India by fuel type in 2020. The primary energy consumption in 2010 is estimated to be around 580 million metric tonnes of Oil Equivalent (mmtoe), projected to increase to 931 mmtoe by 2020. According to this projection, electricity consumption in India will grow 6.4% annually over the period 2005-2020 [2]. Fossil fuels dominate as the source of electricity which are major source of CO₂ emissions.

One of the implications of increasing concentration of green house gases (GHG) is overall rise in average temperature of earth. This rise in temperature in turn responsible for change in weather, sea levels etc., which is commonly referred as *climate change*. According to International Energy Agency (IEA) *World Energy Outlook 2008*, 97% of

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Source: Lawrence Berkeley National Laboratory

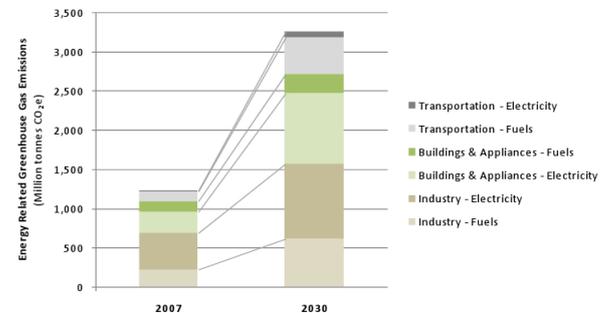
Fig. 1: India projected consumption by fuel type

projected emissions comes from non-OECD countries. Fig. 2 shows sector wise GHG emissions projections in 2030 for India. India is playing an active role in International climate negotiations and is the site for over a quarter emission reduction projects in Clean Development Mechanism (CDM) pipeline [3].

II. BASIC TERMINOLOGIES

A. Basics of Energy Efficiency Certificate Trading Schemes:

In general any energy efficiency certificate trading scheme can be described in the following steps [4]:



Source: Stockholm Environment Institute

Fig. 2: Projected GHG emissions for India

- i) The government identifies most energy intensive sectors / industries in the country and impose certain obligations on these selected parties.
- ii) The government or authorized party determines the activities that can be undertaken to meet targets for energy efficiency, how measurement, reporting and verification process will be carried out etc.
- iii) Parties able to meet their targets within deadline are eligible for white certificates for amount of energy saved.
- iv) These certificates in turn can be used to meet their targets at later point of time or can be traded with parties who are in shortfall to meet their targets.

Under such a system, producers, suppliers or distributors of electricity, gas and oil are required to undertake energy efficiency measures to achieve energy savings target set by regulatory body. Certificates issued for energy savings are generally termed as White Certificates (WhC)[5]. Different countries have different terminology for white certificates. In Italy, certificates are called Energy Efficiency Titles; in the UK, energy efficiency commitments; in India, Energy Savings Certificates; and in France, certificates of energy savings.

B. Cap-and-trade versus baseline-and-credit system:

The energy saving obligation systems around the world are broadly categorized as *cap-and-trade* or *baseline-and-credit* systems. These systems are defined as:

“... in **cap-and-trade system** an aggregate cap on emissions is distributed among individual parties covered in the form of emission permits; the distribution may be for free or via auction and may be based on various criteria” [6].

“... a **baseline-and-credit system** refers to obtaining credits¹ for project activities due to which the emissions or the energy use of a party are taken below their baselines” [6].

One of major implementation issues with the baseline-and-credit system is that monitoring and verification can be a very tedious and questionable process. There are mainly two approaches for emission accounting in cap and trade systems: downstream and upstream approach. In an upstream approach, obligation is on actual emitters to handover the amount of allowances equivalent to their emissions in the previous year. In a downstream approach, end users are allocated quota for their emissions based on the baseline [6].

C. Kyoto Protocol:

United Nations Framework Convention on Climate Change (UNFCCC) was formed to fight against global warming and reduce greenhouse gas emissions. The Kyoto protocol was added to the treaty after approval from most of the member nations. The major difference between the convention and protocol is that the goal of the convention was to encourage nations to stabilize GHG emissions whereas the protocol asks for commitments to reduce GHG emissions. The Kyoto Protocol offers three market based mechanisms other than regular measures taken by countries to meet their

targets. These mechanisms provide incentives to parties to achieve their targets in more cost effective ways [7]. The Kyoto mechanisms are:

- i) **Emissions Trading** - also known as “carbon market”. Countries having spare emission units can sell to those countries who have exceeded their allocated emission units.
- ii) **The Clean Development Mechanism (CDM)** - allows countries with commitments under the Kyoto protocol to implement emission reduction projects in developing countries and earn certified emission reduction² (CER) credits which can be used to meet their target [7].
- iii) **Joint Implementation (JI)** - allows countries with commitment under Kyoto protocol to implement emission reduction projects in another country with commitment under protocol to earn emission reduction units³ (ERUs) which can be used to meet their targets.

