16

EDUCATION, SCIENCE & TECHNOLOGY

Technology Partnerships for Renewables: Key to Energy Security

ASIA-EUROPE ENVIRONMENT FORUM

3rd Roundtable

Stockholm, Sweden, 26-28 August 2004

EDITED BY
BERTRAND FORT & FRANCIS X. JOHNSON

IGES

SEI STOCKHOLM ENVIRONMENT INSTITUTE

ASIA-EUROPE FOUNDATION

ASIA-EUROPE ENVIRONMENT FORUM

Technology Partnerships for Renewables: Key to Energy Security

3rd Roundtable

Stockholm, Sweden, 26-28 August 2004

UNEP

IGES

SEI STOCKHOLM ENVIRONMENT INSTITUTE

ASIA-EUROPE FOUNDATION

Published by

Asia-Europe Foundation
and
Institute for Global Environmental Strategies

Designed and Printed by
Publishing Interface PteLtd

ISBN: 981-05-4099-X

"Technology Partnerships for Renewables: Key to Energy Security"

CONTENTS

CHAPTER I

Summary and Synthesis of Discussion

CHAPTER II

Technology: What Kind of Energy is Sustainable for Various Consumption Needs?

CHAPTER III

From an Idea to a Market: Sustaining the Technology Innovation Process

CHAPTER IV

Asia-Europe Platform: From Technology Transfer to Technology Exchange

....

ACKNOWLEDGMENTS

The "Asia-Europe Environment Forum Asia-Europe 3rd Roundtable: Techonology Partnerships for Renewables: Key to Energy Security" was held in Stockholm, Sweden, on 26-28 August 2004. In the tradition of the first two roundtables under this series, the proceedings and papers of this meeting have been published in this volume.

The co-organisers, namely, the Asia-Europe Foundation (ASEF), the Institute for Global Environmental Strategies (IGES), the United Nations Environment Programme (UNEP), and the host for this roundtable, the Stockholm Environment Institute (SEI), would like to thank the following people who have contributed toward making the meeting and this publication a success.

Firstly, we would like to thank the roundtable participants for sharing their valuable thoughts and the fruitful exchange of ideas during the conference. In particular, a big thank you to all the contributing authors for their dedication and hard work, without which, this publication would have not been possible.

We would also like to thank the editors, Mr. Bertrand Fort (ASEF) and Mr. Francis X. Johnson (SEI) for their hard work in putting together this volume.

We sincerely thank the members of the Asia-Europe Environment Forum Steering Committee for their valuable input into the conceptualisation of the roundtable and identification of participants: Ms. Ella Antonio of Earth Council; Mr. Philippe Bergeron of the ASEAN Network for CDM Investment Promotion (ACE); Mr. Raman Letchumanan of the Association of Southeast Asian Nations (ASEAN) Secretariat; Mr. Axel Michaelowa of the Hamburg

Institute of International Economics (HWWA); Mr. Daniele Ponzi of the Asian Development Bank (ADB) and Mr. David Stanners of the European Environment Agency (EEA).

We are particularly grateful for the efficient work of Ms. Sol Iglesias (ASEF), Ms. Ira Martina Drupady (ASEF), Prof. Roger Kasperson (former Executive Director, SEI), Mr. Göran Nilsson (SEI), Ms. Helena Forslund (SEI) and Mr. Yong Chen (SEI) in organising this roundtable. Mr. Yong, Ms. Iglesias and Ms. Ira have also contributed greatly in the editing process of this book.

Gratitude goes to the Swedish Institute and its former Director General, Mr. Erland Ringborg, for supporting this event through sponsoring the participation of 20 Asian scientists to attend both the roundtable as well as the concurrently-held EuroScience Open Forum 2004.

A very special thanks also goes out to Mr. David Fouquet (Asia-Europe Project) and Dr. Dörte Fouquet (Kuhbier Law Firm) for their excellent ideas and useful advice during the preparation of this roundtable.

We also appreciate the kind assistance and advice of Ambassador Viveka Bohn and Mr. Tony Clark of the Swedish Ministry of Sustainable Development in co-ordinating communications between the co-organisers and the ministry during the conference.

We would also like to thank Mr. Yves Dussart of the Directorate General Environment, European Commission for his valuable assistance during the final stages of production of this volume.

Finally, the co-organisers would like to take this opportunity to warmly welcome the Indonesian office of the Hanns Seidel Foundation (HSF) which is taking the lead from the Singaporean office of HSF as a co-organiser of the forum. We also welcome Mr. Philippe Bergeron (ACE Jakarta), Mr. Christian Hegemer (HSF-Indonesia), Christer Holtsberg (Swedish Environmental Secretariat in Asia) and Ismid Hadad (KEHATI Indonesian Biodiversity Foundation) as new members of the steering committee.

Wonil Cho
Executive Director
ASIA-EUROPE FOUNDATION (ASEF)

Johan Röckstrom
Executive Director
STOCKHOLM ENVIRONMENT INSTITUTE (SEI)
SWEDEN

Hideyuki Mori
Director
ASIA-PACIFIC FORUM ON ENVIRONMENT AND DEVELOPMENT (APFED) SECRETARIAT

and

Project Leader
INSITUTE FOR GLOBAL ENVIRONMENTAL STRATEGIES (IGES)
JAPAN

Surendra Shrestha
Regional Director
UNITED NATIONS ENVIRONMENT PROGRAMME
REGIONAL OFFICE FOR ASIA AND THE PACIFIC (UNEP-ROAP)

Introductory Messages

....

