CSE dossier

factsheet 6

TOWARDS A NON-CARBON ENERGY TRANSITION

FOURTH SESSION OF THE CONFERENCE OF THE PARTIES TO THE UNITED NATIONS FRAMEWORK CONVENTION ON CLIMATE CHANGE

BUENOS AIRES, NOVEMBER 2-13, 1998

Centre for Science and Environment
41, Tughlakabad Institutional Area,
New Delhi-110062 India
Tel: 91-11-6986399, 6983394
Fax: 91-11-6985879
E-mail: cse@sdalt.ernet.in
Website: www.cseindia.org

It is often argued that if industrialised countries were to reduce their emissions while developing countries are increasing their emissions, then the entire effort of the industrialised countries will get nullified. Therefore, the US, in particular, has taken a strong position that all nations, including developing nations, must become a part of the effort to reduce carbon dioxide and other gases that cause the heating up of the Earth. The Western companies have also been fuelling this argument because they believe that if they alone have to bear the cost of reducing emissions, then they will become uncompetitive in the world market and either they will go out of business or firms which generate high quantities of greenhouse gases will move to countries which do not have restrictions on their emissions.

Unfortunately, greenhouse gas emissions are strongly correlated with economic growth and since a large part of the world consists of countries that are very poor, they will inevitably increase their emissions as they grow economically. It would be churlish to imagine that leaders of developing countries will want to bear an extra economic burden at a time when they are aspiring for rapid economic growth. Neither can they accept global economic inequality of the kind that prevails today.

At the same time, cutting down current global emissions to the scale required in order to avert climate change is not going to be an easy task. It will require an enormous technological change in energy efficiency which will involve considerable research and will also generate more expensive technologies increasing all-round costs of living.

A CARBON-FREE ECONOMY

All these intractable problems can, however, be surmounted if the world makes a serious effort to move towards an energy economy that is built on sources that are carbon-free like solar and biomass energy, wind power or hydroelectricity instead of the existing reliance on fossil fuels like coal, natural gas and petroleum-based fuels. Then the threat of climate change will get arrested and each nation would be free thereafter to use as much energy as it wants.

A recent study points out to the benefits that will accrue to the world in combatting climate change with the rapid phasing in of solar energy technologies. Instead of global carbon emissions continuing to grow constantly for nearly 180 years and reach a peak of 49 billion tonnes of carbon in 2175 with average global temperatures rising to a maximum of 6°C (relative to the base year of 1860), emis-

sions will peak in 2035 in just 40 years at about 37 billion tonnes of carbon and start declining thereafter if research and mass production can keep cutting the cost of solar energy technologies by 50 per cent every decade. By 2065 solar energy would have become competitive with fossil fuels to the extent that it will replace fossil fuels in every economic sector. Even a relatively pessimistic scenario in which solar energy costs decline by 30 per cent per decade make a salutary difference. If this latter scenario is accompanied with a carbon tax on fossil fuels of about US$100 per tonne, then the latter scenario will become as effective as the more optimistic scenario in which solar energy prices fall by 50 per cent every decade.

Thus, the rapid penetration of solar energy technologies in the energy sector has the potential to turn the the threat of climate change into a problem that would last only for a few decades in the early part of the 21st century instead of a problem that will continue to threaten human beings for centuries to come[1].

The most heartening thing is that despite all the neglect of solar energy by governments and enormous subsidies to fossil fuels, solar energy systems are already making their way into the market. Annual US sales of solar energy technologies are already about US$1 billion. Photovoltaic technology has already seen considerable advances in the last 20 years and though its costs remain high, they are

Table 1
Impact of solar energy on combatting the threat of climate change

Scenarios	World GDP loss in first 100 years	Use of oil and coal reserves	Penetration of solar energy	Annual global carbon emissions in 2100	Peak emissions	Global temperature
Baseline model (We are currently following the baseline model. The model predicts 1995 emissions at 7.2 btC. Actual emissions were about 7 btC.)	1.3% in first 100 years and up to 5.2% by 2285	All oil and coal reserves consumed	370 years to move completely to solar energy	About 37 btC	In 2175 at about 49 btC	Rises to a maximum of 6°C relative to the base year of 1860
Decreasing cost of solar energy by about 50 per cent per decade (DCSE 50) *Optimistic Assumption*: Electricity conversion cost reaches 4 c/kwhr in about 4 decades	0.32% in first 100 years	Only 1.5% of world's estimated coal reserves are exhausted	All economic sectors run by solar energy by 2065		In 2035 at about 13 btC	Rises by 1.5°C and declines after 2055; Global mean temperature in 2195 is the same as 1995
Decreasing cost of solar energy by about 30 per cent per decade (DCSE 30) *Pessimistic Assumption:* Electricity conversion cost reaches 4 c/kwhr in about 7 decades	0.74% in first 100 years	Only 8% of world's estimated coal reserves are exhausted	All economic sectors run by solar energy by 2105		In 2055 at about 18 btC	Peaks in 2095 and takes 320 years to reach 1995 level

