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ON THE ENFORCEMENT OF ENERGY RELATED NORMS AND PRACTICES FOR A CLEANER ENVIRONMENT

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On the Enforcement of Energy Related Norms and Practices for a Cleaner Environment

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ABSTRACT

It has been established that future energy growth will mostly occur in the developing world. To meet projected growth, the World Bank estimates that developing countries will require investments of over $100 billion per year for the next thirty years to meet electricity needs alone [1]. Two of the already proven approaches to preserve a clean environment are concerned with **(i)** the stabilisation of the supply of and demand for electric energy, and **(ii)** the promotion of renewable energy technologies for electricity generation [2]. On one hand, energy efficiency improvements can slow the growth in energy consumption, save consumers and countries money and reduce environmental impacts. Renewable energies, on the other hand, are environmentally friendly sources since most of them are emissions free. Explicit government policies are necessary to overcome existing barriers hindering the adoption and large scale implementation of both energy efficiency and renewable energy technologies. In addition, policies, norms and standards are needed to sustain global intervention in these fields. The enforcement of energy related norms and practices for a cleaner environment requires careful reading of the international experience, scrutiny of emerging non-traditional policies and evaluation of already proven practices in light of local conditions to weight their advantages against associated costs. In this paper, the focus will be on selected issues for which policies, norms and standards can be set. The selected topics are related to efficiency standards, codes and product labelling to promote energy efficiency [3,4]; and taxation [5], externality costs[6] and metering options[7] to create incentives for renewable energy systems. Examples based on the international experience in these fields will be provided throughout the paper to support the proposed concepts.

1. Introduction

The United Nations Framework Convention on Climate Change with the objective of stabilizing concentrations of greenhouse gases to a safe level, went into force in March 1994 by requiring each country to establish a policy followed by some action plans. A number of developed countries are already committed to returning greenhouse emissions to 1990 levels by the year 2000 whereupon international co-operation on environmental conservation is expected to be a significant factor in the world energy market in the years to come [1]. According to the Environmental Protection Agency (EPA), 34% of NO_x and 68% of SO_2 world emissions are from electrical utilities. Therefore, with growing evidence and conviction that environmental degradation constitutes a threat, it is important that governments are adjusted towards environmental maintenance particularly in the energy sector. This would require the integration of environmentally sound practices into economic policy making at all levels supported by economic and financial incentives targeting both utilities and consumers.

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Two of the already proven approaches to preserve a clean environment are concerned with (i) the stabilisation of the supply of and demand for electric energy, and (ii) the promotion of renewable energy technologies for electricity generation [1]. In both cases, however, policies, norms and standards are needed to sustain global interventions in these fields. The enforcement of energy related norms and practices for a cleaner environment requires careful reading of the international experience, scrutiny of emerging non-traditional policies and evaluation of already proven practices in light of local conditions to weight their advantages against associated costs. In this paper, the focus will be on selected issues for which policies, norms and standards can be set. The selected topics are related to efficiency standards, codes and product labelling to promote energy efficiency; and taxation, externality costs and metering options to create incentives for renewable energy systems. The effective penetration of such technologies will certainly lead to reduction in both electric energy demand and fossil fuel used for electricity generation, and hence, to a cleaner environment.

2. Energy Efficiency

It is well established that future energy growth will mostly occur in the developing world (Fig. 1) [3]. The world electricity demand shows a steady upward trend of 1.5-2% per year. A 2% per year population growth in less-developed countries (LDC), coupled with steady economic growth, resulted in a growth in energy consumption of about 4% per year in the past few decades. If this rate continues, energy is expected to double every 17 years [2]. At the same time, the projected growth rate of energy demand in OECD countries is about 1.2% per year. This means that the energy consumption in LDC would surpass that of industrialised countries around the year 2010. In addition, if developing and transitional countries focus exclusively on expanding conventional energy supply options to meet energy demand growth, they will quickly exhaust their capital resources. To meet projected growth, the World Bank estimates that developing countries will require investments of over $100 billion per year for the next thirty years to meet electricity needs alone [3].