MESSAGE FROM THE MINISTRY OF SUSTAINABLE DEVELOPMENT, SWEDEN

Mr Krister Nilsson
State Secretary
MINISTRY OF SUSTAINABLE DEVELOPMENT, SWEDEN

In 1972, world leaders gathered in Stockholm under the auspices of the United Nations for the first world conference on the human environment, which came to be known as the Stockholm Conference. This first "Earth Summit" marked the entrance of environmental issues onto the world stage and ever since, the city of Stockholm has acted as a meeting place for dialogue, discussions and decisions on the environment as well as many other issues of global significance.

Several years ago, in a conference in Stockholm on military security in the Baltic Sea region, the President of Lithuania, Mr Valdas Adamkus, entered the stage and expressed that the greatest threat to his country was no longer a military invasion. Instead, the greatest threats were to be seen inside the country "...if we don't succeed in providing our citizens with a good environment, clean water, clean air and a functioning waste management system" as he put it.

Today his message feels even more correct, especially in the perspective of energy policy and climate change.

Energy policy today addresses, more obviously than ever before, issues such as the economy, independence, environment and security in its traditional sense.

The recent dramatic change in the oil-price level, has underlined the win-win solution that renewable energy represents and the urgent and growing need for a global agreement on energy policy.

The high price of energy hinders the possibilities for economic growth in many countries throughout the world. Renewable energy therefore cannot only combat climate change but also poverty and hunger, stimulate peace and stability, create access to energy and give possibilities for economic development, communications and education.

From figures presented, one can conclude that the rise in oil prices represents the annual development assistance contribution for developing countries. This also underlines the importance of a global energy policy, if we are to reach the millennium development goals.

It is in this context that round table meetings such as these are important for developing common ground for further efforts.

In the framework of Asia-Europe co-operation, there is an active role to be played, both when it comes to joint action and development of global policies.

In Johannesburg, Klaus Töpfer commented on these results by saying, "we have less than we wanted but more than we expected."

This statement is true when it comes to the decision on energy. For this reason it is important that we, at the world summit, managed to put the issue of energy policies on the global agenda. And maybe the fact that we did not reach the results we wanted helped stimulate a large amount of follow up activities.

With the ASEM meeting in Lecce, the Asia-Europe Environment Forum and many other international initiatives after Johannesburg, we have managed to create a political momentum for action - a political momentum much stronger than before.

In Johannesburg few delegations were open to discuss targets for the introduction of renewable energy; at the Bonn conference this summer, most countries, regions and financial institutions presented ambitious plans and targets.

At the conference "Stockholm Thirty Years On" which was held in preparation for Johannesburg, our late Minister for the Environment, Kjell Larsson, said:

"Three years before the Stockholm Conference, in July 1969, the whole world sensed the prospect of a limitless future. A footprint in lunar dust symbolised technological advances and hope.

Today, thirty years on, the ecological footprint left by the developed countries illustrates the vulnerability of our planet and the dangers of an unrestricted technological development."

What Kjell Larsson said at that time focuses on the main issue of today. How can technology be a driving force for change rather than a part of the problem? What strategies, financial instruments, research and co-operation are needed?

The Swedish experience is that long-term targets for the share of renewable energy in the energy system can and should be set. By doing so, national and local planning becomes a driving force for change. Targets also stimulate sector responsibility, motivate investments, research and demonstration projects. Targets and timetables set by governments enable joint ownership for all relevant ministries.

In order to reach a substantially increased use of renewable energy, it is important to increase the competitiveness of renewable energy sources. This can be achieved by lowering production costs for these energy sources and acting for internalisation of the external costs of all energy production and, in particular, the use of fossil fuels. Sweden has a long tradition of a CO_2 tax and that is most important reason why we have managed to decouple CO_2-emissions from economic growth.

Sweden has favoured general and market-based instruments to stimulate increased use of renewable energy. One example of this is the green electricity certificate system that was introduced a year ago. It is believed that this scheme will turn out to be more cost-effective than other measures to promote renewable energy sources.

An important aspect of such a scheme is that it must provide long-term incentives for private financers to make investments in renewable energy.

This is especially important in deregulated and liberalised energy markets such as the one in Sweden.

There is also the need for special targeted actions for those renewable energy sources that have a large energy potential and can show potential for substantial cost reductions - so they can become a competitive alternative. Offshore wind power is one such example. Therefore the certificate system has been combined with an "environment bonus" for introducing these technologies to the market.

In order to promote renewable energy and energy-efficiency in Sweden, several years ago, the government also introduced a program called the Local Investments Programme (LIP).

The LIP projects have been focusing on introducing innovative solutions. Within this framework, projects focusing on sustainable energy solutions are estimated to an annual decrease of CO_2-emission with more than two million tonnes, which is equivalent to 3% of the national emissions in 1990.

A new programme called the Climate Investments Programme (CIP) is now following the LIP. In its first phases it will run over the period 2003-2006.

Crucial to these investment programs is for the local municipality to develop the programs themselves, choosing technology that suit the local conditions best. One lesson learned is that on the local level partnership with local business, building joint energy solutions are easily found. The investment support from the government is more in the form of a catalyst.

The Swedish government has also presented tax reductions for private housing as well as public buildings and hospitals that are investing in energy efficient technologies.

Besides measures like these, it is important to keep in mind that renewable energy faces other obstacles besides competitiveness. Some examples are the lack of acceptance, insufficient infrastructure, unclear or absent laws and regulations and not the least, a lack of understanding of the challenges faced. It is understood that focused government efforts can help the change of both behaviours and attitudes. Gains in environment quality have to be communicated to the public in order to mobilise support for further decisions and changes in economic incentives.

