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## Green Energy Plays a Growing Role in the World But Has a Long Way to Go to Realize Its Valuable Potential

*This issue of Climate Alert features reports from the Washington Summit on Protection of the World's Climate, held September 4-6, 1996 in Washington, DC. Earlier coverage of the Washington Summit, including text of talks — a challenge on solar energy by Peter Goldmark, President of the Rockefeller Foundation, and a summary of the proceedings by Sir Crispin Tickell — appeared in Climate Alert September - October 1996, Volume 9, Number 5.*

### OVERVIEW

Enthusiasm for renewable energy opportunities resonated through the sessions of the September '96 Washington Summit on Protection of the World's Climate as participants considered the two billion people in the world who lack power off the grid and the many options they could be using to satisfy their needs. Public/private partnerships could speed applications of alternative sources of energy such as wind and solar. International R&D projects could show ways to save on lighting and heating, and to make machines run more efficiently. With much more aggressive development and prodding, products and processes could take advantage of economies of scale, and green energy prices would begin to fall. An opportunity exists for a grand bargain, and countries could begin to achieve their economic goals.

High return projects do exist, some governments have made forceful efforts and there is a strong move for reform, privatization and attempts to bring inflation down. For instance, the World Bank's Enterprise Housing Divestiture Project will cut heating costs 30 to 40 percent so residents can afford their utility bills. Payback will be made in two to five years.

As various nations begin to take advantage of the many opportunities, niche markets will open up in both developed and developing countries. India produces two million two-stroke electric scooters a year. A PV electric scooter is cost competitive and, produced in volume, would have a huge market. Two and three-wheel vehicles in the non-industrial world could give a large boost to transportation. Roofing shingles are already very competitive energy generators , have the near term potential to penetrate mass markets in the US and Japan and show great potential for off-grid regions.

Barriers to many alternative energy markets are institutional lending practices and lack of consumer financing. Uganda wants to go solar and can't get the money; India has a frightening power shortage and sees no way out but large scale expansion of conventional fossil fuel plants. There are huge opportunities for scaling up projects and underwriting them. Good things can happen fast, according to Nevillle Williams, a nonprofit solar developer, who channels capital where opportunities exist. The fall in prices of renewable technology has arrived just in the nick of time.

The World Bank's Global Environment Facility has a budget of $200 million a year to develop a number of programs to remove barriers to renewable energy and encourage efficiency technologies. It is looking at more energy efficient equipment for refrigeration, air conditioning, cooking and irrigation; production of home electricity, village mechanical

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United Solar Systerms Corp. Photo

**Surface Energy and Environmental Resource Center, Atlanta, GA** A portion of the roof is covered with Uni-Solar shingles which generate pollution-free electricity.

## Overview

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water-pumping, building heating and cooking, water heating and lighting. Other programs include solar thermal, advanced mass turbine, fuel cells, coal gassification.

The Summit focused on the countries which account for about 60 percent of global carbon dioxide emissions, but so far most of the industrialized nations can only boast of plans or good intentions for limiting emissions. Only Germany and the UK among the countries making presentations expect to stay within the Climate Convention's goal of reducing $CO_2$ emissions to 1990 levels by the year 2000. And the UK acknowledges its success is partly due to the government-mandated switch from coal to gas, with a little assist from a recession. China and India admit their heavy reliance on coal far into the future, and Mexico is projected to continue its heavy reliance on oil. However, the exciting advances in renewable technologies offer an effective route to cheaper energy.

Europe is more willing than the US to acknowledge that even small climate changes may have a big effect on society, and European banking and insurance industries have expressed concern. A Dutch White Paper examining an array of European scenarios foresees $CO_2$ concentrations still rising in 2050 with climate already changing. Since prices of fossil fuels are likely to remain low, renewables will constitute only a small share of energy use for decades. But a study of European economies has shown that $CO_2$ emissions can be lowered in the region without raising costs. Because of the high priority on economic growth which will lead to a significant rise in energy consumption, $CO_2$ emissions can be stabilized "only with strong conservation action and a shift in fuels. An immediate worldwide response is essential."

Looking at the rest of the world, Brazil has the greenest energy system with 60 percent of all energy consumed consisting of renewables (mostly hydropower). Mexico has the potential for solar and wind power which would be of great benefit to five percent of its population, but its heavy dependence on oil makes it unlikely to shift to renewables any time soon. Although it has cities full of cars producing local pollution, few effective steps have been taken to improve air quality. Japan, also heavily dependent on oil, may find it impossible to achieve 1990 levels of emissions even by 2030 if total consumption continues to grow at one percent a year. But major industrial producers have given high priority to limiting greenhouse gases and various measures are being considered. Russia is in third place (just behind China) as a worldwide emitter of greenhouse gases, but it sees the possibility of stabilizing emissions by 2010. Along with Germany, it looks forward to the feasibility of joint implementation.

Solar technologies elicited the most intense interest at the Summit, and had a strong boost from keynote speaker Peter Goldmark, President of the Rockefeller Foundation. Two US companies joined forces in 1995 to manufacture and sell PV (solar electric) modules, develop solar-powered electricity generation facilities and sell their energy in the world market. India was chosen for the first joint venture because of its large amount of solar radiation. Roof-top shingles are a very promising subset of this technology: in Japan, the US and in direct sales to retail or wholesale customers in the developing world. The single biggest barrier to their use is lack of information about them, according to a DOE spokesman.

