Let's talk "energy efficiency + energy modesty"

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Keywords
energy efficiency, energy modesty, allocation efficiency, international energy efficiency policy, climate change, CDM, international technical cooperation, financial cooperation, developing countries

Abstract
Climate change and dwindling carbonaceous fossil fuel reserves require a focused policy approach to develop more efficient financial allocation strategies to reduce fossil fuel energy consumption through energy efficiency (EE) and promote renewable energy sources (RE). Decision making with respect to which short and medium term paths to follow in reducing fossil fuel consumption and greenhouse gas emissions is primarily lobbyist driven and lacks any comprehensive systematic approach in international technical and financial co-operation. This paper examines examples of funding policy with respect to energy efficiency and renewable energy projects and analyzes the shortcomings only in the Indian context. It is argued that the present sluggish market penetration and commercialization of renewable energy technologies for electrical power generation is mainly due to inadequate policy and subsidy strategies. A case is made that national energy efficiency programs may generate a much larger commercially viable market for technologies and services if renewable energy promotion policies are changed since both EE and RE are not competing strategies, but are symbiotic. Furthermore, this paper argues that neither EE nor RE are long term solutions to the energy scenario until a third factor, the "energy modesty", EM, of a society is improved.

Introduction
This paper touches upon important issues with regard to sustainable energy development in India. As a developing country, India is in a transition period, developing towards a more urbanised and industrialized nation with increased consumerism. Furthermore, India's agricultural sector should increase food production by at least 4% per annum requiring mostly irrigated land. The associated growing electrical demand for water pumping further exacerbates the gap between energy supply and demand. To achieve this growth and development, India experiences a 1% growth in energy consumption to support 1% growth in GDP. In contrast, other more industrialised nations such as Germany achieve an annual 1% growth in GDP with a 0.2% increase in energy consumption.

There is a degree of urgency to decouple this unsustainable correlation between economic growth and energy growth by regulatory, fiscal, and market driven measures since public funding of power generation, transmission, distribution and other infrastructure investments to supply energy are insufficient. All 26 State Electricity Boards (SEB) are in dire financial difficulties and are barely able to recover their operational costs, not to mention investing in capacity expansion.

In recognition of these difficulties the Government of India has passed the Energy Conservation Act 2001 and established in March 2002 the Bureau of Energy Efficiency (BEE), a statutory body in charge of implementation the Act. Furthermore a long overdue electricity bill is discussed. BEE's far reaching mandate covers all sectors of society, including not only highly energy intensive industries, but households, commerce and the entire power generation and distribution sector as well. BEE's powers are vested in the

Table 1. Past and future electrical power capacity mix in percent of total installed capacity.

Source	1956	1990	2002	2012
Thermal Power Plant (coal, gas, oil)	65	69	71	62
Atomic Power Plants	0	2	2.50	4.3
Hydro Power Plants	35	29	24	27.5
Other renewable energy	0	0	2.5	6.2
Sum	100	100	100	100

[MoP, annual report 2002]

Act's rules and regulations that may be best described as a carrot and stick approach to entice market transformation. The honourable Prime Minister of India, Shri Atal Vajpayee presented at the inauguration of the "International Conference on Strategies for Energy Conservation in the New Millennium" in New Delhi, on 23 August 2002, the Action Plan of BEE to the public with the well meaning advice:

"Friends, for too long, throughout the world, energy "conservation" has in practice meant energy "conversation". This time, I ask all of us, to "walk the talk"

This paper not only address energy conservation, energy conversion, and energy conversation in India, but it also discusses more complex issues such as the energy intensity of India, the industrial "performance bandwidth", energy modesty, the energy balance or imbalance, renewable energy potential, and a new interpretation of Shakespeare's Hamlet: "To BE(E) or not to BE(E), that is the question."

The power balance or imbalance of India

India's power mix was and will be heavily influenced in the midterm by coal and thermal power plants (see Table 1).