D. Key elements in target setting agreement programs:

A number of governments have been using target-setting agreements⁴ as a tool for promoting energy efficiency programs specially within the industrial sector. According to a report by Lawrence Berkeley National Laboratory (LBNL), 23 such target setting programs exist, running over 18 countries including Europe, Australia, New Zealand etc. for GHG emissions reduction or improving energy efficiency [8]. The key elements of a such programs are target-setting, identification of techno-economic options for energy savings, benchmarking, energy-efficiency audits, measurement, reporting and verification processes.

III. GLOBAL FRAMEWORKS

A. United Nations Environment Programme:

The United Nations Environment Programme (UNEP) is a designated entity to handle environmental issues at both regional and global level. The members of the organisations are elected by UN General Assembly for four year term. The selection is based on the principle of equitable regional representation [9].

B. Intergovernmental Panel on Climate Change:

The Intergovernmental Panel on Climate Change (IPCC) is leading intergovernmental body established by the United Nations Environment Programme (UNEP) and World Meteorological Organization (WMO) [10]. IPCC is responsible for reviewing and assessing the most recent and scientific information produced worldwide relevant to the understanding of climate change. IPCC provides the world with current status of climate change and its potential consequences [10]. The need for a political and global platform to tackle climate change came as a result of first IPCC Assessment Report in 1990. This led to the creation of UNFCCC, the international treaty with the aim to take measures to reduce

²each CER equivalent to one tonne of CO₂.

³each ERU equivalent to one tonne of CO₂.

⁴sometimes also referred as voluntary or negotiated agreements.

¹emission credits or energy efficiency certificates.

global warming and cope up with the inevitable temperature increase [10].

C. United Nation Framework Convention on Climate Change:

The United Nations Framework Convention on Climate Change (UNFCCC) is an intergovernmental environmental framework to tackle the challenges posed by climate change. UNFCCC declared climate system as the shared source whose stability can be affected by industrial and other emissions of greenhouse gases [7]. The accompanying Kyoto Protocol was discussed above in II-C

D. World Business Council for Sustainable Development:

The World Business Council for Sustainable Development (WBCSD) is a global association of about 200 companies which deals with business and sustainability [11]. The companies committed to sustainability gets invitation from the executive committee of WBCSD. These members are obliged to provide their environmental performance publicly covering all details of sustainability activities [11].

IV. ENERGY EFFICIENCY SCHEMES AROUND THE WORLD

A. United Kingdom:

UK government came out with Climate Change Programme in November 2000, which focused on planning to meet both Kyoto and domestic targets. Number of policies were introduced with climate change programme for reducing GHG emissions [12]. Climate Change Levy (CCL) and Climate Change Agreements (CCAs) are the key components of the program [8]. Climate Change Agreements were introduced in April 2001 and are defined as the agreements between company/companies and government under which industries can claim up to 80% discount from CCL upon meeting their energy savings or carbon-saving targets [12]. By 2010, CCA's plan to achieve 9.2 MtCO₂ reductions in carbon dioxide emissions [8]. The terms under which eligible parties can claim discount in levy are set by CCA. Agreements between sector association and government are termed as "umbrella agreements" whereas agreements between individual facility and sector association/government are termed as "underlying agreements" [12]. Obligated parties in CCA are termed as *target units*⁵. Individual sector comprises of number of target units having individual targets. These individual target sum up to meet sector targets [13]. Target unit analyses the potential for energy savings in the site before approaching sector association. The Department of Energy and Climate Change then helps to work out on these targets based on sector targets. Targets are based on throughput and energy consumed for each process [13]. Once in two years the target units are assessed for meeting their targets, based on which they are eligible for accepting discount on CCL for next two years. If target unit is going to fail to meet its target, it has to buy carbon allowances for the shortfall. Target units able to exceed their targets can have

⁵A target unit consist of a facility or group of facilities that combine to form the target unit.