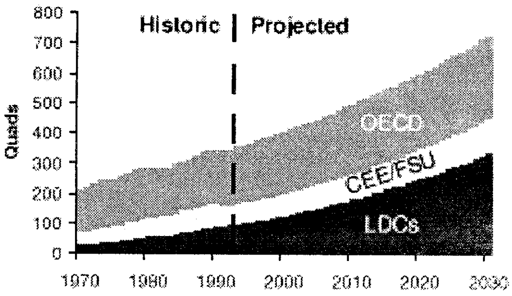

Fig 1. Annual Energy Consumption

One way to curb the growth in energy consumption is through the implementation of energy efficiency programs. Energy efficiency improvements can slow the growth in energy consumption, save consumers and countries money and reduce environmental impacts, especially greenhouse gas emissions. Explicit government policies are necessary to overcome existing barriers and achieve cost-effective energy efficiency improvements, along with their associated environmental benefits. As Fig. 2 demonstrates [3], rather than meeting less than a quarter of capital needs, nearly 50 percent will be met.

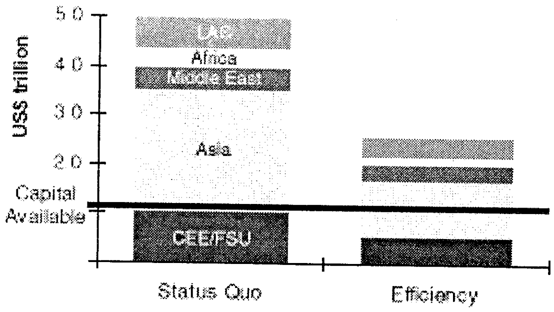

Fig 2. Capital requirements for the energy sector

Most developing countries have inefficient and worn-out energy equipment, and often lack modern technology and up-to-date industrial structures. Technological changes and financial vulnerability in developing countries may best be resolved by changing the economic and market structures to facilitate relevant investments. Such a process is being addressed by the governments concerned but requires a serious and dedicated follow up. Regardless of the estimation technique, the future market for energy-efficient products and services in the developing and transitional world will be large. According to a study by the US working group on Global Energy Efficiency, the energy efficiency market in emerging economies will be worth about $55 billion per year, and the OECD market less than $19 billion per year (see Figure 3) [3].

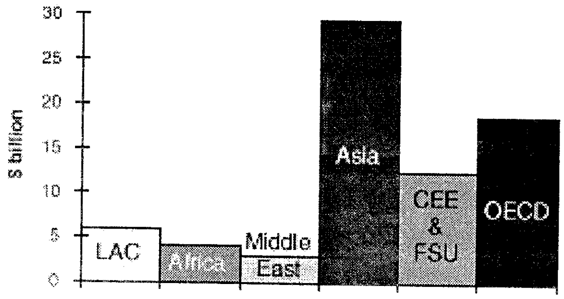

Fig. 3. Average annual investment in energy efficiency

A full list of energy efficiency policies or measures includes the following [4]:

1. Efficiency standards and building codes, product labelling
2. Taxation,
3. Energy cost,
4. Product testing and building energy audits,
5. Education and training,
6. Financial incentives,
7. Research, development and demonstration, highlight

In this paper we will emphasize only the first 3 items. The second and third items will be discussed in sections 3.1 and 3.2 respectively while the first item is treated in this section.

Improved end-use efficiency can contribute significantly to developing economies. Among the benefits are:

- Less need to build new power plants
- Reduced greenhouse gas emissions

Energy efficiency standards for appliances have been implemented in at least 9 countries around the world, while at least 11 countries have energy labelling programs [5]. The substantial savings obtained by countries that have implemented these energy efficiency programs demonstrate that there is a significant potential to be explored.

Notable improvements in end-use efficiencies can be achieved through energy-efficiency programs which include standards and labelling practices. Table 1 shows the large efficiency improvements for typical household appliances in the United States in the late 80s and early 90s [4]. As seen around 29.1% reduction in energy can be achieved, and as a consequence a large saving in GHG emissions. The US mandatory minimum efficiency standards program has resulted in large energy savings and large consumer benefits. For $1 increase in the price of products due to US efficiency standards, consumers save an average of $3.2 on energy consumption over the life of the product. Appliance and lighting standards have reduced the US annual residential energy consumption by more than 3%.

Table 1. Efficiency improvement for typical household appliances.

APPLIANCE	1990 STOCK AVERAGE ANNUAL ENERGY USE (KWH)	1994 NEW UNIT AVERAGE ANNUAL ENERGY USE (KWH)	% DECREASE IN ENERGY USE
Refrigerator-freezer	1220	670	45.1
Freezer	1010	500	50.4
Clothes washer	890	670	24.7
Clothes dryer (electric)	930	830	10.8
Dishwasher	620	500	10.4
Room A/C	970	830	14.4
Total annual energy use	5640	4000	29.1

To actively promote energy efficiency programs in developing countries, a number of technical, political and bureaucratic barriers must be overcome. On the technical level, the establishment of a national standards program is desirable. The latter is defined as a set of elements that ensure that energy efficiency standards and labelling efforts are appropriate, updated over time, and sustained. The components of such a program are [4]:

- **Accredited testing facilities**: testing laboratories must be internationally accredited. The International Organization for Standardization (ISO) and the International Electrotechnical Committee (IEC) have set standards for accreditation systems. These are:

  ISO/IEC Guide 58: 1993-calibration and testing laboratory accreditation systems: general operation for operation and recognition
  ISO/IEC Guide 25: 1990-general requirements for the competence of calibration and testing laboratories.