One conclusion from the Swedish experience is that a mix of several initiatives is required in order to foster the change from fossil to renewable energy.

However, it is firmly believed that more and better needs to be done in the field of renewable energies and energy efficiency, both for our people and for our climate. There are big challenges ahead and only through joint efforts will we be able to make a difference in the years to come.

Platforms such as the Asia-Europe Environment Forum can play an important role in shedding light on the challenges ahead and on what can be achieved through working together.

Efforts can be intensified to stimulate an exchange of experience, technology transfer and research. The implementation of an emission-trading scheme in Europe can in this perspective serve as a catalyst.

It would also be interesting to explore the possibilities for an Asia-Europe partnership focusing on a sustainable transport sector, a sector that in many ways poses the largest threat to the climate and that is generally not addressed by actions such as trading schemes.

On a long-term basis, an exchange programme for students should be developed with a focus on environmental issues as discussed at the ministerial meeting in Lecce and intensify contacts between universities. In order to establish contacts between universities, the Swedish government supports the Chalmers University in Gothenburg in their efforts to create a network of universities focusing on sustainable development.

And finally, discussions in forums like this round table should be a common ground for the upcoming energy discussion that will be held in the Commission for Sustainable Development (CSD).

....

LET US RING THE BELL OF CHANGE FROM STOCKHOLM

Prof. Emil Salim
Eminent Person
EXTRACTIVE INDUSTRIES REVIEW, WORLD BANK GROUP

and

Former Chair
WSSD PREPARATORY COUNCIL, INDONESIA

Thirty-two years ago, in 1972, the first world conference on the environment was held in Stockholm, the same city where we are now convening for the Asia-Europe Environment Forum 3rd Roundtable today. Certainly, the 1972 Stockholm Conference has sent a powerful message of hope to the world that better life for all human beings and living creatures is feasible by caring for our environment.

As a delegation head from a developing country, I brought this message back to Indonesia. Development can be advanced without having to destroy the environment in the process. What the world needs is to co-operate together to build on a different path of environmentally sound development. Indonesia was ready to follow this new course. It needs, however, co-operation with the world to develop concepts, policies and capacity-building on this new course.

Various international meetings on the environment have been held since the Stockholm Conference. There was the United Nations Environment

Programme Special Session of the Governing Council in Nairobi, Kenya in 1982 on the topic "Ten Years after Stockholm"; followed by the United Nation Conference on Environment and Development in Rio de Janeiro, Brazil, in June 1992 attended by head of states and governments, launching Agenda 21. Finally another World Summit on Sustainable Development was convened in Johannesburg, South Africa, in 2002, and attended by head of states and governments firmly reiterating their commitment to follow the path of sustainable development.

Judging from the frequency of these international summit meetings, it is reasonable to assume that the development pattern will drastically change from conventional, economic-centric development to sustainable development following a triple track approach of economic, social and environmental development.

Sustainable development requires a different paradigm that uses:

- More renewable and less non-renewable resources;
- more renewable and less non-renewable energy;
- more useable output and less waste as well as pollution;
- more output and service and less use of space; and,
- more immaterial goods and services rather than material ones in consumption.

Nothing is more obvious in sustainable development than the shift from non-renewable fossil fuel-based energy to renewable energy resource-based development. The reality up to now, however, is miserable.

First, the International Energy Agency (IEA) has predicted that the energy supply mix in the future will grow in percentage of total energy as follows:

	2000	2030
Oil	37	36
Coal	36	33
Gas	15	17
Hydro power	8	8
Nuclear	2	4
Renewable energy	2	3

Fossil fuel, oil-coal and gas, are predicted to still be *the* major world supply sources for energy in years to come, only reduced slightly in percentage from 88% (2000) to 86% (2030), while renewable energy will improve marginally from 2% (2000) to 3% (2030).

Second, many development experts predict that global development will be pulled by the "locomotive" of Asian development, primarily of China and India. The population of China will grow from 1.3 (2004) to 1.48 (2025) and 1.43 billion persons (2050). The population of India will grow from 1.08 (2004) to 1.36 (2025) and 1.63 billion persons (2050). Both countries want to climb up the development ladder, to a better standard of living. Agriculture, industry and transportation will increase the use of energy. Although both countries recognise the need for shifting energy use towards renewable energy, the only known source of energy that can meet these development needs is non-renewable energy. This is special true in transportation. Developing countries are searching for the proper renewable energy source that can supply energy for transportation and industrialisation. This requires a different car technology, using fuel cells and hydrogen. This technology however is still at the infant stage. It requires change to a transportation system that is less dependent on individual private cars to allow origin-destination flow of cargo and persons more efficiently. It calls for different spatial planning and urban development that reduces the distance gap to optimise utilisation of space. Unfortunately the current development is following a "business as usual" pattern as conducted by the current industrial countries in the past. Innovations and inventions on the sustainable development pattern are rather scarce.

Third, the market fails to give adequate incentives to push development into the road of sustainability. Developing countries cannot tap on these new ideas or implement them because of market failure to move on the sustainable path of development, especially in energy. Prices of fossil fuel do not reveal internalisation of external costs, such as costs of pollution, resource depletion, environmental destruction and degradation, increase in health hazards, disruption of indigenous people's way of life, etc. Fossil fuel is overvalued, while non-renewable energy on the other hand is under-valued. Under such an unequal level playing field, renewable energy cannot compete fairly with non-renewable energy.