TABLE I: Results of UK Climate Change Agreements

	All Sectors		
	Actual (MtCO ₂ /year)	Target (MtCO ₂ /year)	Actual minus Target (MtCO ₂ /year)
Absolute savings from baseline - Target Period 1	16.4	6	10.4
Absolute savings from baseline - Target Period 2	14.4	5.5	8.9
Absolute savings from baseline - Target Period 3	16.4	9.1	7.3
Absolute savings from baseline - Target Period 4	20.3	11.1	9.2

Source: Department of Energy and Climate Change (DECC), UK

excess carbon allowances to trade in UK Emission Trading Scheme with other units that did not meet their targets [13]. The performance target year for each CCA is 2002, 2004, 2006, 2008 and 2010. Table I shows summary of results. One can easily see from these results that there has been continuous improvement across all sectors.

B. Australia:

The world's first trading scheme for white certificates (energy efficiency certificates) started in New South Wales (NSW) as a part of larger greenhouse gas emission trading scheme (GGAS) [14]. Energy Saving Scheme (ESS)⁶ is separated from GGAS due to ongoing energy obligations. As the name suggests, the main aim of GGAS scheme is to reduce the greenhouse gas emissions linked to generation and usage of electricity [15]. NSW aims at low cost emission abatement in all 3 sectors namely residential, commercial or industrial. Target for individual benchmark participant is set based on their electricity supply to state. In 2005, the penalty was AUD 10.50⁷ per tonne of CO₂-e [16]. Participants able to meet their targets are awarded with New South Wales Greenhouse Abatement Certificates (NGACs). Actions which reduce GHG emissions in the customer side are known as demand side abatement reductions [17]. Till December 2008 approximately 90 million tCO₂-e of GHG emissions were abated [4].

ESS identified electricity retailers/suppliers for energy savings. Target calculation was based on the percentage of their total electricity sales, and each energy saving certificate is equivalent to abatement of one tonne of CO₂. Retailers failing to achieve their target within a deadline are penalized. The penalty is calculated based on difference between actual reduction in emission achieved and target in per tCO₂-e. The penalty in turn decides the maximum price for energy saving certificate [4].

C. Italy:

In Italy, energy efficiency obligations were introduced with the implementation of first European directives on liberalisation of electricity market in 1999-2000 [18]. In the following

⁶ESS started its operation from July 2009.

⁷As penalty is not tax-deductible hence at 30% marginal tax rate, the impact of penalty is AUD 13.65.

three years an independent Authority for Electricity and Gas with the help of public consultation designed the technical and economical regulation governing the system [18]. The scheme came into effect in January 2005 [19]. Some of the parts of mechanism were updated in December 2007 [18]. This scheme was driven by Italian Kyoto commitments and was expected to meet the framework designed under the EU Directive of Energy End Use Efficiency and Energy Services. It covers all energy end users. The obligations allow energy distributors to meet their targets by improving their own business. However, at least 50% of the WhC must be met via electricity and gas consumption [20].

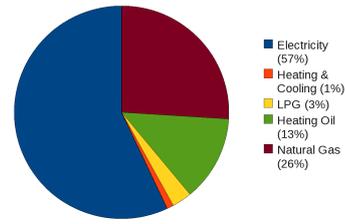
D. Great Britain:

The Energy Efficiency Commitment (EEC) scheme in Great Britain⁸ is successor to Energy Efficiency Standards of Performance (EESOP), which was active for period 1994-2002. The EEC was planned to be active in 3-year cycles from 2002 to 2011 and was confined to domestic sector [21]. The UK regulator, the Office of gas and electricity market (OFGEM), took charge for setting supplier's individual targets, administration of supplier's activity, enforcement of legislation and reporting to government on progress. The overall target was 62 TWh for first phase and 130 TWh for the second phase. At the end of the EEC-1 (2002-2005) phase, suppliers had achieved 86.8 TWh of energy savings which is 140% of the overall target [22]. At the end of EEC-2 (2005-2008) phase, suppliers had achieved 187.3 TWh of energy savings which is 144% of the overall target [23]. In place of third phase of EEC, a new scheme Carbon Emission Reduction Target (CERT) 2008-2011 came into existence. CERT counts savings in terms of carbon and has target of 185 million tonnes of CO₂ (lifetime) for current phase. CERT was also confined to domestic sectors. Each suppliers target is known as its "carbon obligation". As the suppliers were allowed to carry forward any savings in excess of their EEC-2 targets, 37.8 million tonnes of CO₂ (lifetime) were carried over to CERT 2008-2011. At the end of the first year of CERT programme, overall achieved saving was 93 million tonnes of CO₂ (including carry over) which accounted for 50% of the overall target.