Progress in green energy activities in countries around the world that account for about 50 percent of spending on renewables are described below.

## Brazil Has Water Power And Ethanol But Can They Meet Rising Needs?

Jose Goldemberg

Brazil has the greenest energy system in the world, according to Professor Jose Goldemberg of the University of Sao Paolo, with renewables accounting for 60 percent of all energy consumed in the country, a fact which has been true for many years. Energy consumption has been growing at the rate of four to five percent a year, and will probably double in about 15 years. Can the share of renewables remain at high levels for the next decade? Goldemberg answers this question with a cautious "Yes."

Brazil has poor reserves in coal and oil, but 90 percent of its electricity generation comes from hydropower. There are still good prospects for hydro in the Southeast, although the government expanded its water power sites too fast, Goldemberg said, and they are very controversial. Many of the potential sites in Amazonia are far from consumers, and building new dams leads to environmental problems. (Jeff Seabright later elaborated that inun-

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dation of hundreds of square kilometers of rain forest and extremely high transmission costs would result.)

The country also produces 200,000 barrels of ethanol a day (12 billion liters a year), replacing one half of daily gasoline consumption. It is the largest modern program for renewable energy production in the world. The program has involved government subsidies, with some initial help from the World Bank. Originally it was hoped the production costs would decline with economies of scale as output grew and technology progressed. When gasoline prices fell in the 1980s and the cost of alcohol after 1990 flattened, this did not happen. Nevertheless, ethanol production has led to a significant decrease in carbon dioxide emissions, lowering them by 15 percent. Brazil emits one percent of world energy-related $CO_2$ emissions.

The use of biomass — fuelwood and charcoal — while declining, is still an important resource, accounting for 12 percent of all energy used in the country. In a modern form, gassified wood, while not as good as natural gas, is also useful. A $30 million prototype facility under a Global Environment Facility grant, is being implemented, with General Electric turbines, and the first plant should be operating in a few years. There is a good chance the cost will decrease with economies of scale in time.

It should be noted, Goldemberg concluded, that except for hydroelectricity the renewables in Brazil have required Government intervention (with World Bank assistance) either through subsidies and/or administered prices. "The motivation for the programs has not been environmental protection but the generation of jobs and other market considerations. Market mechanisms would not have done it alone."

Ambassador Richard Benedick, Senior Fellow, World Wildlife Fund, commenting on Professor Goldemberg's remarks, pointed out that Brazil's rapidly growing population, typical of most developing countries in the South and continuing despite lowered birth rates, faces greater numbers of people in the future and rising aspirations. Mounting demand for energy lies ahead. Goldemberg rightly places emphasis on biomass, Benedick continued, because that is where Brazil's comparative advantage lies.

While the "resource geography" for other countries may be different, the long-term portents are similar. Although fossil fuel prices are currently low, it is difficult to imagine they will remain so as reserves are depleted. It is therefore of real benefit to nations to promote the rapid commercialization of renewables and energy-efficient technologies. For countries like Brazil, there are particular advantages and opportunities:

- markets are growing rapidly
- dependency can be avoided
- energy security is enhanced
- new technologies will enable countries to leap-frog over interim phases and improve long-term competitiveness
- less intensive existing power grids and entrenched utility interests will ease adoption of renewable systems
- renewables provide a profitable use of agricultural waste

Jeff Seabright, Director of the Office of Energy, Environment and Technology at US AID, questioned whether Brazil will have the resources to continue to subsidize hydropower and alcohol. Industries in the more industrialized South and elsewhere are becoming increasingly concerned about potential blackouts.But there is an enormous potential market, he pointed out, with increased demand for energy throughout the country as a result of expected considerable economic growth. .

Small-scale renewables and utility-scale wind and biomass projects could be options for the more than 20 million people in remote communities not served by electric utility lines. One third of the nation's people have no access to energy, he noted. In the Northeast, wind power generation could supply a significant portion of this demand, followed by solar, biomass, cogeneration and diesel power. Renewable energy potential represents investment opportunities totaling billions of dollars. There is also a huge opportunity for replacing diesel systems with photovoltaics and wind.

According to Seabright, Brazil will need to invest more than $4.5 billion per year in new energy generation, and an equivalent amount in transmission and distribution. The enormous technical potential can be translated into market incentives; the financial windows are open. A $600 billion energy efficiency market will grow fivefold in the next 20 years, Seabright said, as power needs grow.

For years, companies and individuals deferred investments in energy efficiency because they were uneconomic or too risky in Brazil's inflationary economy. With inflation down, businesses and individuals will address a backlog of investments that includes energy-efficient equipment. But "many potential funding mechanisms remain largely untapped due to the lack of knowledge on the part of local producers, the project executors, and the rural extension agencies of the specific opportunities. Furthermore, the local credit agencies lack the technical capability to evaluate renewable energy project proposals," a need which could be fulfilled by consultants or through training.

US AID has a major energy program in Brazil, concentrating on:

- Energy efficiency, including working with the World Bank on a project which is the single largest World Bank grant for this activity
- Renewables, with pre-investment cost-sharing
- Private power
- Training

Despite the large market potential and favorable market conditions, it is difficult to gauge the size of Brazil's

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## Brazil

*(Continued from page 3)*

green energy financing market. It is a Catch-22 situation: those willing to finance a project need a demonstration of the demand for renewable energy and energy efficiency before they make a commitment; but a demonstration requires an already financed project.