Fourth, the Convention on Climate Change and Kyoto Protocol is a small attempt of interference to correct the market. Unfortunately, even in the last climate change convention of December 2004, the United States government as the largest carbon dioxide emitter is still refusing to ratify Kyoto. If we are all living in the same world, why is there no common commitment to solve global common problems on a multilateral basis? Why is there such arrogance in pushing one's own agenda for one country's own interest on a unilateral basis? If the source of pollution is not equal between developed and developing countries, is it not appropriate if developing countries are demanding a common but differentiated responsibility to cope with global environmental pollution? While the debate on the scientific evidence of climate change is going on, the World Bank and FAO are already feeling the need to move *beyond* mitigating green-house-gas endangering global warming and move into efforts of *adapting* to climate change. In this effort it is clear that developing countries and the poor farmers will be the main loser in the efforts of coping and adapting to climate change.

Fifth, in a recent Extractive Industry Review (EIR) Report commissioned by the President of the World Bank Group (WBG) to an independent eminent person, entitled "Striking a Better Balance" (2004), as well as the internal evaluation report by the Operation Evaluation Group of International Bank for Reconstruction and Development (IBRD), International Development Agency (IDA), International Financial Corporation (IFC) and Multilateral Investment Guarantee Agency (MIGA) – all parts of the WBG, entitled "Extractive Industries and Sustainable Development" (2003), came to the same conclusion that many extractive resource abundant countries experienced negative growth during the 1990s. An integrated strategy of extractive industrial development is required with the presumption that its successful development must not provide only adequate returns to investors but should also provide adequate revenues to governments, mitigate negative environmental and social effects, and benefit local communities. Up till now, natural resource extraction methods, including that for energy, has not been sustainable.

Most disturbing however are the findings of these reports that the WBG has been timid in financing renewable energy development. In spite of the clear recommendations of the EIR Report to the WBG to stop financing oil and coal development projects on concessionary terms and finance renewable energy projects instead, the sober facts are that the WBG Board of Executive Directors has rejected the recommendation and they still urge the WBG to develop fossil fuel projects in developing countries "for the sake of poverty alleviation." Of course it is interesting to note that the beneficiaries of WBG financing in fossil fuel projects are Halliburton, Exxon, BP, Shell and other giant companies linked to the oil industry.

Meanwhile, the WBG has responded to the EIR recommendations by "raising the allocation of funding to renewable energy to US$400 million by 2008." Please note that WBG involvement in the Turkey-Georgia pipeline project absorbed US$400 million.

Many serious high-level discussions on sustainable development have taken place up till now. But why are the results in implementation so poor – including by the WBG? The problem lies in the national and global decision-making mechanisms. Environmental issues are handled by the ministries for the environment, while energy issues by the ministries of energy. The allocation of financial fund is in the hands of the ministries of finance. In most cases because of price distortions due to market failure and because of lack of coherent sustainable energy policies, the gravity of funding moves toward fossil fuel, which is considered much cheaper and more practical then renewable energy.

At the international level, ministers of finance never attend conferences on environment and development, while energy conferences are usually attended by ministers of energy. Under these circumstances, renewable energy will never be seriously discussed or effectively funded by both ministries. The same conditions apply in the Board of Executive Directors of the IMF and WBG whose members are usually from the ministries of finance or central banks. The cardinal point here is that social and environmental sustainability issues are outside the mainstream of economic development in financial and economic institutions, nationally as well as globally.

This grim fact also explains why the various important summits fail to produce the necessary results because of failure to follow up by the "powerful" sector ministers outside the ministries for the environment. Platforms such as the Asia-Europe Environment Forum, which aims to facilitate debate and dialogue among civil society, governments and other stakeholders, has potential to play an important role in promoting convergence rather than divergence among the concerned actors in sustainable development efforts.

On the other hand, the management of WBG complains that there are no viable renewable energy projects to meet the standards of project financing. However, on a bilateral basis there are numerous projects than have been successfully implemented on renewable energy. For example, Denmark has a successful program in Mali in spite of the prevailing price distortions in energy. These success stories need to be known by WBG so that financing for these kinds of projects can multiply not only in Mali but also in other developing countries.

European countries success stories must be imitated and transferred wherever possible to all other developing countries, and pushed for financing by WBG and regional development banks in Africa, Latin America and Asia.

Another bold effort must be made in human resource development. Europe has its skills in renewable energy technology, policy, legal framework, incentive systems and institutional development requirements. Europe has skills in clean coal technology, in zero carbon emission technology, in wind, wave, solar and hydro energy. These skills are in governments, business enterprises as well as civil society.

Asia needs these skills for its renewable energy development to be fully fledged. These needs can be met if we work together through the triangle partnership of: government-business-civil society. These three groups must be convinced to commit to the development of renewable energy as the main engine of Asian growth. These three groups must work hand-in-hand together in a triangle of partnership in Asia and Europe.

The "locomotive" of the twentieth-first century development is Asia. Asia must develop on a sustainable path. This can be achieved if European ministers, business CEOs and prominent leaders of civil society joint forces with their Asian counterparts and push for renewable energy and sustainable development into the mainstream of Asian, European and the global development. Only then can we expect the new paradigm of sustainable development can become a reality.

Stockholm was the cradle of environmental development 30 years ago. Stockholm can become again the cradle of another revolution to give impetus to changing toward an effective course of sustainable development fuelled by renewable energy and moved forward by the triangle of partnership in particular in between political leaders, business CEO and inspiring leaders of the civil society in Asia and Europe.

Let us ring the bell of change now and here from Stockholm today.