Note: DCSE: Decreasing Cost of Solar Energy

Source: Ujjayant Chakravarty, James Roumasset and Kin-Ping Tse, "Extraction of Multiple Energy Resources and Global Warming", University of Hawaii, *mimeo*.

likely to come down to less than 10 cents per kilowatt-hour early in the next century[2]. Enron and Amoco are already building a 100 MW plant in Nevada, USA and have been looking for funds to build a 50 MW photovoltaic power plant in India[3].

PRE-CONDITIONS FOR THE TRANSITION

In order to promote rapid expansion in the use of solar energy, there are two important things that need to be done:

One, there is great need for more research money to be provided. A carbon tax of $5 per tonne of carbon which will increase the price of oil by just $0.65 per barrel but it will generate $10-15 billion in the US alone which could be used to fund solar energy[2]. According to the Worldwatch Institute in Washington, DC, less than 9 per cent of energy R&D budgets of industrialised countries is spent on solar and other renewable sources of energy[3].

Two, there is an urgent need to provide a growing market for solar technologies so that mass production can further bring the cost of solar technologies down. This is where a system of emissions trading built on entitlements can play an important role. Developing countries like China and India are growing at a rapid rate. Any entitlement they obtain would get used up rapidly. But as it is unlikely that they can use up their entire entitlement in the immediate future, they would have the potential to trade their unused entitlements. This provision would immediately give them the incentive to move towards a low emissions developmental path so that the benefits from trading emissions can stay with them for a long time.

For example, if India were to find the current high cost of a solar power plant set off by the economic advantages obtained by saving emissions and earning money from trading the saved emissions, asa compared to the lower cost of building a coal power plant, then it is quite likely to think in terms of investing in a solar power project and thus help to create a global market for solar energy technologies worldwide by helping to bring the costs of solar energy technologies down. The economic equation would look something like this:

(The high cost of a solar power plant) — (The money earned from trading the saved emissions) = (The low cost of a coal power plant)

This emissions trading system would, thus, also provide sufficient financial resources and an "enabling economic environment for technology transfer" to take place, as indicated in Article 10 of the Kyoto Protocol.

It is equally important to note that such an economic environment would help to create a **global market** for western solar energy technologies — first in developing countries and then later in industrialised countries — and help to kick-start the global transition towards zero emission technologies. This makes sense because developing countries have more solar energy than Western countries and if global warming is to be averted in the long run, the more solar energy is used by them instead of oil and coal, the better. Also, developing countries have millions of settlements even today which do not have grid-supplied electricity. There are more than two billion people today who have no access to electricity. Solar energy systems should serve these people in the future rather than carbon-producing electric grid systems.

Technological advances are also taking place in using hydrogen as a source of energy which will have major impacts on the transport sector. By 2010, vehicles operated on fuel cells and electric batteries are expected to be on the road which will considerably reduce carbon emissions from the transport sector. Automobile companies are putting in considerable R&D efforts into electric cars. According to media reports, Chrysler has estimated that with a production volume of 300,000, it could produce electric vehicles as cheaply as petrol vehicles except for the cost of the batteries[2]. But many

There is an urgent need to provide a growing market so that mass production can reduce the cost of solar technology

Table 2

Cost of carbon saved when switching from a coal based power station to a solar power station

Cost Item	Coal-based power station	Solar power station
Carbon emissions (assuming coal has 29.3 MJ/kg and 75 per cent carbon, coal plant efficiency is 35.1%)	260C/kwhr	0 gmC/kwhr
Capital cost	$1653/kw	$2185/kw
Operating/maintenance costs	$47/kw-yr	$8.8/kw-yr
Fuel cost (assuming coal cost is $2/GJ)	$0.02/kwh	$0.00/kwh
Total electricity cost, at 0% cost of capital [i]	$0.034/kwh	$0.047/kwh
Cost of saved carbon [ii]	**$48/tonC**	
Total electricity cost, at 10% cost of capital	0. $05/kwh	$0.118/kwh
Cost of saved carbon	**$107/tonC**	