## China Faces Many Complexities Besides Heavy Reliance on Coal

As almost everyone in the atmospheric community knows, the principal energy source for India and China is coal. At present 75 percent of China's energy comes from coal.

According to the assumptions for a baseline Chinese scenario presented by Professor Wu Zhongxin of Tsinghua University, the "primary energy supply will continue to depend largely on the exploitation and utilization of domestic energy resources," meaning coal. Importation of a large amount of natural gas and oil "will be considered as national strategy" in the long term. The country plans to speed up its exploitation of hydropower, and is in the process of building immense dams, such as the Three Gorges Dam on the Yangtze River. Nuclear power is expected to play an important role in easing pressure on fossil fuel supplies, especially in the coastal areas where economic growth is high and energy is short. A smaller role is envisioned for renewable fuels: biomass, wind, solar, waste gassification as a supplementary source for "rural and remote areas."

China's population, at 1.14 billion in 1990, is estimated to grow to 1.3 billion by 2000, and will eventually level off around 2050. China's economy has been growing at the impressive rate of 9 - 10 percent in the early 90s and is expected to slow somewhat in the years 2000 - 2010 to 7 to 8 percent.

The scenario for $CO_2$ emissions resulting from vigorous economic activity as presented by Prof. Wu starts with 590 million tons of carbon issued into the atmosphere in 1990, more than doubles to 1324 Mt-c in the year 2010 and rises to 1853 in 2030. (Emissions are currently running at 10.5 percent of the world total.)

Despite its projected heavy reliance on coal, China accords a high priority in its energy development policy to technologies for mitigating greenhouse gas emissions and has plans to implement a national program.

**Technology** priorities include:

- more energy efficiency and conservation
- improved demand side management at the local village level
- changes in the transportation sector

Important mitigation technologies in the **industrial** sector involve:

- the upgrading of industrial processes and replacing small boilers with larger units
- improving electric furnaces, and electric motors, including speed adjustment

**Residential and commercial** sector changes include:

- substituting city gas for cooking fuel,
- installing district space heating
- promoting energy saving in buildings, lighting and electric appliances

**Transportation** sector improvements include:

- upgrading of vehicle performance
- changes in truck tonnage

Energy savings from such actions are considerable, estimated to amount to 12 percent for boilers and 25 percent for electric motors and lighting.

Other gains have been made and will continue in harnessing methane emissions from coal mines to use as domestic fuel, as raw material for industry and for power generation.

Most greenhouse gas mitigation policies have been included in China's energy development plans, and the rate of emissions in relation to energy production is expected to decline dramatically in the future. However, because of the growth of the population, the economy and the accompanying energy consumption rates, greenhouse gas emissions will "inevitably increase by [a] large amount," Wu stated.

China is the second largest power user in the world after the US, according to Susan McDade of UNDP, and consumes three times the amount of energy as India and five times as much as Brazil. For now, with its consumption rate of one ton of carbon equivalent per capita in 1990, its per capita emissions are small.

Only one-third of China's household energy — which itself has very low thermal efficiency — is generated by power plants, adding to the complexity of the situation. In general a very large proportion of power generation comes from very small power stations. However, the economy is so buoyant that it is able to meet demand despite its low efficiency.

The challenge, McDade said, is to act now: to renovate capital stock and at the same time, in public policy, to change operations from the public to the private sector. Township and village enterprises are unregulated and account for 30 percent of the total value added to the GNP. They are plugged into the market economy and export-oriented. These enterprises are the main source of new employment and the main reason emigration rates are not larger.

Many energy efficiency processes are not possible because of tight credit, and it is here that Western banks and other lending organizations could have a major influence. China lacks experience in renewable energy and thus offers a large opportunity for partnership with other countries.

China is by far the most important country with which to form a green energy partnership, said Bill Nitze, assistant administrator for international activities at US EPA. The country has the highest sustained rate of growth and ambitious goals, but by 2010 it will have doubled its greenhouse gas emissions from the energy sector. He noted that efficiency has

improved but China will fall short of achieving climate convention goals.

He suggested according special status to improving efficiency as a joint project on sustainable development in partnership with China. EPA can set up with Beijing an energy efficiency center covering Green Lights, energy service companies, industrial end use efficiency in building materials, in iron and steel. Other options include a feasibility study on coal gassification, development of energy efficient refrigerators, coal bed methane fluid process, research on livestock ruminant emissions, a joint program on mobile sources of emissions and a look at non-oil-based fuel options for autos (considering that by 2010 it is conservatively estimated that China will have two million cars).

These proposals are just a modest beginning, said Nitze, and have omitted research in such areas as health. Fundamental changes in the social structure of China are needed, Nitze stated. Even with the optimistic assumptions of Professor Wu, he noted, we will see a doubling to a quadrupling of emissions or even worse. "We cannot permit this to happen."

Climate change brings a number of threats to China including the possibility of sea level rise inundating an area of China the size of Portugal, possibly displacing 70 million people, McDade commented. Sir Crispin Tickell added that there are drastic changes in rainfall patterns in China, in addition to the fact that there is a general shortage of both water and heat in the country. There are many jokers in the pack, he suggested.

## EUROPE

### *Group Declares Carbon Emissions Can Be Lower Without Raising Costs*

While many macro studies have concluded that reducing $CO_2$ emissions would "inherently lead to economic losses, " a review of several dozen studies by an international research group led by Florentin Krause shows industrialized countries could "achieve major reductions in carbon emissions at zero or negative net cost —even before considering the benefit of avoided damages from global climate change." Krause is one of the lead authors of the UN IPCC economic assessment of climate change mitigation costs and is head of a private group conducting international studies.