Chapter 1

Summary and Synthesis of Discussion

1

SUMMARY AND SYNTHESIS OF DISCUSSION[1]

Bertrand Fort
Director for Intellectual Exchange
ASIA-EUROPE FOUNDATION

and

Co-ordinator
ASIA-EUROPE ENVIROMENT FORUM

Internationally-respected authorities such as former Chairman of the World Summit on Sustainable Development (WSSD) Preparatory Council, Dr. Emil Salim of Indonesia, and Prof. Michael Grubb, Policy Director of The Carbon Trust of the United Kingdom (UK), joined around 40 other experts on renewable energies at the third roundtable of the Asia-Europe Environment Forum series in Stockholm, Sweden, on 26-28 August 2004.

The roundtable dovetailed the successfully-concluded International Conference for Renewable Energies in Bonn, Germany on 1-4 June. The Bonn Conference ended with a strong declaration by 154 governments that renewable energy should play a major role in the energy economy of the 21st century—a development with important implications for co-operation and renewable energy investment between Asia and Europe.

Opened by Sweden's State Secretary for the Environment, Mr Krister Nilsson, the roundtable concluded with a scientific session held at the EuroScience

[1] *The co-organisers wish to thank the efforts of Dr. Philippe Bergeron for his contribution to this summary as rapporteur for the meeting.*

Open Forum (ESOF) 2004, the first pan-European initiative to present science to a large audience of about 400 participants.

In the tradition of the Forum's first two roundtables, the proceedings and papers of this meeting are published in this volume.

The meeting aimed to provide answers and recommendations to the questions and issues of:

- Technology: What Kind of Energy is Sustainable for Various Consumption Needs?;
- From an Idea to the Market: Sustaining the Technology Innovation Process;
- Asia-Europe Platform: From Technology Transfer to Technology Exchange; and,
- *in addition, a roundtable conclusion session entitled* "It's Not Easy Being Green? Prospects and Perspectives for Green Technology in Asia and Europe" was held as a scientific session of EuroScience 2004 and open to all participants and the general public.

Summary of Discussion

Renewable energy doesn't only concern the mitigation of climate change although it is a key and increasingly important element of it. Renewable energy can also significantly contribute to economic development and poverty alleviation, and thus, is inextricably linked with the pursuit of sustainable development. On this basic premise for Asia-Europe co-operation on renewables, the following key messages emerged from the meeting:

- With the continuing double trend in Asia and Europe of existing markets' maturation coupled with emerging markets, **renewable energy production cost will eventually be comparable to current carbon-based supplies, boosted further by an expected systemic rise of the oil prices** caused by the growing global imbalance between supply and demand.

- From the bottom-up perspective and **in the context of dialogue exemplified in the Asia-Europe Environment Forum, the most promising action would be to foster Asia-Europe partnerships for the mutually beneficial development and deployment of renewable energy solutions and renewable energy investments** in the two regions.

- In addition to public support for research and development (R&D) in renewable energy technologies, **institutional capacities are also a key to commercialisation of renewable energy technologies. The European experiences are highly relevant to market penetration of renewable energy technologies in Asia.** Multilateral fora and exchange programmes between the two regions could bridge the gaps and promote mutual learning.

- The **Asia-Europe Foundation (ASEF) through its Asia-Europe intellectual exchange networks and the Asia-Europe Business Forum are ideally suited to follow-up on the event** and help nurture the networks and activities apt at stimulating renewable energy investment in the two regions.

The discussion points clustered around four basic points:

(1) *Understanding the processes,* which underlines that the development of technology is not necessarily the issue–technologies are available but the crucial factors are how the technologies are used and how the governments, business sector and other social partners drive the process effectively.

(2) *Strengthening the paradigm,* which is the framework through which renewables respond not only to climate change issues but also to the environmental, economic, and social issues of sustainable development.

(3) *Possible suites of action,* which refers to the various levels and modalities for concrete Asia-Europe collaboration to promote the development and use of renewables.

(4) *Education, training and capacity building,* probably the most vital and viable area for Asia-Europe co-operation.

Understanding the Processes

The renewable energy market can be spread into different market segments. Each segment calls for a differentiated policy mix for stimulation and development. At least three clearly different segments are of importance and could be applied in both Asian and European contexts, although the policy, investment and market conditions do vary significantly.

- **On-grid industrial/urban grade electricity supply** addressing industrialising/industrialised countries' needs that require policies stimulating the development of an increasing market share for renewable energy electricity production and encouraging competitive regulation once the market has been established.

- **Decentralised off- or on-grid rural electricity supply** (for example for lighting, small motive power, communication, cooking, other small household appliances, etc.) that have a social rationale in developing countries and far-flung areas. These applications call for policies fostering R&D for inventive low cost technology development, creative production and distribution cost abatement, original financing models for renewable energy investment risk pricing and coverage (alternative collateral) and innovative business models for project feasibility and viability development for investment facilitation.

- **Decentralised non-electricity rural applications** that have a poverty alleviation justification. The deployment of these applications necessitates policies stimulating project development and financing in the poverty alleviation context such as self-help systems and micro-finance.

Stimulating renewable energy is an internalisation process by public and private investors of environmental externalities. Normally, the cost of greenhouse gas (GHG) emission as well as the unsustainable and irreversible depletion of natural resources such as coal, oil or natural gas and environmental damages by emissions of other pollutants such as Sulphur Dioxide (SO_2) and Nitrogen Oxides (NO_x) are not factored in when economic activities consume fossil energy sources. Internalising an externality can only be driven by energy pricing policies that level the playing field and require energy producers to integrate environmental mitigation expenditure into their overall production cost. Considering the sustainability of renewable feed-stocks (wind, solar, small-scale hydroelectricity, biomass, geothermal, ocean wave and tide, etc.), these policies raise the price competitiveness of renewable energy against traditional fossil energy supply in the long term.