The percentage development is based on a 109 151 MW power capacity addition for the next 10 years of which 36 597 MW are Hydro, 65 339 MW are Thermal and 7 215 MW are Nuclear. This is the national plan. [MoP, 2001]. It must be pointed out that since 1994 and at a time when SEBs were in a much better financial position than today, the Centre Government, the SEB and the private sector invested on the average only in 3 414 MW annual capacity addition. The highest ever annual capacity addition of 4 532 MW took place in the year 1999. Since then the financial situation of the SEB has been worsened and the so called independent power producer sector, IPP, almost collapsed since SEBs cannot afford[1] to reimburse an IPP adequately. Costs of adding 1 MW of power generation, transmission and distribution capacity are at least 1.5 million Euro. The past power capacity addition performance and the dire financial situation of most SEBs, as well as a weak and sceptical IPP sector, will make it difficult to add 11 000 MW of power capacity annually. The present widespread nationwide power shortage, which is particularly severe in rural areas, will therefore worsen if the GDP of India growths at expected 6% -8% annually. The annual electricity consumption in India has risen hundredfold from 5 000 GWh in 1950 to 500 000 GWh in 2000, or at an average rate of 9.7%. The present chronic power shortage is at 18% for peak demand (MW) and 10% for electricity (MWh). However these two figures do not adequately reflect on the serious problems and often outright human and economic misery associated with this shortage.

Support to reduce this supply and demand gap as well as decouple economic growth from electricity consumption growth is part of BEE's objective.

Energy intensity as questionable national performance indicator

The term energy intensity is not a uniquely defined term and depending on the reference source is either defined as GDP divided by energy consumption [BP, 2002], or energy consumption divided by GDP [Kapadia, 2000], or energy consumption divided by GDP on purchasing power parities [IEA/OECD, 2001]. Others [UNESCO, 2001] mix up energy intensity with efficient use of energy resources and declare it as a indicator that expresses the energy efficiency of a country in regards with its production infrastructure. Since energy intensity reflects the combined effects of structural changes in the economy and the changes in the mix of energy sources one may only conclude that energy efficiency measures certainly reduce energy intensity in a given industrial sector but high energy intensity does not necessarily mean an inefficient use of energy. On a PPP basis India's industrial energy intensity is still three to four times higher than those of Germany, USA and Japan [Kapadia, 2000] although some of the industries are equally energy efficient than the most modern plants in developed countries. It is the Indian energy performance bandwidth[2] problem causing a high energy intensity combined with India being in a transition period from a mostly agricultural society to an industrial and more urbanized nation. Consequently the national energy intensity of India went up from 0.73 in 1985 to 0.91 in 1992 and has not much reduced to 0.88 despite efforts in modernization of the industry. Most developed countries such as USA, and IEA Europe have steadily reduced their energy intensity from a high of 0.32 – 0.22 in 1985 to a low 0.26 – 0.18 in 2000 [IEA/OECD, 2001].

A much more interesting indicator that tells about sustainable development and to what extend a country will face more and more difficulties in the future to ensure adequate energy supply to support its GDP growth is the indicator:

"What % of energy growth is necessary to support 1% growth in GDP"

Germany requires presently about 0.2% more energy to support 1% GDP growth. India requires about 0.8% to 1.2% more energy to support 1% GDP growth. Consequently India requires about 5 times as much energy to grow by 1%. One may falsely conclude that Germany being very energy efficient and India being very energy inefficient. There is of course a difference but it is not as dramatic as the difference

1. Since almost all SEB are financially bankrupt it is a common practice to not pay IPP, coal suppliers, the Central Government and others for power, loans, services and fuels. The situation has worsened dramatically since sales of some SEB do not even cover purchase costs of power, leaving no funds left for, covering losses, operational costs, loan servicing and asset addition. SEB have therefore no choice but to default on their obligations.
2. Performance bandwidth in this context means the % difference in specific energy consumption per unit product in an industrial sector, which may easily reach 100%.

in energy consumption growth suggests. The difference comes more from the fact that industrialization, urbanization and consumerism has peaked in Germany while India has a long way to go to reach the saturation level prevailing in Germany. One may only conclude that countries with low energy intensity have managed to move into a category of "efficient" nations that have a much easier time to manage future energy demand for economic growth.

Energy efficiency and performance bandwidth

India's energy efficiency suffers from a large performance bandwith problem and the law of large numbers. This indicator measures the difference between the best and the worst energy consumption for the same product in %. Almost all of the the industrial sector groups represent hundreds of plants and typically hundreds of owners. Plant energy performance for the same product differs often by more than 50% due to plant size, manufacturing process and technology. Some firms are modern world class facilities while others are living museums. This pushes the average specific energy efficiency of an industrial sector down. In other words published average sector performance data is of little use. The following example of the cement sector which is highly energy intensive -46% of manufacturing cost are energy costs- illustrates the issue.

The cement sector in India, the second largest in the world, consists of 123 larger plants owned by 54 companies and 365 so called mini cement plants of which very little is known when it comes to energy performance. This core sector consumes about 20 million tons of coal and 9 billion kWh of electricity annually. It employs 135 000 people, and has an annual turnover of 5 billion Euro per year. The 123 larger plants produced 102 million tons of cement while the 365 mini plans produced 6 million tons in 2001.