Florentin Krause

In a paper entitled, *Energy Policy in the Greenhouse*, Krause and his co-authors assert the macro studies they reviewed make two major flawed assumptions: 1) that current markets for energy efficiency and other carbon-reducing energy technologies are already operating at optimal economic efficiency, and 2) that current patterns of taxation of capital, labor, pollution and energy are already economically efficient. When these assumptions are replaced by more realistic ones, and a societal view taken, predicted economic losses turn into opportunities for economic gains, the authors argue.

Competition between energy supplies and efficiency investments are hampered by the failure of the market and other economic efficiency problems. Many of these can be improved by what the authors call market transformation policies:

- financial incentives for manufacturers to make more energy efficient products ("golden carrots")
- utility payments to buyers of more energy efficient equipment and buildings (DSM - demand side management)
- government rebates for efficient vehicles paid for by fees on inefficient ones (feebates)
- stringent building, appliance and auto efficiency standards ("sticks")

Because cost/benefit tested programs using these instruments save energy at a profit, emissions are reduced without incurring a loss.

These gains can be augmented by tax shift policies and subsidy reforms. Just by removing subsidies from fossil fuels, carbon emissions would be reduced. When imposing an energy tax or a permit auction system, gains can offset the costs to the economy from higher energy prices, the authors noted. When compared to a policy of doing nothing, these market transformation and tax reform policies could yield a large potential for decreasing emissions at no cost or even at a profit. If they were implemented in the near-to-medium term, sizable benefits would result during the transition to a low carbon future. The sooner the transition is begun, the greater the benefits to the economy and the climate.

Macro modeling (top-down) studies on which most governments have relied to date systematically fail to capture key "no regrets" policy options. Top-down assessments model either a cap on emissions linked to tradable emission rights, or an energy or carbon tax. They focus on the interaction between the energy sector and the economy at large. Calculations of the policy impact of actions are based on past relationships between energy consumption and economic output. Policy cost calculations are based on changes in the GDP.

Because bottom-up assessments identify pervasive market failures in energy and especially energy efficiency markets, they find market transformation policies based on incentives and regulations to be economically more efficient.

But most bottom-up studies still overestimate costs because they do not account for policy feedbacks on fuel and technology prices, or for secondary air pollution benefits. They assume that market transformation policies will succeed in shifting all annual investments in energy-consuming devices toward better efficiency, somewhat underestimating the time needed to achieve a certain level of emissions reductions.

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## Group

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The conclusion of Krause and colleagues is as follows:

- the OECD countries could cut carbon emissions by 50 percent without posing an economic burden, and most likely at a benefit
- as an intermediate goal, a reduction in emissions of 20 percent which was first recommended in the Toronto Conference in 1988 could be achieved in the next 20 years or so, again at a net economic benefit

**Policy Requirements**

Policymakers can focus first on the most cost-effective "no regrets" measures and on proven designs for regulatory and incentive programs. If a portion of the revenues from an energy tax is used to finance such incentive programs, energy taxes could be kept much lower than suggested in most top-down studies while still inducing large emission reductions.

**Global Prospects**

If R&D successes are transferred to developing countries and incorporated there, emission reductions of 50 percent or more on a global basis should be achievable without hampering the economic goals of the developing countries and again with no net mitigation cost or with a possible surplus.

**Future Policy Research**

Because most macroeconomic modeling studies fail to capture the potential economic benefits from no-regrets emissions reduction policies, their usefulness for guiding climate policy is questionable. State of the art modeling approaches involve the linking of top-down macroeconimic models with detailed bottom-up analyses of market transformation options and energy efficiency potentials. Without such linkage, economic modeling merely reproduces historic patterns of investment shaped by economically inefficient, faulty market frameworks. "Therefore, a bottom-up analysis of optimal energy services, efficiency levels, and policies is indispensable for a credible greenhouse policy cost assessment."

## *Germany Adopts Home Measures And Tests Joint Implementation*

Otto Graf

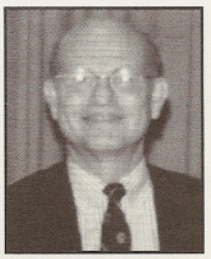
Domestically, Germany has taken several measures to reduce $CO_2$ emissions:

- Electricity rates were modified to ensure greater fairness among different economic sectors and to strengthen incentives to save.
- The government has set minimum payment levels electric companies must pay for energy generated from renewables.
- It has increased the tax on oil to encourage use of public transportation.
- It has changed the tax on autos from one based on engine displacement to a new one based on emission levels.
- It has approved a thermal insulation ordinance, reducing heating requirements for new buildings by an average of 30 percent.
- It has undertaken technical research on refinement of power plants, turbines and renewable energy.

Internationally, at the Berlin Climate Conference Germany sought an agreement that would bind signatories to specific emissions reduction goals within a clear time limit. The Berlin Mandate failed to include this measure, but it will be taken up at the COP3 meeting in Kyoto in 1997.

Germany also "pays particular attention" to Activities Implemented Jointly, according to Otto Graf, first secretary for Science, Technology and the Environment of the German Embassy. A pilot phase has been set up to test the effectiveness of this instrument designed to reduce emission goals at the lowest possible cost.