Experience in Europe shows that renewable energy development and investment are best promoted by a staged process involving first a technology push followed by a market pull. The first step is an initial innovative technology development needed to demonstrate technological viability and create the market. The second step is a market "pull momentum" driven by a growing economy of scale and a "learning by doing" cost reduction effect. This stepped process calls for a suite of market-making policies that need to be introduced (and retrieved when their impact becomes market-distorting) to nurture and guide each step of the renewable energy technology market cycle (innovation, cost reduction, competitiveness, maturity, decline).

The United Kingdom (UK) has embarked on an audacious strategy to apply this process with the objective to rebalance its energy supply spread that should lead to – by 2050 – a lowering of the carbon component of its energy mix by 60%. The envisioned strategy foresees an initial technology push and market creation phase through an R&D effort in advanced solutions especially in wind and wave technology to be followed by a cost lowering phase driven by the "learning by doing" effect. This is expected to lead to a renewable energy production cost comparable to current carbon-based supply. This favourable convergence of production costs is projected to be boosted further by an expected systemic rise of the oil price caused by the growing global imbalance between demand and supply. The sustained growing demand especially from rapidly industrialising Asian countries cannot be matched anymore by an "easy to exploit" global supply that is now at its peak and will soon enter a slow and steady decline.

Another contribution to the current renewable energy production cost differential against the carbon solution is the **dissimilar project cash flow profile of investment** that produces electricity for decentralised off- or on-grid supply. Fossil fuel-driven electricity supply has a low initial investment cost (diesel generator technology as a case in point is mature and well established; its economy of scale helps keep the investment cost low) matched by slowly but continuously rising operation and maintenance (O&M) costs to pay for the feed-stock throughout the life of the investment even if the cost of environmental pollution is not counted. Renewable energy solutions (solar, wind or equivalent) on the other hand have much larger initial investment cost. The key is that they also have nearly negligible O&M expenditure and very limited negative environmental impact thereafter.

The financing cost of a renewable energy investment, depends on the cost of the risk taken. This risk is currently not well known and strongly dependent on the electricity sale price that a producer can achieve. In a nascent market with a marginal market share (globally, renewable energy accounts for less than 3% of electricity supply against 70% for fossil fuel-based supply), this depends on the pricing policies imposed by the regulator to create and nurture the renewable energy market (quota, feed-in, etc.). *Feed-in policy (a fixed guaranteed price for electricity fed into the grid) so far seems to have been the only successful pricing model capable to generate sizable renewable energy investments and a significant renewable energy supply market in Europe.* Given the risk of market distortion that the "feed-in" policy can cause once the market is well established, more competition stimulating pricing policies (such as the quota system which imposes on the grid operator a minimum quota for renewable energy supplied electricity without fixing its price) are needed once the renewable energy market has become significant.

Finally, it is important to note that **renewable energy and energy efficiency mutually reinforces each other** because of the limited unit capacity of renewable energy investment. The renewable energy market can significantly benefit from an integration of energy efficiency facilitating policies that foster demand-side management, industrial green productivity and performance contracting models and contribute to make energy savings an attractive and profitable investment proposition.

Strengthening the Paradigm

An analysis of various possible future global energy supply scenarios points to two clearly separate and mutually exclusive development paths: **a low carbon global energy use scenario** and a **separate higher carbon scenario.** The trail of reports published by the Intergovernmental Panel on Climate Change (IPCC) as scientific input to the negotiation process of the United Nations Framework Convention on Climate Change (UNFCCC) makes it increasingly evident that there is a climate change risk with any high carbon scenario. **More efforts need to be developed to strengthen the paradigm**

shift and ensure that not only developed countries but rapidly industrialising economies particularly in Asia recognise the global sustainability value of a low carbon scenario and embrace early enough carbon emission reduction strategy compatible with the UNFCCC objectives and the Kyoto protocol targets.

The reality is that renewable energy remains a marginal element of the current global energy supply mix while carbon energy supply remains predominant with precious little prospect for significant abatement in the foreseeable future. This calls for more forceful mobilisation of global decision shapers like the World Trade Organisation (WTO), the International Monetary Fund (IMF), the International Energy Agency (IEA) and other relevant global energy institutions. It is important that *current environmental costs of fossil energy depletion are internalised at the global level to avoid market distortion* between nations with different fossil energy endowment and carbon emission reduction regime. A possible approach is to integrate an ecological dimension into the economic profile of nations to ensure that national economic development is on a sustainable path in a global context.

Intriguingly, **the funding allocated by the World Bank Group for renewable energy investment stimulation** (around US$ 400 million per year by the year 2010) **seems to lack ambition and stays rather moderate.** This figure barely matches the cost of a single oil pipeline between Georgia and Turkey. **Considering the threat of climate change and the opportunity of renewable energy as mitigation strategy, vastly larger financial resources ought to be devoted by the World Bank as well as other institutional and private investors** to the promotion of widespread renewable energy investments, especially in Asia.

Although the targets of the Kyoto protocol of the UNFCCC are not sufficient to effectively control and stabilise global carbon emission at a level considered safe under the latest findings of the IPCC experts, they are steps in the right direction and deserve full support. There is an urgent need to revive the UNFCCC/Kyoto momentum. With recent ratification of the Kyoto Protocol by Russia, the Protocol has come into force on February 16. However, the United States' current rejection of the Protocol and the lack of binding emission reduction targets for China, India and also Korea, remain as challenges. Additional efforts are needed to ensure that the Kyoto targets are achieved by countries with committed emission reduction objectives. Moreover, mechanisms and incentives are needed to mobilise countries currently without emission commitments to set targets compatible with globally sustainable emission convergence and contraction objectives.