It is pointed out that this large performance bandwidth is already present on a small sample of 40 plants considered to be well managed and energy efficient. Kiln size has a direct bearing on energy consumption of about 8% for thermal energy and 2% for electricity if two size groups below 3 000 tons per day (tpd) and larger 3 000 tpd are looked at. Moreover, coal ash varies from 5% to 40% and consequently the calorific value of the coal also varies from 4.8 kWh/kg to 8.8 kWh/kg. Taking into account the underperformers of the 123 largest plans the bandwidth goes up even further. In summation, India's cement sector has plants that are highly energy efficient and implementing the industries best practices, but also has plants that are at the rock bottom of energy performance (see Table 2).

This large performance bandwidth poses a problem for BEE's strategy and delivery mechanism to reduce specific energy consumption in the industrial sectors [Cement sector task force meeting, 2002].

For BEE and its national and international contributors it is most easy to work with the top performers and better their already good performance even more [Pratik, 2002].

BEE therefore has a choice of whom to support. Within a large performance bandwidth the following impact of BEE's work may be likely:

Choice 1: "Improve the worst performers without losing too many"
Choice 2: "Lift the already efficient top performers marginally and don't care about the underperformance at the bottom, further widening the bandwidth, since the lower bottom seems to be very resilient"
Choice 3: "Improve the middle sector of the performance bandwidth"

The focus of many agencies on Choice 2 is perhaps based on the fact that too much money and time is spent in workshops about life cycle cost assessments talking to the top performers while the under-performers and unorganized sectors are staying away and cannot be reached.

It is easy to hand out workshop flashcards as a reminder, saying:

"Before buying an electric motor for US$ 1 000 remember that you have just invested in a technology costing you US$ 100 000 over the next 20 years"

It is a totally different story preventing the competition knocking at the door of an electric motor buyer presenting a flash card:

"Buy a US$ 500 motor! You will save US$ 500 today, although you may no longer be in business 10 years down the road due to high electricity costs and wrong business decisions"

For whatever reason, the second flashcard seems to still be much more appealing to industrial equipment buyers judging by the much larger market share of grossly energy inefficient plant equipment and the large number of under performers. Lack of serious concern for not being in business 10 years down the road is something we fail to accept or understand so far. It is particularly foreign to those alien to the country and its social fabric.

The framework of the Energy Conservation Act enables BEE to follow a vertical as well as horizontal approach. The vertical approach represents a list of 15 designated consumers groups that fall under the Act. These groups are asked to look into and to invest in financially attractive energy conservation measures. The horizontal approach represents the manufacturer of energy intensive plant equipment and household appliances. Under this category fall manufactures of lights, ballasts, air conditioners, refrigerators, fan

Table 2. Performance bandwidth for energy consumption in 40 cement plants (2001).

Performance Indicator	Minimum	Maximum	Bandwidth%
Thermal energy in kCal/kg of clinker	663	917	38
Electrical energy kWh/ton of cement	69	107	55
Section-wise in kWh/ton materials			
Crusher	0.63	3.86	613
Raw Mill			
• Ball Mill	17	26	53
• Vertical Roller Mill	12	24	200
Kiln			
• SP	23	35	52
• PC	19	39	205
Coal Mill			
• Ball Mill	24	44	83
• Vertical Roller Mill	19	39	205
Packing	0.84	2.78	331

and blowers, pumps, boilers, compressors, generators, transformers, HVAC systems, turbines, cooling towers, heat exchangers, vacuum pumps and furnaces. Manufacturers of these appliances and equipment will be asked to improve labeling as well as performance documentation of said equipment.

In the appliance and equipment sector there is an even larger bandwidth problem than in the designated energy consumer group. A designated consumer under the Indian energy conservation act, is a consumer group required to improve energy efficiency. As an example take the water pump manufacturing sector. India's future growth in agriculture depends mostly on irrigated land. Presently about 15 million water pumps of 5 to 10 HP are in operation consuming an estimated[3] 34% of the national electricity generation. Even worse, farmers pay about 0.5 Rs/kWh (1 Eurocent/kWh) while supply costs are on the order of 4 to 7 Rs/kWh (8 to 14 Eurocents), driving State Electricity Boards into bankruptcy. There is of course no shortage of national pump manufacturers offering very energy efficient pumps. However 75% of the national output of pumps for agricultural and industrial use is manufactured by the so called informal sector that does not comply with norms and has no interest in improving the performance of their pumps which are sold at about 60% of the price of a reputed manufacturer's brand.