## *Dutch White Paper Urges ImmediateWorldwide Action*



Bert Metz

Fossil fuel prices may remain low, and renewables will have only a small share of energy use for decades in the Netherlands and Europe, according to a Third White Paper on energy policy prepared by the Dutch government. Only in those scenarios that are optimistic about technology and that take account of ecological considerations will $CO_2$ emissions be reduced. All scenarios see $CO_2$ concentrations in the atmosphere still rising in 2050, with the climate already changing. Therefore, immediate worldwide response is essential, and Dutch energy policy must be ambitious and realistic, said Bert Metz, deputy director for Air and Energy of the Netherlands Ministry of the Environment.

Describing European trends, Dr. Metz said the high political priority placed on economic growth will lead to a significant rise in energy consumption, particularly in transportation and electricity. Imports of Russian and Middle East gas and oil are likely to grow, and nuclear energy will come under increasing pressure. The possibility of stabilizing $CO_2$ emissions will be achieved only with strong conservation actions and a shift in fuels.

In the decade from 2010 to 2020, the Dutch economy will be sensitive to price shocks as political vulnerabilities increase. By the years 2020 to 2050, climate change may become a more serious risk, price and political uncertainties may be even more critical and renewable energy will be essential, according to the Third White Paper. With climate change exerting ever more urgency, immediate action is needed today, Metz said.

In 2010, the share of biomass energy as a percent of total com-

mercial energy use will amount to around five percent for the European Union use as a whole in a so-called conventional wisdom scenario, with countries like Denmark, Ireland and Portugal at around 10 percent or more and Finland at 15 percent. The top three European countries with technical wind potential are UK (highest), followed by Spain and France. A figure of 12 percent has been suggested by the European Commission.

The Dutch recently decided to have renewables amount to 10 percent of total energy use by 2020. The biggest contributor to this growth will be biomass and waste, more than doubling over their year 2000 share. Heat pumps will also play an increasingly important role, and the use of wind energy in that period is expected to almost triple. Renewable energy will be competing, however, with low-cost, fossil-fuel-based electricity generation. Least expensive energy-generating options in 2020 are expected to be natural gas/ combined cycle systems; land-based wind systems may be comparable. Photovoltaic systems (although their cost is expected to fall) and sea-based wind energy are predicted to be in the high cost range.

To accelerate the use of renewables, the Netherlands is adopting the following measures:

- an energy levy on end users, using the revenues for subsidies on renewables
- a fiscally neutral energy tax, exempting renewables
- reduced value added taxes on renewable electricity and equipment
- establishment of a green electricity market (voluntary acceptance by consumers of a premium to pay for all renewable electric)
- guarantees for prices paid for electricity sold back into the grid
- subsidies for research, development and demonstration

To strengthen the supply side infrastructure for renewables the Netherlands plans a wind energy export platform and an action plan for solar export.

## *UK Panel Looks at Ways Financial Community Can Boost Solar Energy*

"Britain will meet the Climate Convention of reducing greenhouse gas emissions to 1990 levels by 2000," Sir Crispin Tickell asserted. Sir Crispin is Convenor of the British Government Panel on Sustainable Development. He attributed this success to the switch from coal to gas and "to some extent the current economic recession." For the future, the government is committed to increasing petrol prices on a continuing basis by five percent more than inflation.

Europeans are much more likely than Americans to acknowledge that even small climate changes may have a very big effect on society, said Jeremy Leggett, Director of the Oxford Solar Investment Summit. The fear that companies may not be able to honor their insurance contracts has captured the attention not only of the insurance industry in Europe but also the banking community. More than 60 insurance companies signed an insurance commitment in November 1995, stating, "We will seek to consider environmental considerations in our asset management."

One banker has remarked, "We must recognize the financial markets will be affected by climate change." And another has said, "There is substantial risk. It does not appear risks are being adequately discounted in the market."

The Chartered Insurance Institute has laid down a challenge, said Leggett: All investment managers should modify their investment accounts to make allowance for global warming. Clearly there are enormous opportunities to finance the various alternative energy systems. In strategic planning the focus should be on solar photovoltaics, and there is a role financial institutions can play in solar markets. Are insurance companies changing their investment pattern? John Topping asked. "The jury is still out," Leggett replied.

In the UK, according to Leggett, there is only one solar PV building, and the country has a much worse record in spending on solar energy then either the US or Japan. However, several major European institutions have expressed interest in a collaborative market-building exercise in solar photovoltaics.

We should focus on marketing to change energy use; price will not solve the problem, said David Freeman, former general manager of the Sacramento Municipal Utility district and former chairman of the Tennessee Valley Authority. The world doesn't know that the cost of photovoltaic power has declined faster than the price of coal has fallen, he said. The march of technology is taking place but the public is still oblivious. However, if you put a solar panel on a home to run four light bulbs, a black and white TV, a radio cassette, or to help the family to read, you will have much more success, he said. We are not going to go much further on government support, but there is an opportunity in the private market, and we should persuade the oil companies to go into the solar business for their survival.

## India Looks to GasAnd Renewables toReduce Use of Coal

Like China, India depends heavily on coal for energy. With coal as the primary source of industrial and electricity generation, it is also the main source of greenhouse gas emissions. However, Nandita Mongia, deputy coordi-

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## India

*(Continued from page 7)*

Nandita Mongia

nator of the Global Environment Facility for Asia and Pacific of the UNDP, stated that there is significant potential for reducing emissions in the country and saving money while doing so. There are mitigation options for the electric power and forest sectors, and carbon emissions may profitably be avoided through both efficiency improvement and fuel switching.