<u>*ISO/IEC Guide 43*</u>: development and operation of laboratory proficiency testing

- **Appropriate testing procedures**: standards are based on test procedures to measure energy efficiency. Test procedures are specified by national and international standards organizations as listed in Table 2.

Table 2. Standards organisations

International	Int. Organisation for Standardisation (ISO)
	Int. Electro-technical committee (IEC)
Canada	Canadian Standards Association (CSA)
China	National Bureau of Standards
Europe	European Committee for Standardisation (CEN)
	European Electro-technical committee Electro-technical committee (CENELEC)
Japan	Japan Institute of Standards (JIS)
Australia	Standards Australia
New Zealand	Standards Newzealand
United States	Association of Home appliance Manufacturers (AHAM)
	American National Standards Institute (ANSI)
	air-conditioning and Refrigeration Institute (ARI)
	American Society of Heating, Refrigeration and Air-conditioning Engineers (ASHRAE)
	American Society of Mechanical Engineers (ASME)
	Illuminating Engineering Society of North America (IES)

- **Energy labels**: labels are the cornerstones of market pull strategies for energy efficient equipment.
- **Energy efficiency standards**: they eliminate the least efficient products from the market. A key element of a standards program is building a periodic review and adjustment of the standard. Energy standards can specify maximum energy use or minimum energy efficiency.
- **Supportive policies**: the government must set legislation, which mandate standards and labels.
- **Monitoring and enforcement**: standards and labelling programs must be monitored and ensured through a credible enforcement scheme.
- **Periodical revision**: to ensure the right modifications as markets improve
- **Stakeholder inputs and evaluation**: to ensure sustainability

3. Renewable Energy Related Policies

Renewable energies are environmentally friendly sources since most of them are emissions free. However, renewable energy technologies around the world are facing a number of critical barriers that hinder their adoption and large scale implementation. A full list of policies or measures to promote renewable energy technologies includes the following:

1. Taxation
2. Energy cost
3. Education and training
4. Financial incentives
5. Research, development and demonstration

In this paper, the focus will be only on the first 2 approaches.

3.1 Carbon Tax

Carbon taxes can be used as an effective policy once it is believed that polluters must compensate society through taxes. These revenues are then used to protect the environment. Charges and taxes can be of three types [7]: emission charges, user charges and product charges. Emission charges are based on pollutants emitted, user charges are charges for the use of public effluents, and product taxes cover taxes on products whose production and consumption creates pollution.

The use of carbon tax revenues to finance or encourage renewable energy technologies will [6]:

- reduce air-pollution, acid rain and smog, which also result from fossil fuels
- reduce health costs associated with air-pollution
- increase domestic employment. A study by the worldwatch institute in 1990 found that wind energy creates more jobs per 1000 GWh of electricity produced (542) than either nuclear (100) or coal (116).

But on the other hand, Although the implementation of a carbon tax will yield to CO2 emission reduction at the least cost, the adoption of such a tax will impose certain economic costs on the society and such costs must be weighted against benefits that may be realized. The impacts of a global carbon tax on local economies depend on the distribution of damages that would otherwise be caused by global warming. The percentage of GDP loss following a common carbon tax is higher (i) the higher are emissions per unit of GDP , and (ii) the larger is the elasticity of substitution between fossil fuels and other factors [7]. Table 3 summarizes different studies on the estimate of the distributional costs of national carbon taxes intended to achieve the same percentage reduction in each region. As seen, the tendency is towards higher costs for developing countries.

Table 3. Estimates of costs of a carbon tax by region. [Cost in 2020 (% of GDP)]

COUNTRY/REGION	BARNES ET A. (1992)	OLIVIERA (1992)	MANNE (1992)	RUTHERFORD (1992)
US	2	1.1	2.2	1.3
Other OECD	1.9	1.2	1.1	0.4
China	2.8	0.7	2.7	2
Ex-USSR	0.9	1.7	3.1	1.5
Rest of the world	2	3.8	4.9	2.3

3.2 Energy Cost

There are three types of costs associated with electric energy as a product. Costs that are included in the price paid by the consumer are known as internalised. Costs that are related to environmental protection are called internal environmental costs. Finally, the costs that are unpaid are called external environmental costs [8].