Perks, fiscal incentives, rules and regulations, direct subsidies as well as other schemes will be part of the BEE's strategy in support of voluntary compliance under market driven schemes. The carrot and stick approach will be followed. However BEE will not offer yellow painted sticks as a poor substitute for juicy carrots.

Renewable energy as part of a national sustainable energy policy

India is one of the few countries that have a ministry for renewable energy, the Ministry of Non-Conventional Energy Sources, MNES. The estimated combined economic as well as uneconomic potential of electric power generation by renewable energy sources was published on January 4th, 2002:

Total installed power capacity:	100 000 MW
Amount generated by renewable resources:	3 000 MW
Installed wind power capacity: (India ranks 5th in the world)	1 267 MW
Small hydro power capacity: (India ranks 10th in the world)	1 341 MW
Biomass based power generation: (India ranks 4th)	273 MW
Generation by biomass gasifiers: (India ranks 1st)	35 MW
Approx. potential of renewable resources:	100 000 MW

There is no doubt that India should and must continue to increase the fraction of power generated from renewable energy sources. However it is unrealistic to assume that the present and future efforts will have any significant long term impact or may even significantly contribute to a sustainable energy scenario for the following reasons:

Reason 1: If India is not able to decouple its GDP[4] growth from energy consumption growth, she will need to put in place 220 000 MW of additional power generation, transmission and distribution capacity over a period of 20 years to the already existing 103 000 MW.

Reason 2: Officially published figures concerning the contribution of renewable energy to the power mix lack reliability and transparency. The on-paper installed MW capacity is of little relevance since the generated MWh are the important indicator. There is a lack of allocation efficiency with respect to funding since subsidies have been mostly given for the investment and not for the long term generation of power, resulting in MW capacity installed that no longer generate electricity.

Reason 3: The total investment required for additional 220 000 MW G+T+D[5] is on the order of magnitude of 264 billion US$, or 13 billion US$ per year for conventional power generation. However the public sector is in no position to spend more than 2 billion US$ a year on power G+T+D expansion regardless of whether it comes from renewable or conventional resources.

Reason 4: India does not have a national law allowing private sector power plant operators[6] to sign long term power purchasing contracts with State Electricity Boards at commercially viable conditions, since electrical power is a concurrent subject in India, meaning the States have the final saying while the Union Government recommends. State Electricity Regulatory Boards are setting the tariffs, political interference is strong and social considerations have to be taken into account. One may or may not negotiate a favorable contract.

In this context the German experience with adding power from renewable energy to the conventional power mix is of interest. The German Renewable Energy Act provides a sustainable subsidy to investors, paid by the State Electricity Utilities that is purely based on generation and delivery of power to the grid. The table below shows the reimbursement that is guaranteed over the technical life of the plant. Investors, who just look for a tax haven, or fast depreciation of a renewable power plant, cannot come into the picture based on the Act. The guaranteed tariffs are above average tariffs from the power mix and are also much higher than spot market prices to give renewable energy a chance.

3. About 30% of India energy consumption is not metered. In particular lifeline customers and farmers pay a monthly lump fee or nothing at all. The data base of 26 State Electricity Boards about their authorized and unauthorized customers is highly questionable. Even data about the infrastructure in the field such as poles, cables, transformers is unreliable. Consequently neither technical losses nor commercial losses are known. All published power consumption data in India is therefore unreliable and errors of 30% to 60% are common.
4. Assuming 6% growth and 6% electricity consumption growth.
5. Generation, Transmission and Distribution.
6. Neither for renewable nor for conventional power.

Table 3. Tariff based on the German Renewable Energy Act.

Renewable Source	Plant size	Eurocents/ kWh	Rs/kWh
Hydropower and power from gas from municipal waste sites	Up to 500 kW	7.66	3.83
Gas from water treatment plants	500 kW to 5 MW	7.65	3.83
Biomass power plants	Up to 500 kW 500 kW to 5 MW 5 MW up to 20 MW	10.23 9.20 8.69	5.12 4.60 4.35
Wind power	Any size, the first 5 years after 5 years, depending on volume	9.10 6.19 to 9.10	4.55 3.10 to 4.55
Geothermal	Up to 20 MW Beyond 20 MW	8.95 7.16	4.48 3.58
Photovoltaic, Solar	Up to 5 MW	50.62	25.3

Exchange rate 1 Euro = 50 Rs (January 2003)

Table 4. System approach to efficient power.