A switch from coal to natural gas is one option. If it is not feasible, a switch to a renewable such as biomass is a good possibility. Among renewable options, hydropower has tremendous potential but has not been adequately tapped. Possibilities for savings from reduction of $CO_2$ emissions by the year 2005 are greatest in the aluminum and steel industries, followed by household lighting and wind power generation. Scenarios for the years 2005 and 2025 show efficiency, fuel switching and renewables make fairly similar contributions.

Professor Saifur Rahman was skeptical; he felt there are not data to back up the conclusions. Rahman recently moved from Virginia Tech University to the National Science Foundation to head its energy programs. Unless the industries involved are brought in, he feels there is a poor chance for success of reducing emissions. There is no visible support from government on the policy level. Talks with shop owners, public servants, students and others reveal little interest in climate change.

Karan Capoor of the Environmental Defense Fund remarked that politicians respond to votes and money. In India, the constituents are the people plus the steel and paper industries. Industry needs up-front capital; to fund energy projects it needs to get the financial sector to see where money can be made. The most substantial financial support must come from the private sector. A major obstacle, he said, is lack of agreement on incremental cost of financing green energy projects.

## Japan Has Many Options; Photovoltaics Is a Significant One

As in most other countries, Japan's emissions have been increasing in the 90s, in Japan's case from 320 million tons of Carbon in 1990 to 343 MtC in 1994, reports Shuzo Nishioka, Director of the Global Environmental Research Division of Japan's Environment Agency. The target for the year 2000 is reduction to 330 MtC. A committee searching mid-term technological possibilities issued a report in May 1996 suggesting reduction of $CO_2$ emissions by 6.6 MtC by the year 2000. This could be done by picking up promising technologies in the following areas:

| | |
|---|---|
| Energy conversion | 1.80 |
| Industry | 1.97 |
| Residential | 1.43 |
| Commercial | 0.49 |
| Transportation | 0.92 |
| TOTAL | 6.61 |

Some examples of the technologies listed were:

advanced combined cycle enginves: gas turbines plus boiler plus steam turbines

ultra-supercritical steam cycle; pressurized fluidized bed combined cycle

repowering of nuclear plants

repowering of private thermal power generation

industrial waste power generation

steam jet gas turbine or gas turbine and waste power generation

compact fluorescent lamps

improved heat pump and air conditioner systems

lean-burn gasoline engines

introduction of CNG and hybrid vehicles

Japan has already taken some steps:

1) pledging to improve energy efficiency in automobiles nine percent by the year 2000

2) strengthening standards and subsidies under the Energy Conservation Act

3) exercising local government initiatives, such as traffic control in Kamakura City

4) a voluntary program led by Keidanren; approval of 11 Joint Implementation projects

Akira Kinoshita of a Tokyo-based engineering research firm reports that Japan has achieved the highest efficiency intensity in the world. In addition, the nation has diversified its energy supplies to include nuclear, gas and coal, but dependence on oil remains at 60 percent. The target for oil's share in the year 2000 is 53 percent. Given this reliance on fossil fuels and noting that the public grows ever more wary of nuclear energy, it is going to be very difficult to reach the goal of stabilizing $CO_2$ emissions at 1990 levels on a per capita basis by 2000, Mr. Kinoshita argues.

If total final consumption continues to grow at one percent per year and, assuming 100 gigawatts of nuclear capacity and two percent growth of new energy inputs, it will be impossible to achieve the emission target even by 2030, he says. (Additionally, non-OECD Asian developing countries are expected to increase their demand share to 33 percent compared to 24 percent today, based on the assumption that it will be possible to radically reduce energy intensity. Since energy intensity has been rising rather than falling and considering the lack of energy institutional capacity, reaching the target will be a very difficult task.)

For Japan to reach its 2030 target, it would have to reduce growth in energy requirements from one percent per year to 0.5 percent . Various measures could be used:

- better housing insulation
- stricter standards for appliances
- more use of public transport
- more efficient commodity flows

• consolidated urban circuits
• improved fuel efficiency for vehicles
• accelerated demand system management

The government could strengthen incentives for new energy so that it could grow from one percent of the total energy mix to two percent.

The most significant measure would be support of photovoltaics. Other steps would include:

• encouragement of continued purchase of new energy by utilities
• government support for municipal wind energy projects at 5 - 10 sites
• introduction of 200 clean energy-based cars in specific areas. (The share of government and municipal cars using clean fuel will be targeted at 10 percent.)
• government support for cogeneration facilities from waste and other unused sources
• encouragement of use of heat pumps
• fuel cell use by industries and municipalities

Kinoshita advocates a "more holistic transformation in urban and traffic systems" taking external costs into full account. He also urges optimum recycling of water, multi-functional reservoirs, and effective use of rainfall. Greening could greatly reduce urban temperature; if urban green coverage could reach 50 percent, maximum city temperatures could be reduced 4 - 5 ° C. Roof greening is estimated to save energy consumption in office buildings by 16 percent and 31 percent in collective housing.

Kinoshita describes a "total integrated management of energy and urban systems," based on an information system consisting of both hardware and software to build a chain or network for production, conversion, transport, final consumption, waste disposal and recycling. The information systems will integrate diversified use patterns in industrial, transportation, commercial and residential sectors with diversified large and small scale supply sources.