There are also strong economic reasons to strengthen the paradigm shift towards a greater ratio of renewable energy in the global and local energy supply mix. Carbon energy markets are monolithic and monopolistic. This has led to market instability, greater volatility of price (evidenced by the numerous energy crises experienced by the world in the last forty years) and overall sub-optimal energy price. Consumers have so far been the only group to pay the cost of this volatility. **In the current global carbon based energy supply regime, feed-stock price variation and energy production cost are systematically pushed to consumers that have no real possibility to defend themselves.** Both feed-stock suppliers and electricity producers are the unjustified beneficiaries of the regime. Many have so far enjoyed partially unfair and excessive gains. For instance, recent European energy deregulation moves were meant to also redress this imbalance and shift some of the pricing power to the consumers. With fossil fuel still predominant and in the hands of a very small number of large producers, results remain insignificant so far.

To rebalance the pricing power in the energy sector, there is a **need to develop policies that cultivate widespread decentralised renewable energy investments** so that renewable energy becomes a more significant element of the overall energy supply mix. A more significant renewable energy market share can contribute to a much enhanced robustness, security and stability of the overall energy markets. It can also open the door for lower overall energy price through a superior risk mitigation strategy that spread the risks to economic agents that are best able to carry them at least cost.

Possible Suites of Action

Possible policy actions should start with a levelling-off of the playing field through the **internalisation of environmental – both local and global – costs associated with the burning of fossil fuels, and elimination of a number of pervasive and perverse national and local subsidies** still provided to carbon-based energy suppliers. These contribute to correction of market distortion that conspire to make renewable energy less attractive and competitive than it would otherwise be.

A series of top-down and bottom-up policy actions may also be desirable. At the global institutional level, multilateral and bilateral co-operation in the development, deployment and diffusion of renewable technologies deserve immediate actions.

One example is the proposition at the Bonn Conference to recommend the **establishment of a separate international renewable energy agency** to promote the interests of renewable energy. If a word of caution is justified to warn against the capacity of such agencies seriously influencing sovereign governments in changing their energy policy in favour of renewable energy, institutional efforts to promote more forceful strategies to accelerate renewable energy deployment remain certainly desirable. Useful institutional actions to be undertaken by such an agency could include studies showing the economic benefits of a more significant percentage of renewable energy in the overall energy mix of nations and regions, comparative policy analyses of renewable energy market creation and deployment strategies, and the publication of suites of regulatory recommendations regarding:

- Creation of renewable energy markets;
- keeping them competitive when established; and,
- stimulating innovative techniques for the swift deployment of relevant technical, managerial, financial and business model solutions.

Other advantageous top-down efforts would be to position renewable energy and its potential **toward the security of the global energy supply and stability on the radar screens of global institutions** like the WTO, the IMF, the World Bank and many other institutions with global energy concerns.

At the national level, there is also certainly a **demand for the development of strategic country renewable energy need assessments clarifying the more promising renewable energy market segments and documenting renewable energy technology opportunities** based on national renewable energy feed-stock endowment, national interest and the stage of economic development. These national strategic needs assessments could then establish the policy framework best able to create and nurture renewable energy markets in the retained technology fields, define incentives able to mobilise the interest of local and international investors and guide entrepreneurs willing to consider in country renewable energy investment.

From the bottom-up perspective and in the context of dialogue exemplified in the Asia-Europe Environment Forum, the most promising action would be to foster Asia-Europe partnerships for the mutually beneficial deployment of renewable energy solutions and renewable energy investments in the two regions. Fostered partnerships could include:

- A variety of **business models** from the development of feasibility and viability studies of renewable energy investment projects;
- the establishment of renewable energy equipments production facilities through the development of **financial services schemes targeting specific renewable energy investment needs**;
- capacity building in **commercialisation of renewable energy technologies through institutional innovations and training of technological know-hows**, under an Asia-Europe co-operative framework; and,
- **co-operative R&D initiatives** between Asia and Europe, particularly in areas of relative competence such as wind and bio-fuels technology from Europe, solar energy in China and Japan.

To practically foster investment, such partnerships could be promoted through a dedicated technology exchange network that mobilise the interest of a broad set of renewable energy stakeholders including government, industry, finance, civil society and academia. **This network could then facilitate the development of an enabling business-driven environment**, build value-adding human resources capacity and stimulate the development of innovative financing mechanisms which the private sector and other interested parties can effectively tap to deliver solutions to the renewable energy opportunities of the two regions.

Regarding institutionalisation, however, it would be important to first **review existing frameworks or networks** that could effectively be leveraged upon rather than duplicated. Thus, existing networks such as the following: Renewable Energy and Energy Efficiency Partnership (REEEP), a coalition of progressive governments, businesses and organisations; the European Commission-Association of Southeast Asian Nations (EC-ASEAN) Energy Facility wherein organisations, institutions and companies from the EU and ASEAN participate; Climate Technology Initiative (CTI), established at the first Conference of Parties to the UNFCCC to foster international co-operation in the development and diffusion of climate-friendly and environmentally sound technologies and practises, and others.

Education, Training and Capacity Building

Building the capacity for enhanced renewable energy absorption, especially in Asia, is clearly a critical step needed to stimulate greater investment uptake. Even in Europe, professional competence in renewable energy planning and deployment is relatively limited and currently confined mostly to the EU countries with particularly pro-active renewable energy deployment strategy and policy (Denmark, Sweden, Germany, the Netherlands and Spain). Among Asian developing countries, China and India have already accumulated a significant expertise in selective technology, but the **expertise remains scarce as a whole.**

There are broad opportunities for developing a multiplicity of professional curricula in renewable energy technical, financial and institutional engineering through co-operation between **specialised institutes in Europe and interested higher education in Asia.**

There is also a large demand for formal as well as on-the-job professional training in renewable energy engineering that can be satisfied through specialised **consultancy services** as well as the encouragement of business ventures allowing Asian and European professionals to work side by side in developing and operating investment opportunities in the two regions. An Asia-Europe Technology Exchange for Renewables (AETER) network as recommended in this book is a plausible proposal to explore[2].