Notes:i) Assuming 85% capacity factor for coal, 25% capacity factor for solar, and a 30 year lifetime.

ii) Cost of saved carbon is defined as net present value of costs (at specified discount rate) divided by total carbon saved.

of these technologies will not reach the developing world unless its special needs are taken into account. If India, for example, were to have as many cars on a per capita basis as USA, it would have 500 million cars as compared to about 4 million that exist today. But in the decades to come India will definitely have a 100 million or so scooters. These vehicles are today 70 per cent of the total number of vehicles in India. Like India, other Asian cities like Bangkok and Taipei, too, are chock full of scooters. But hardly any Western company is thinking of working on electric or fuel cell scooters. This situation needs to be rectified[4].

Emissions trading would, thus help developing countries to enter into the most meaningful form of participation — to borrow the phrase that the US government uses so often.

Technological advances will have major impacts on the emissions from the transport sector. By 2010 cars using fuel cells are expected to hit the road

But then one of the rules of emissions trading would have to be that no trade can take place that does not involve a transition to the use of non-carbon or biomass energy sources instead of trading being the cheapest alternative to the cost of reducing greenhouse gas emissions in industrialised countries as is being proposed by the US. In the latter case, the world will definitely get emissions trading and industrialised countries will be able to do 'creative carbon accounting' to meet their emissions reduction targets but climate change would not have been averted.

There cannot be a better solution than fixing 'emissions entitlements' and 'pegging emissions trading to non-carbon energy sources alone' because it will be both socially just and ecologically effective. And for forward-looking Western countries which are the most technologically advanced, this prposal should bring a glitter of gold in their eyes. Indeed, if a solar transition were to take place, they would then replace the oil-producing countries as the biggest suppliers of energy. But in order to appreciate this proposal they must have a vision for the future instead of a narrow vision that is locked into the narrow and current economic interests of the oil and automobile industry.

Rough calculations carried out by Sivan Kartha of the Stockholm Environment Institute in Boston show that the cost of carbon abatement is US$50-110 per tonne of Carbon if power were to be generated today from solar power stations instead of coal-based power stations[5]. (See table 2)

But to get exact figures for India, specific details of the Indian context will be needed like cost and performance of local coal and solar plants, carbon content of Indian coal, etc. An earlier study done for the World Bank which looked at four alternative electric supply options — wind farms, industrial cogeneration, solar thermal power plant, and demand side efficiency — for a 500 MW addition to the Chandrapur power plant in Maharashtra[6]. The cost of a tonne of carbon saved was as follows:

Table 3
Cost of carbon saved through alternative options for the 500 MW addition to the Chandrapura Power Plant in Maharashtra

Alternative Options	Cost per tonne of carbon save
Industrial cogeneration	US$3
Demand side efficiency options	US$7
Wind farms	US$17-32
Solar thermal power plant	US$64-82

Source: Stockholm Environment Institute, The Effect of a Shadow Price on Carbon Emissions in the Energy Portfolio of the World Bank: A Backcasting Exercise, Boston, quoted by Sivan Kartha 1998, Boston, *personal communitication.*

This data gives us some idea of the cost that we will have to accept for a solar transition at least in the initial years before the prices begin to fall further.

1 Ujjayant Chakravarty, James Roumasset and Kin-Ping Tse, "Extraction of Multiple Energy Resources and Global Warming", University of Hawaii, *mimeo.*
2 William Hoagland 1995, Solar Energy, *Scientific American* 273, September, p.170-73, quoted in Ujjayant Chakravorty *et al, ibid.*
3 Worldwatch Institute's State of the World 1998.
4 Anil Agarwal 1997, The Way of the West is Poison, *Time.*
5 Sivan Kartha 1998, Stockholm Environment Institute, Boston, *personal communication.*
6 Stockholm Environment Institute *et al*, The Effect of a Shadow Price on Carbon Emissions in the Energy Portfolio of the World Bank: A Backcasting Exercise, Boston, quoted in Sivan Kartha 1998, Stockholm Environment Institute, Boston, *personal communication.*