E. France:

The law for Energy Saving Certificates in France came in July 2005 [24]. The law laid out the rules to generate consumers energy savings. The overall target set for the phase 2006-2008 was 54 TWh with no intermediate annual targets. Under the scheme, the Obligated parties included all electricity, gas, LPG, oil, cooling and heating for stationary applications fuel suppliers that supply over 0.4 TWh/year [6]. The global breakdown of obligation share for obliged parties is as shown in Fig. 3. The individual target set for each suppliers was based on their annual sales beyond a fixed threshold [25]. Based on the threshold, 10 obliged parties were identified and held responsible for 85% of the total

⁸Great Britain is discussed separately from UK here because of structural difference of schemes in respective places.



Source: French Agency for Environment and Energy Management

Fig. 3: Global Breakdown Obligation Share

energy saving obligation [24]. Certificate trading was active in this scheme. The penalty set in case of non-compliance was 0.02 euro/KWh.

Some of the early indicators of unsustainability of the scheme were: estimated price for certificate for first year was around 10 euro/MWh, which is half the penalty price of 20 euro/MWh [26]. By 31st July 2009, the total achieved energy savings was 65 TWh which was 20% above the set target. The WhC trade market remains marginal because of lack of real demand [24].

F. US acid rain programme

The Title IV of Clean Air Act set a goal to reduce annual emissions of sulphur dioxide (SO₂) by 10 million tons below 1980 levels [27]. To achieve this goal, Acid Rain Programme came into existence. According to the U.S. Environmental Protection Agency (EPA), the main objectives of Acid Rain Program are: to facilitate trading of allowances to minimize costs and maximize energy efficiency, to achieve environmental benefits through NO_x, SO_x reductions and promotion of pollution prevention.

V. INDIA

A. Background:

India's contribution to global CO₂ emission is currently approximately 5% [28]. The IEA projected growth rate of CO₂ emission between 2007 and 2030 is 4.1% per year [28]. At this growth rate, CO₂ emission by India will be more than double by 2030.

Fig. 4 shows energy consumption in India by fuel type. It can be seen that roughly more than 50% of the India's electricity comes from coal which is major source of CO₂ emission.

Table II shows the projection of world's top five CO₂ Emitters to 2030 as compared to 2005. In 2005, India was 5th largest CO₂ emitter. In 2007, it became the 3rd largest CO₂ emitter. The growth rate of CO₂ emissions in India is higher as compared to countries which are emitting higher amounts of CO₂.

One of the biggest challenges for developing countries like India is to have a balance between fast economic growth and global threat to climate change. The National Action Plan on Climate Change identifies eight different national missions to meet our development objectives along with

TABLE II: Worlds Top Five CO2 Emitters

	2005		2015		2030	
	Gt	rank	Gt	rank	Gt	rank
US	5.8	1	6.4	2	6.9	2
China	5.1	2	8.6	1	11.4	1
Russia	1.5	3	1.8	4	2	4
Japan	1.2	4	1.3	5	1.2	5
India	1.1	5	1.8	3	3.3	3

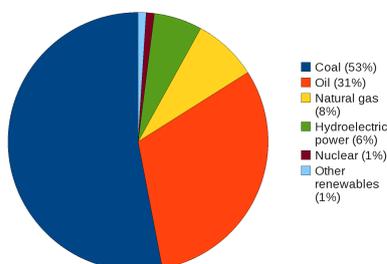
Source: International Energy Agency

addressing issues for climate change. The eight missions are: National Solar Mission, National Mission for Enhanced Energy Efficiency, National Mission on Sustainable Habitat, National Water Mission, National Mission for Sustaining the Himalayan Ecosystem, National Mission for Green India, National Mission for Sustainable Agriculture and National Mission on Strategic Knowledge for Climate Change. India's energy intensity is the fifth lowest in the world but there is substantial scope for saving energy [29]. Half of the commercial energy is consumed by industrial sectors. Industry and Transport have highest potentials for energy savings. Some of the key policy considerations are lack of adequate energy supply options and increasing demands, scope for energy efficiency measures and climate change considerations [29].