Total Cost = internal general cost + internal environmental cost + external environmental cost

The external environmental cost is a societal cost attributed to the damage that the process of electricity generation is inflicting on our societies. In general, this cost can be characterized by:

$$\textit{Total Externality Cost} = \textit{Size of damage} \times \textit{Value of environmental damage per unit of damage}$$

where:
Total Externality Cost = total external cost to society, in dollars;
Size of damage is expressed in physical units (Tons emitted, or m^2 degraded); and
Value of Environmental Damage is expressed in dollars per physical unit of damage (\$/Ton, $\$/m^2$).

The externality cost that depends on power plant fuel consumption, can be characterized by:

$$\textit{Externality Cost}\ (\$/kwh) = EF\ (Tons/BTU) \times HR\ (Btu/kWh) \times ED\ (\$/Tons)$$

where
EF = Emission Factor, in Tons/Btu of fuel consumed;
HR = Heat Rate of power plant, in Btu/kWh; and
ED = Value of Environmental Damage, in \$/Tons

EF and HR are physical parameters that can be measured, while ED can be calculated using any of the following three different approaches [9]:

i. Costing the external environmental damage
ii. Abatement costs
iii. Mitigation costs

The two principal methods of monetization are calculating damage costs and calculating mitigation costs. Damage cost estimations involve analysis and prediction of four factors [8]:

- emission quantities
- emission concentrations in the receiving medium
- the effect of those concentrations on the medium, and
- the economic value of those effects.

A fundamental issue when determining external environmental costs is the valuation of human life. The study of such evaluation includes morbidity costs as well as mortality costs, a range of valuation for the U.K. is given in Table 4 below for minor, major, and fatal injuries in both occupational and public sectors. (Costs are given in British Pounds) [9].

Table 4. Costs of injuries in the U.K.

SECTOR	MINOR	MAJOR	FATAL
Occupational	50-5000	5000-0.5M	0.5M-5M
Public	100-10000	10000-1M	1M-10M

To summarise the steps to follow when evaluating the externality cost are given in Table 5. [9]

Table 5. Steps for external costs evaluation

FACTOR	EXAMPLE
Evaluate *BURDEN*	Emissions of SO2 and NO_x, construction activities, and water abstraction.
Establish *IMPACT*	Acidification of water courses, loss of potential habitat, intrusion into landscape.
Calculate *COST*	Commercial value of ecological /habitat loss, and value of scenic view.

As to mitigation and control, three pollution-control techniques have, historically, been considered:

- ☐ emission standards, which are an important form of command-and-control measure
- ☐ emission charges
- ☐ fees, or taxes, and
- ☐ marketable emission allowances

An emission standard is simply a legal amount of a pollutant an entity can emit. Standards allow pollutant emission levels to be controlled, but they do little to promote cost minimization. Fees and taxes are ways to penalize the polluters as was discussed in section 3.1 above. Finally, as to marketable emission allowances, they do not fall in the scope of this paper, and so interested readers will have to refer to other references for more details.

In many developing countries the external environmental cost is normally not taken into consideration in the economic calculations of energy generation. As such, a comprehensive research as well as suitable policies and norms are needed to identify the increase that must be added to the present cost of electricity. In this respect, it is worth mentioning that when the external cost of energy generation is considered, the whole mix of generation technologies may be radically altered. For example, recent studies in Germany show that the external cost makes the cost of electricity generation from conventional thermal plants higher than that from wind power plants by 0.7c/kWh. Examples of recent estimates of values of environmental damage in the US are given in Table. 6.

Table 6. Value of Environmental damage (1989$/LB)

	SO2 $/LB	NOX $/LB	CO2 $/LB C	CH4 $/LB	N2O $/LB
EPRI (87), Rural	048	0.07	-	-	-
EPRI (87) Urban	1.27	0.07	-	-	-
Chernick and Caverhill (89)	0.92	1.58	0.042	0.37	-
MA DPU (90)	0.75	3.25	0.040	0.11	1.98
Pace University (91)	2.03	0.82	0.026	-	-
NV PSC (91)	0.78	3.4	0.04	0.11	2.07

3.3 Metering Options Supporting Renewable Energy

This paper will discuss only a single issue related to the way the owner of a small (residential) renewable energy system will be compensated for when he generates electricity. In the US, norms have already been developed in a number of states who support the purchase of renewable energy based electricity at the retail price; a matter that provides an excellent incentive to people willing to invest in renewable energy technologies.