Item	5 MVA Substation in rural area	4.5 MW Biomass Power Plant in rural area
Investment	35 Million Rs or 0.7 Million Euro*	175 Million Rs or 3.5 Million Euro
Fair price for either kWh generated or avoided	3 Rs/kWh or 6 Eurocents/kWh avoided	3.6 Rs/kWh or 7.2 Eurocents/kWh generated

*To reduce technical losses in distribution and water pumping by 30%.

Table 5. Socio- Economic impact of biomass power plant.

Project Size, (nominal power plant capacity)	4.5 MW	
Land area of procurement	300 square km	
Cultivated area within the procurement area	150 square km	
Number of land holdings within this area	10 000	
Rural population in this area	50 000	
Agricultural labour in this area	8 000	
Price for biomass*, moisture free basis, per ton	1 150 Rs	24 US$
Value ploughed into rural economy per year	44 000 000 Rs	920 000 US$
Permanent jobs created in biomass supply	500	

*Price refers to as delivered.

The tariffs have been lowered by 1% for biomass, 1.5% for wind and 5.5% for photovoltaic, annually, since 1.1.2002.

Reason 5: The present policy of only subsidizing power generation should change, because at least 30% of the more expensive electricity from renewable resources is wasted in the T+D system or inefficiently utilized by the consumer. The analysis for a 5 MW biomass power plant in operation[7] and a 5 MVA power substation providing electricity to about 600 irrigation pumps and their owners is presented. The commercial market for both types of projects is fairly large in India, with a realistic potential of about 500 biomass power plants and 5 000 suitable substations (see Table 4).

Field data indicates that in order to generate biomass power, or engage in reduction of distribution and water pumping losses a fair price of 7.2 Eurocents and 6 Eurocents per kWh respectively will be necessary. However it is also shown that both activities should be undertaken simultaneously to have the maximum benefit to all stakeholders.

In the case of the of the biomass power plant the following socio-economic impacts have been reported (see Table 5).

Any significant increase in private sector investment in commercially viable renewable energy power generation projects depends therefore on a policy change with respect to fair long term power purchasing contracts and a more integrated system approach that generates additional profits at the distribution and consumer site. Outright investment subsidies of up to 90% or fiscal measures such as 100% first year depreciation of capital investment have resulted in a rush of biomass, PV, and wind power plants, but have not resulted in a sustainable market oriented towards long term development, which requires long term power purchasing tariffs to lesson the risk of investors.

The MNES has already established 1994 guidelines for promotional and fiscal incentives by State Governments for power generation from non-conventional energy sources and recommended at this time a minimum rate of 2.25 Rs/kWh with no restrictions on time or quantum of electricity supplied for sale. This base price shall be escalated at a minimum rate of 5% every year, to 3.32 Rs/kWh (6.6 Eurocents/kWh) in 2002. However due to financial constrains very few SEB's

7. Actual case of power plant in Karnataka operating on cane trash, coconut tree fronds and wood for 2 years.

are willing to sign long term power purchasing contracts including a 5% annual escalation rate. It is foreseen that the tariff will be frozen at 3.63 Rs/kWh in 2004, with no further annual escalation allowed.

The sustainable energy supply scenario equation

Improved energy efficiency (EE) and renewable energy (RE) will contribute to a more sustainable energy supply and demand development in India. However the most important factor may be the future "Energy Modesty" (EM) of the nation. Unfortunately energy modesty has not been practiced in developed nations. The Indian society has therefore very little understanding and appreciation for energy modesty concepts.

It holds: **Energy Sustainability = EM + EE +RE**

While EE and RE do not require any more clarification, the concept of Energy Modesty does. EM is by far a more effective instrument, but at the time a more complex and difficult goal to achieve. Energy modesty means many things. It could mean to systematically improve the investment climate for less energy intensive industries, e.g., India's information technology (IT) and software industries which have a large US$ turnover related to a marginal energy input. It also means scaling down equipment to match the job being done (i.e., eliminate over-sizing). The observation of whether a glass of water is half full or half empty is irrelevant. It is more important to recognize that there is too much glass for the job to be done. EM could also mean the combination package of increased water harvesting, reduced losses in the national power transmission and distribution network and fewer but more efficient irrigation pumps. However, we don't have to go as far as the following entry from a competition for the best TV commercial/slogan for energy efficiency in rural households: "Save energy eat your chicken raw". Less drastic advice such as putting a lid on the cooking pot may save 20% of the fire wood or gas as well. Energy modesty is a concept that starts in peoples' heads. The Energy Conservation Act 2001 and BEE recognizes the importance of this issue through several provisions.