Believing cost effective use of energy should be pursued on a global scale, he advises planning in developing countries to avoid the failures made by the industrialized countries. He recommends:

• distributing model package projects to developing countries as a link in the chain of Joint Implementation
• development of planning models to support an energy system integrated with urban planning
• establishment of international facilities to bring together planning experts

Roger Gale, President of the Washington International Energy Planning Group, pointed out that in Japan major industrial producers as well as government have accorded high priority to efforts to limit greenhouse emissions.

## Mexico Suffering Severe Strain; Little Progress in Green Energy Expected

Luis Manuel Guerra

Renewables make up seven percent of energy use in Mexico, and their benefits could be expanded to people not connected to the electricity grid, Manuel Guerra reported. Guerra is Director of the Instituto Autonomo de Investigaciones Ecologicas (INAINE), an environmental organization. He estimated five percent of the population could be connected to the renewables, solar and wind power, but heavy dependence on oil, unlike the situation in India and Brazil, will probably not change, and more rational use of energy is not foreseen. The only expected progress is an increased use of natural gas. Nuclear energy usage — at one percent — is not expected to grow, even though opposition is declining.

Mexico is in a turmoil and changing rapidly. The debt crisis which began in 1982 showed that a change in structure is required, but this is not properly understood by the nation, according to Guerra. Dependence on oil has shaped the economy of the country, but oil revenues are now far below what they were in 1982. A year and a half ago there was a tragic collapse in individual income. And while gross domestic product fell seven percent, energy consumption did not slow.

The GNP reflects recurrent crises, partly as a result of heavy reliance on oil revenues, a fact which has not been faced in a proper manner. Freeing up of government ownership in the mid-80s under GATT led to the privatization of companies and the growth in maquilladoros, which last year were the only sector of the national economy expanding.

Under NAFTA the country has become more outward looking, except for the oil industry which was excluded. NAFTA does not address energy issues specifically although it did grant US and Canadian companies greater access to certain portions of the energy market. It also pressures Pemex, the national oil corporation, to pay greater attention to environmental concerns, particularly near the US border.

\ There is some shift to more environmentally friendly power uses, mainly a shift to wind energy in the Isthmus region. But Guerra said the prospects for an intellectual shift to renewables is not there, although there is certainly the potential for solar and wind power.

Can the social structure withstand all the changes that the country is undergoing? In 1986-88, inflation was 100 percent. Later it fell to eight percent and since 1994 inflation has abated more. But too much dependence on oil and on short-term capital is appearing again.

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## Mexico

*(Continued from page 9)*

Guerra lamented the erratic coucade and the lack of democracy. He said he does not know if Mexico can remain stable in the next two or three years. The strain is enormous, with a huge in-crease in unemployment. Anthony Dixon, vice president of Salomon Brothers, Inc., agreed with Guerra's perspective, saying he wished the outlook were more optimistic.

Dixon described a financing technique, securitization, the packaging and sale of a diverse pool of loans, a sort of collaterized bond, which could allow renewable energy markets to grow more quickly. The bonds are sold to trusts and pension funds with a AAA rating. A portion of the interest margin provides credit protection to investments; another benefit is strict oversight of the investor. Securitization could have a significant effect, enough perhaps to justify subsidies. It is an accepted global financing technique which has been used in utility rebates, solar house financing and capital markets financing.

The securitization market in Mexico is large and growing, and securitization in the US is often the main source of financing. Under this procedure, photovoltaics for home owners could be sold on credit with a 3-year repayment of the loan. But so far banks are reluctant to lend, despite the experience with Grameen and other credit arrangements in a number of countries. There could also be: securitization of a utility conservation tax, already tried by a Washington State utility in the first transaction of this type, and securitization of leases on wind power equipment as well as on solar and PV plants.

The obstacles to such a scheme, for instance in the sale of household solar power systems in Mexico, are high transaction costs, especially first transactions in new markets. But it is an appropriate and potentially significant contribution, especially in the Mexican utility sector.

Jaime Millan, principal economist for the environment division of the Inter-American Development Bank, discussed opportunities for natural gas as a bridge to the future when renewables may be more feasible in Mexico. Bolivia is selling natural gas to Brazil, and Peru and Ecuador are both drilling for gas, Venezuela has tremendous resources, and Colombia is a sea of natural gas. No other form of energy can compete with it on price.

How backward is Mexico in this area? Small-scale renewables do not play a significant role in climate change, Millan pointed out. They make sense only when there is no access to the grid.

However, transportation in the region is facing a tremendous problem where mega cities are full of cars producing local pollution. Very few people are talking about this severe problem, he noted.

## Russia Hopes to Stabilize CO2 Emissions by 2010

Vladimir Berdin

The Russian Federation is in second place as an emitter of greenhouse gases with its share of total world emissions at 11 percent, stated Vladimir Kh. Berdin, Chief of the Climate Change Division of Russian's Hydrometeorology and Environmental Monitoring Service. (More recent data put China slightly ahead of Russia. The U.S. share stands at 23 percent.) However, if Russia's shopes and plans are followed, the country sees the possibility of stabilizing emissions at 1990 levels by 2010.

Russia's energy sector is a major source of GHG emissions: up to 98 percent of $CO_2$ and more than 50 percent of methane and $N_2O$. Many strategies to limit emissions, therefore, involve the energy sector.

A Russian federal energy power policy looks forward to reducing emissions and increasing energy efficiency by using new technologies in fuel and power resources, both in production and consumption.