B. Perform Achieve and Trade Mechanism:

The Energy Conservation Act of 2001 provides a mandate on implementation of measures for use of energy in an efficient manner through Bureau of Energy Efficiency (BEE) in the central government and designated agencies in states. To enhance energy efficiency, four new initiatives have been taken [30]. These are:

- i) To increase cost effectiveness of measures taken to use energy in more efficient way in large industries. Tradable certificates will be allotted for the amount of excess energy saved (Perform, Achieve and Trade)
- ii) Innovative measures are being taken to promote energy efficient appliances in certain sectors (Market Transformation for Energy Efficiency)
- iii) Mechanisms that will help in financing demand side management programmes (Energy Efficiency Financing Platform)
- iv) Development of fiscal instruments for promotion of energy efficiency (Framework for Energy Efficient Economic Development)



Source: Energy Information Administration

Fig. 4: Total Energy Consumption in India by fuel type (2006)

The anticipation is that these measures would help in saving 10,000 MW by the end of 11th Five Year Plan in 2012 [30]. According to National Action Plan Mandate, Perform, Achieve and Trade (PAT) is defined as:

“... a market based mechanism to enhance cost effectiveness of improvements in energy efficiency in energy-intensive large industries and facilities, through certification of energy savings that could be traded.”

BEE has identified large energy intensive industries and facilities having large scope for energy savings under Energy Conservation Act. These units are called “designated consumers”. Specific Energy Consumption (SEC) reduction targets are set for these designated consumers. The targets would be some percentage reduction of current SEC. The calculation of percentage reduction will be mainly based on the best SEC in the sector and the mixture of fuels used. Measurement and verification of achievement of these targets will be done by BEE accredited auditors. Consumers which take extra measures and exceed their targets will be rewarded with Energy Savings Certificates (ESCerts) for amount of excess savings. ESCerts can be traded, or used for compliance, with consumers unable to meet their targets. There will be a financial penalty for non compliance. There is a huge bandwidth in SEC values in almost all sectors. In most of the sectors, the best unit in the sector is comparable to most efficient unit in the world. Because of such huge diversity in SEC values it is difficult to have a single standard among identified consumers in the sector. Targets must be in some way ‘unit’ specific keeping the sector target in mind. One idea is to have bands of target for units in each sector. The scheme mandates to reduce SEC by some percentage based on current SEC within the sectoral bandwidth [31]. Approximately 700 units have been identified by BEE as designated consumers covering around 9 different sectors. Some of the sectors covered are: Aluminium, Cement, Iron & Steel, Chlor Alkali, Fertilizer, Pulp & Paper, Textiles etc. Next steps to be taken for the scheme are implementation of the protocols for target setting, design of the trading scheme, target notification to designated consumers and operating rules and notification of accredited verifiers [32].

C. Inputs for PAT Scheme

We now describe some of the important questions that need to be addressed while designing the critical parameters of the PAT mechanism:

- i) How will BEE set targets for individual plants in the same sector as surrounding situations may differ from plant to plant? For example, in the cement industry the quality of lime (hard or soft) will determine how much energy is required in grinding and similar processes.
- ii) The compliance behaviour of each plant will be different once a target is set for them. Assuming the time frame for the first milestone is three years, what sort of incentives will be provided to a plant that achieves savings in the first year as compared to the ones that implement these measures during the consecutive years considering the fact that the Monitoring, Reporting and

Verification (MRV) will be done after the time span of 3 years?

- iii) The credibility and the methodology of MRV is important as this determines the number of energy savings certificates issued.
- iv) How will BEE set a penalty for plants who fail to achieve their targets after three years? Will it be mandatory for them to go for certificates? Or they will have an option to pay penalty only. The dynamism of the market should also be considered while setting targets.
- v) What will be the difference between the cost of the certificates and the penalty?
- vi) What will be duration of validation of certificates? Will some extra benefit (like tax saving, reduction in price per unit of electricity purchased from government) be given to plants who have certificates?
- vii) What will be the range of technological upgrade options available/provided to the plants? Are all or only specific technologies allowed? Are plants allowed to come up with their measures to reduce energy consumption or it is mandatory to follow measures suggested by authorized/regulatory body?
- viii) Methodology of target planning must be transparent, well understood, and perceived to be fair, on issues including: (a) SEC analysis of each sector (b) Estimate energy efficiency potentials (c) Base-lining (d) Set targets for designated consumers (e) Compliance period (f) Monitoring, Reporting and Verification (g) Reconciliation and (h) Issuance of certificates

VI. CONCLUSIONS

The design and implementation of any energy efficiency scheme and policy is tough. This is an iterative process as parameters of policy have to be changed based on the feedback and results after the first compliance period. Standardization must be done for the processes like setting targets for designated consumers, pricing for certificates, penalty for obligated parties if they are unable to meet their targets and rules for trading of certificates.

VII. ACKNOWLEDGMENTS

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