BEE's energy conversation, energy conversion, energy conservation

Based on the action plan BEE has divided the task of implementing the provisions of the Energy Conservation Act into 10 thrust areas: 1. Indian Industry Programme for Energy Conservation, 2. Demand Side Management, 3. Standards and Labelling, 4. Energy Efficiency in Buildings and Establishments, 5. Energy Conservation Building Codes, 6. Professional Certification and Accreditation of Energy Managers and Energy Auditors, 7. Manuals and Codes, 8. Energy Efficiency Policy Research Programme, 9. School Education, and 10. Delivery Mechanism for Energy Efficiency Services.

Thrust areas 6, 7, 8, and 9 focus on Energy Conversation through training and awareness building modules as well as through a constant dialog with members of the legislative and other ministries concerning improved policy.

Thrust areas 1, 2, 4, and 10 focuses on Energy Conservation since activities lead to verifiable and measurable impacts in terms of barrels of oils saved and support to service providers who offer commercially viable and financially attractive energy conservation investments.

Thrust area 3 deals with the subject of Energy Conversion, because industrial equipment and appliances convert one form of energy into another at a given loss which BEE likes to reduce through improved equipment design and improved system integration [Action Plan, BEE, 2002/2003].

The first and second law of energy efficiency

There is a First and Second Law of Thermodynamics. Similarly BEE is promoting through the provisions of the Energy Conservation Act as well a First and Second Law of Energy Efficiency:[8]

First Law BEE-1 = **B**uy **E**nergy **E**fficient (Equipment)
Second LawBEE-2 = **B**e **E**nergy **E**fficient (in operation)

Giving a new meaning to Shakespeare's Hamlet basic question: "To BE(E) or not to BE(E)"?

Success of BEE-1 and BEE-2 mainly depends on a change of the social fabric prevailing at the management and operational level of industry and commerce. BEE-1 only takes place if buyers are informed and have a choice. Thrust area 3 and 7 will improve decision making because well trained energy managers will have a better understanding of which equipment to buy based on improved documentation as well as labels concerning equipment performance. BEE-2 addresses a totally different problem at the operational level. It is not the exception but more the rule that retrofitting and modernising plant equipment and manufacturing processes to reduce energy consumption will only give the expected energy cost savings on paper if staff at the operation level are not trained and motivated to ensure a more energy efficient operation. A very typical example is the replacement of an old steam boiler with a design efficiency of 76% and operational efficiency of 65%, by a new more efficient boiler of design efficiency 82%. This new boiler will in no time working at an operational efficiency of 65% as well, if measures to support BEE-2 are not initiated.

The success of any national drive for a more energy efficient society and sustainable energy management is therefore the sum of BEE-1 and BEE-2.

BEE's concept and recommendation of allocation efficiency of funding

There are always more pressing problems than the funding and financing available to solve them. One may therefore assume that selection and funding of projects would follow an efficient allocation path, where projects are selected based

8. Coined by Kaupp, GTZ, Manila 1990.

Table 6. Comparison of major performance indicators of efficient and inefficient utilities.

Performance	Typical	Most SEB
Station use	6%-8%	6%-12%
Frequency fluctuations around 50 Hz	0.2 Hz	2 Hz
Voltage fluctuations around 240 V	5%-7%	10%-40%
Statistical no-availability	0.1 hours per year	About 200-800 hours/year
Thermal efficiency	43%	37% (because of high ash coal)
Technical transmission and distribution losses	7%-9% from 440 kV to 220V	Estimated 30% from 220kV to 220 V
Commercial losses	<1%	>20%
Financial standing	Profitable	Financially bankrupt

[Energise, v1, 2002]

on a systematic analysis taking into consideration a general low cost/high impact philosophy.

An interesting case in question is large wind farms in India. Wind power is a reliable and proven technology that can be financially attractive. Wind farms have enjoyed investments subsidies or 100% first year depreciation since 1993 although some of the financial and fiscal incentives have been removed recently. However there is a difference between a good subsidy and bad subsidy policy.

Let us look beyond the wind farm and follow the path of a kWh of electricity through the transmission and distribution system as well as its conversion to useful work in large fans.

The present high losses in the D+T system will reduce one kWh electricity to 0.75 kWh or less. The blower works at a low overall efficiency of 60%. Both inefficiencies will result in a combined loss of 55% of the useful energy input. National policy makers promoting power from renewable energy such as wind farms have four choices:

Choice A: Subsidize investment costs for the wind park by fiscal/financial incentives to keep the electrical tariff for green power low.
Choice B: Increase the wholesale tariff for green power.
Choice C: Subsidize investments to reduce in a financially attractive manner technical losses in the distribution and use of electrical power by 20%.
Choice D: Encourage investment in financially attractive investments in reduction of technical losses in the distribution and use of electrical power.