Currently, this strategy estimates that 40 - 45 percent of potential energy resources are consumed inefficiently, one-third of them in the fuel and energy sector. Greatest losses are in electropower and heating supply, next in industry, and the rest in the municipal sector and in agriculture and transport. Much greater use of natural gas is suggested to improve this record, with gas's share targeted to rise from 41 percent in 1990 to 48 - 53 percent by 2010. Other measures include wider use of hydropower (a "traditional" energy supplier in the Russian Federation) and "non-traditional" renewable energy sources such as solar, wind, geothermal and biomass. Updating power station technologies — gas-turbine and steam-gas equipment — would also be used, to yield potential energy savings of 30 to 100 million tons of carbon equivalent a year by 2000, and 220 - 360 mtce/yr by 2010. Beyond these structural changes, legislative, financial and other measures will be employed to save 50 - 80 Mtce/yr by the turn of the century and 80 - 110 by the end of the next decade.

Energy-saving strategies are expected to reduce emissions 45 - 100 million tons of carbon annually by the year 2000 and 168 - 264 by 2010, according to estimates of the Russian Institute of Global Climate and Ecology. Two scenarios have been used to calculate $C0_2$ emissions by 2010. One, under the First National Communication, shows that reducing GHG emissions 20 percent, partly as a result of the country's economic depression from 1991 - 1995 plus the increasing share of gas in the energy balance and special measures for reducing methane losses, will stabilize emissions in the future.

Another scenario, the fruit of research carried out both domestically and under the US-Russian Country Study Program, takes into account expected changes in GDP, with the share of goods production falling from 61 to 41 percent and the service share rising from 33 to 52 percent by 1995. Natural gas consumption in this scenario is expected to increase to nearly 50 percent of primary energy consumption, and oil and coal to fall to 20 and 12 percent. Per capita GHG emissions will decline by 22 percent between 1990 and 1995. As a result of all these calculations, energy consumption and $CO_2$ emissions are predicted not to exceed the levels of 1990.

Two US-Russian joint implementation projects have already been adopted: one in the forestry sector and another involving gas pipeline leak stoppage. Two more are under consideration, one for district heating and another for forest planning/restoration.

Robert Dixon who directs the US Country Studies Program pointed out that Russia has given a high priority to its country study, assigning to the project leading experts in the climate and energy fields. A third panel member, Ronald Muller, who heads REM Capital Corporation, described his experiences in a joint venture to sterilize logs and eliminate the need for methyl bromide. To succeed in small and mid-size renewable energy projects, Muller said, it helps to overcome an "expertise gap" resulting from the lack of integration of "developers" (those with ideas, management resources and entrepreneurial desire) and "financiers" (those agents — funds, banks, multilaterials, bilateral sources, etc. — possessing financial resources to "make things happen"). The expertise of risk capital should be integrated with the expertise of management and other technical skill to overcome a critical bottleneck in developing these smaller projects.

## US Firm Backs Many Forms of Solar Energy In World Market

Robert C. Kelly

Driven by improvements in technology, increasing demands for energy and concern about global warming, we are in the midst of an energy revolution that will unfold in the next 20 years, declared Robert C. Kelly, chief executive officer of a joint venture, Amoco/Enron Solar Power Development. Amoco and Enron joined forces in 1995 to manufacture and sell photovoltaic (solar electric) modules, to develop solar-powered electric generation facilities and to sell the energy produced by the facilities in the world market.

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## US Firm

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Solar power generation costs are actually declining faster than wind although wind is still cheaper, Kelly reported. A facility will produce thin film from steel, sealed glass and silicon gases (silane). It will be used to produce energy in a big series of arrays on a solar farm in Rajasthan, India under a 25-year contract with Amoco/Enron. India was chosen because of the immense amount of solar radiation available. It is hoped that economies of scale in this facility will allow solar technology to compete with fossil fuels in the bulk electric market, Kelly said. Thin-film module efficiencies increased from three percent in 1986 to nearly nine percent eight years later.

Beyond this process is a huge market for solar roof-top shingles. In the market for new residential buildings, the shingles are comparable in cost to current sources of energy and can compete effectively on the basis of conventional utility rates. In developed economies the shingles can be marketed to wholesale customers through electric power marketing organizations and can compete in retail markets now with solar roof top panels. In Japan, they are very competitive in the re-roofing market because power costs are so high there. In developing economies they can be sold directly to retail or wholesale customers.

Grid-connected solar power is in increasing demand, Kelly pointed out, and this resource will play a significantly increasing role in the global renewable energy market. Solar farms are an excellent option for utilities or countries with a high demand for power and limited options for fuel to produce it. Rooftops provide an excellent grid-connected market in areas with high retail rates and high transmission and distribution costs. Solar technology has unlimited potential and is a key in the drive for sustainable development, Kelly stated.

If there is a 3-year return on investment, why don't people act more rationally and put their money into this technology? asked John Noel, a founder of the Tennessee Valley Energy Reform Coalition and also a real estate investor. The answer may be that the energy producers of the Tennessee Valley Authority speak with a louder voice to politicians, he was told, and fear of an untried domain moves people more than knowledge.

The single biggest barrier is lack of information, said Joseph Romm, Energy Efficiency and Renewable Energy, Department of Energy. It took many years even to convince the DOE of the value of the technology, but the department is now taking a more friendly approach and has had successes with such technologies as a refrigerator compressor and an electronic ballast.

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