Along the capital cost and the cost of financing, the means by which the utility accounts for excess generation sold back to the utility can make a tremendous difference in the economic feasibility of small-scale renewable generation. This matter is decided on through the selection of appropriate metering technique. The two metering options available for small customer-generators are net purchase and sale, and net metering [10].

Option 1: Net Purchase and Sale

Net purchase and sale allows customers owning renewable electric energy generators to use their renewable generation to offset their simultaneous electricity consumption. Beyond this offset, electricity consumed is bought from the utility at the normal retail rate, and electricity generated is sold to the utility at the lower avoided cost rate that utilities are required to pay for power purchases. Net purchase and sale requires two uni-directional meters which measure only consumption or generation.

For example, consider a house with a 3-kilowatt (kW) solar PV system on the roof. Assume the system is generating electric power at its full 3-kW capacity for three consecutive hours, for a total 9 kilowatt-hours (kWh). Further assume the retail rate is 10 cents/kWh and the avoided cost rate is 4 cents/kWh. Thus, as shown in Table 7, the customer's total bill at the end of the three-hour period is a function of the difference between the retail price and the avoided cost price. In our case, 8 cents are to be paid by the customer.

Table 7. Energy pricing under metering of option 1

	HOUR 1	HOUR 2	HOUR 3	TOTAL
Gross Generation (kWh)	3	3	3	9
Gross Consumption (kWh)	3	4	2	9
Net generation meter reading (kWh)	-	-	+1	1
Net consumption Meter Reading (kWh)	-	+1	-	1
Net Bill, Cents	0	+12	-4	8

Option 2: Net Metering

Net metering allows customers to offset their electricity consumption with small-scale renewable generation over an entire billing period without considering when the power is consumed or generated. Net metering uses a single bi-directional meter that registers the flow of electricity in both directions. The application of net metering to the case described above yields different results. As shown in Table 8, net metering allows customers to offset a higher proportion of their retail electricity consumption with their own electricity generation. Customers can effectively earn a higher rate of return on the higher percentage of electricity which they produce due to the consideration of the retail price rather than the avoided cost price.

Table 8. Energy pricing under metering of option 2

	HOUR 1	HOUR 2	HOUR 3	TOTAL
Gross Generation (kWh)	3	3	3	9
Gross Consumption (kWh)	3	4	2	9
Net Meter Reading (kWh)	-	+1	-1	0
Net Bill, Cents	0	+12	-12	0

Below are some conclusions that emerge from the above examples [10]:

- Net metering techniques allow consumers investing in small-scale renewable energy to reduce their bills, and hence encourage investments in renewable energy.
- The bill details reflect the customer decision on two issues: the choice of generation capacity and load management. Note that in option 1, the customer could have reduced his bill to zero if he could postpone the equivalent of 1 kWh from hour 2 to hour 3. Similarly, the customer could have earned 12 cents if he did the same thing but under option 2.
- The economic implications of net metering, is that utilities are likely to face few direct costs from allowing net energy metering if market penetration of customers owned

renewable electric generators remains small. However, if the market becomes substantial, utilities are likely to be concerned about losing revenues needed to cover the fixed costs of their investments in capital expenditures on plant and equipment. In such cases, the utilities may be forced to seek higher rates from their remaining customers to recover the fixed costs.

- One solution to the above concerns is to allow net metering but limit its availability to a fixed amount of generating capacity. The new California net metering law, for example, establishes a limit on the availability of net metering equal to 0.1% of each utility's peak demand. Such a limit was sufficient to allow for market expansion for renewable energy systems.

4. Conclusion

Two of the already proven approaches to preserve a clean environment are concerned with **(i)** the stabilisation of the supply of and demand for electric energy, and **(ii)** the promotion of renewable energy technologies for electricity generation. Along this tendency, this paper has focused on selected energy related topics for which policies, norms and standards can be identified to preserve the environment. The selected topics are related to:

☐ Efficiency standards, codes and product labelling , and
☐ Taxation, externality costs and metering options

Considerable efforts are required to enforce policies, norms and codes relevant to the above topics in the energy industry. To start, a careful reading of the international experience in these fields is a must, and then, the evaluation of already proven practices in light of local conditions to weight their advantages against associated costs is the task to be undertaken by the parties concerned in order to arrive at an energy industry that caters for the environment.

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