So far only choices A and B were followed in India with mixed results. The more appropriate strategies C and D have not been considered although it is often totally unnecessary and in fact counterproductive to subsidize the generation and distribution of power. Instead one could avoid this subsidy or convert part of it into a good subsidy by financially attractive measures at the distribution and consumer level. However this concept is never followed since analysis of the entire system of "generation + distribution + consumer" is foreign to donor projects and has not entered the policy level in India.

BEE's concept of effective demand side management

Most projects promoting Demand Side Management, DSM[9], have either never been heard of or have forgotten the original meaning of DSM, as coined by Gelling of EPRI, USA, 1972:

"The planning and implementation of those utility activities designed to influence customer use of electricity in ways that will produce desired changes in the utility's load shape"

The catch phrase was "to fill up the valleys and cut the peaks" of the daily demand curve (load shifting). The dream of any utility is to have a horizontal flat straight line as a demand curve. This strategy is called integrated resource planning or allocation efficiency of investment, because peak power is always more costly then base load power,. The principle is simple: First implement internal DSM and reduce auxiliary power of a plant as well as transmission losses in the T+D system. Then practice external DSM (i.e., influencing customer behaviour). It is understood from the principle of integrated resource planning that a power utility would engage in external DSM only after the internal DSM opportunities have either been exhausted or further investment into internal DSM would not be financially attractive compared to external DSM. The present scenario in the Indian power industry does not at all call for external DSM except for non-paying customers, based on the comparison of Table 6.

Consequently none of the attributes and preconditions to engage in a meaningful external DSM for the end user is given. Any serious integrated resource planning or allocation efficiency of investment exercise would clearly come to the conclusion: "Whatever national or international resources are available to State Electricity boards, they should be committed to reducing operational costs first, in other words internal DSM". The largest power consuming group in India who is never charged for their consumption is the transmission and distribution network, consuming[10] more than 25% of the national power generation.

The second largest consumer group are about 15 million farmers owning irrigation pump sets. Farmers either get power for free or pay very little[11] implying a very high cross subsidy[12] of power supply to farmers. Consequently present

9. A better term is external DSM.
10. There are no reliable figures available for India since technical T+D losses are lumped with commercial losses and calculated as a difference by subtracting estimated consumption of farmers and other non-metered groups.
11. About 0.5 Rs/kWh (1 Eurocent).
12. In the case of the State of Karnataka with more than 1 Million irrigation pumps, the cross subsidy is 4.02 Rs-0.48 Rs = 3.54 Rs, since supply costs are 4.02 Rs/kWh.

Table 7. Data of verified investment in energy conservation measures and impact, 2002.

Industrial Sector	Lakhs Rs saved in first year	Investment Lakhs Rs	Payback period Years
Aluminum	1 433	10 594	> 9
Automobile	1 819	294	< 0.2
Cement	7 088	10 633	< 2
Chemical	2 733	990	< 0.5
Chlor Alkali	1 210	636	< 0.6
Fertilizer	9 252	9 779	< 1.2
Glass	85	2	< 0.02
Integrated Steel Plant	17 048	1 103	< 0.1
Mini Steel	125	42	< 0.4
Pulp and Paper	4 117	7 031	< 2
Petrochemicals	8 329	3 948	< 0.5
Refractory	48	9	< 0.2
Refinery	5 194	22 775	< 5
Sugar	49	117	< 2.5
Textile	883	441	< 0.6
Total, Lakhs Rupees	59 413	68 394	Average < 1.5
Total, Million Euro	120	140	

[MoP, national awards 2002]
1 Lakh Rs = 100 000 Rs = 2 000 Euro

and future efforts of BEE focus on reduction of technical and commercial losses in power supply to farmers, as well as reduction in the technical losses of the irrigation pump and bore well system. However progress will be very slow [KERC, 2002]:

"The socio-economic and cultural milieu existing in the State, the prevailing culture of unauthorized pump sets, misuse of life line tariffs, theft of electricity have to be tackled in a phased manner. Changing the culture of the consumers takes time and is an enormous task".

BEE, the Kyoto protocol and CDM

BEE follows and supports the recommendation given by the Minutes of Meeting of the Indian Cabinet from 7th November 2000 and has established a CDM Cell. Recommendation provided by Cabinet and the Ministry of Environment and Forests in its note dated 2.11.2000 specifically point out:

- "The cabinet broadly approved the proposal with the guiding principle should be a practical and flexible approach which enables India to get optimal Clean Development Mechanism (CDM) financing/projects with state of the art technology in conformity with our needs, whether of bilateral or multilateral arrangements."
- "A predominately stand-alone character for the CDM, setting it apart from emission trading, recognizing its distinctiveness, with separate decisions for the three mechanism."
- "Concerned Ministries/Departments identify the potential areas for CDM projects and undertake preparatory activity."
- "India's approach will emphasize that CDM projects focus on renewable or highly efficient energy projects that are at the top end of efficiency practice anywhere."

India is establishing in summer 2003 a national CDM authority[13], based on the concept of the Foreign Investment Promotion Board, FIPB.

One of the most reliable annual datasets available to examine the greenhouse gas reduction potential of energy efficiency is based on the summary of the National Energy Conservation Award which is an annual event of the Ministry of Power.

We see that there is an enormous potential for energy savings with very short payback periods, even if we assume that key figures of total investment and first year energy cost reduction may be off by plus or minus 30%. The about 176 firms from 15 industrial sectors that participate in this annual event of the Ministry of Power claim first year savings of about 120 million Euro achieved by 140 million Euro total investment, or an averaged fast payback period of less than 1.5 years with a spread of 0.2 to 2.5 years.

The extremes are not considered. Most measures undertaken by the industry are classical investments of retrofitting, optimization of manufacturing process, waste heat recovery schemes, replacement of inefficient machinery by State-of-the-Art technology and fuel switching.

All measures sustain the first year energy cost reduction over many years to come. Consequently, as obvious from the table, almost all measures except Aluminium and Refineries seem to be financially attractive with returns in the order of magnitude of 30% to 1 000%.

Of course this is only the tip of the iceberg. Maybe 1 out of 10 companies with similar energy cost reduction potential were covered.

Furthermore participants in the national competition are representing mostly larger companies that are in the upper

13. The Designated National Authority, DNA, required by the convention to approve CDM projects.

third of the performance bandwidth of their respective sector. Smaller companies and the underperformers are either not aware or not interested about energy cost reductions measures although they would benefit most in a changing business climate. We estimate that the annual overall investment potential for similar measures with payback periods of 1 month to at most 3 years is at least tenfold or 1.5 billion Euro a year.

Will all this potential be eligible under the CDM? The clear answer is no. The CDM is no subsidy regime. It shall bring about "real, measurable and long term" greenhouse gas reductions. In plain terms, the CDM investor somehow has to demonstrate that his investment would otherwise not have taken place, i.e. to determine "additionality" of his project. Any "business-as-usual" project would not be additional. The criteria for testing additionality have been subject of a bitter international debate and have never been clarified. Small scale projects under the CDM shall receive favorable treatment. They are allowed to determine additionality by showing that barriers to project implementation have been overcome, if financial criteria show that the project in principle is attractive for business. Large projects will be judged by stricter criteria, so the financial criteria will play a larger role here. It is not surprising that the World Bank's Prototype Carbon Fund applies a strict investment analysis for the majority of its CDM project proposals.

What does this mean for Bee's efforts to stimulate the Indian CDM market? It clearly means that projects with annual financial returns in the 50%+ range will have problems to make a case for additionality. It also clearly means that projects with annual financial returns below Indian bank lending rates – i.e. around 15% – will be safely seen as additional. The interim category now becomes interesting. Clearly, everybody has a different view of a reasonable financial internal rate of return depending on the risks involved in the project. And everybody faces barriers of different kinds. The knack of a good CDM project developer is to "smell" which combination of financial indicators and barriers is still accepted as additional by the independent certifiers and the Executive Board. Another watchdog is the international NGO community that is currently watching the CDM with mistrust. The first CDM project proposals have been lambasted by NGOs for being "business as usual". Determination is thus like climbing a sharp ridge without losing one's balance.

A common sense business strategy is thus not to gamble but to take care of "low hanging fruit" projects with a 50%+ return since they make sense anyway. Here is a goldmine that lies idle. CDM should only be envisaged for projects with returns that make one hesitate. There the farmer's perspective should prevail. And the Indian energy scenery abounds with such projects. Hopefully the CDM makes entrepreneurs wake up and sow many seeds!

Acknowledgements

The authors thank the staff of BEE, as well as the many national and international consultants whose advice have been and will be shaping implementation of the national Energy Conservation Law and future of BEE. Their advice has been invaluable in painting a larger and as well a more complex picture of what it means to arrive at a sustainable national energy policy. Complex problems require sophisticated solutions!

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