[2] *For more explanation on this idea, please refer to "Practical Elements for Setting up an Asia-Europe Technology Exchange for Renewables" by Dr. Philippe Bergeron in chapter 5 of this book.*

....

NOTES ON THE SUCEEDING CHAPTERS

The summary and synthesis of discussions has made up this first section, **Chapter 1.**

Chapter 2, "Technology: What Kind of Energy is Sustainable for Various Consumption Needs?" provides two papers that attempt comprehensive answers to this question.

Mr. Peter Danielsson of the European Renewable Energies Federation (EREF), Sweden, shows that renewable energies in general now provide some 14% of the world's primary energy. Data on electricity, for instance, tells us that a number of European countries currently have a much higher than average share of renewable energy. However, while richer countries of Europe have bridged the technology divide in pursuit of higher targets for renewables usage, the vast majority of the rural and "peri-urban" poor in Asia face extremely limited energy choices. Nevertheless, models for financing schemes could be adapted to regional situations; microfinance systems, in particular, demonstrate how small-scale installations of renewables could become affordable to the population.

Prof. Pan Jia Hua of the Research Centre for Sustainable Development, China, raises the essential question of whether or not renewable energy (RE) technologies can meet various consumption needs. Exploring the implications for the use of hydropower, he argues that without commercial viability, renewable energy technologies cannot compete with conventional energy technologies in this respect. He examines the following issues: (1) The types of renewable energy technologies needed in relation to consumption needs; (2) whether these technologies are commercially viable; (3) the extent to which these technologies can supply the energy needed for industrialisation and economic development in developing countries; (4) policy implications of commercialising RE technologies; and, (5) the role of Asia-Europe co-operation on technological development, diffusion and transfer.

Chapter 3, "From an Idea to a Market: Sustaining the Technology Innovation Process" presents three papers that discusses the technology innovation process.

Prof. Michael Grubb of The Carbon Trust, UK, initiates this chapter by highlighting the different views and arguments of technological innovation as well as the institutional challenges of devising policies. He then provides a synthesis of these views, arguing the need to understand the economics of technological innovations. By viewing the innovation process as a complex phenomenon consisting of different stages, he demonstrates that there are diverse potential options in tackling climate change. He then discusses the role of public and private funds in technology investment in the light of the different stages conceptualised in the innovation chain. Finally, he identifies and compares the different kinds of technology co-operations.

The second paper is a contribution from Mr. Guido Alfredo Delgado of the National Power Co-operation (former president), the Philippines, who picks up the discussion on governments' role in policies and market interventions, especially in Asia. By using the case of the Philippines, he emphasises the importance of successfully transforming government policies into concrete, effective market mechanisms. The project using solar power for water pumps, for example, shows the need for policies to help enhance investment in renewable energy.

Dr. Dörte Fouquet of Kuhbier Law Firm, Belgium, provides a European perspective on financing renewables. Drawing on her legal experiences in the area of renewable energy, she discusses the present situation on the support for renewables in the energy market. She then makes several recommendations for policymakers and institutions.

Chapter 4, "Asia-Europe Platform: From Technology Transfer to Technology Exchange" discusses the area of co-operation between Asia and Europe as well as the mechanisms provided under several international treaties and conventions.

Mr. Robert Koh of the Regional Institute of Environmental Technology (RIET), Singapore, points out the potential areas of co-operation as well as the strong government support enjoyed in the RE sector. He also points out a number of barriers that are hindering technology transfer, namely mismatched technologies, affordability and short term business strategies. He proposes the advantages of following an investment-based focus on the end results of economic development such as wealth creation, foreign investment, growth of local industry and research and development.

The next report by Prof. Frank Convery, Ms. Lisa Ryan and Dr. Morgan Bazilian of the Sustainable Energy Authority of Ireland (SEI), use the case study of Ireland to debate on the allocation of public funding to research and development in RE investment. They also discuss the management of such funds as well as the accountability process involved. Finding a dearth of empirical evidences and case studies in the analysis of the issue, the authors posed key questions that they felt needed to be addressed in the topic of RE investment.

Subsequently, Prof. Morihiro Kurishima of Toyo University, Japan, discusses Climate Change Initiative (CTI) and the relationship between combating climate change and RE technologies. By presenting the case of Japan, he discusses the domestic challenges that such technologies face.

In the context of ASEM, the paper of Dr. Philippe Bergeron of the ASEAN Centre for Energy (ACE) in chapter 5 is an excellent summary of the issues to be considered when assessing the desirability and feasibility of establishing a network for the facilitation of RE investment especially by small and medium-sized enterprises (SME) entrepreneurs in Asia and Europe under the ASEM umbrella. He then raises fundamental questions on the conceptual and operational basis of such a network such as governance structure and performance measurements. He points out that there is much to reap and benefit from the co-operation between Asia and Europe and a network facilitating RE investment would be just the catalyst needed. He therefore strongly advocates for the creation of an Asia-Europe Technology Exchange for Renewables (AETER).

In the concluding paper of this volume, Dr. Francis X. Johnson and Mr. Yong Chen of the Stockholm Environment Institute (SEI), Sweden, note how different the roles are for RE technology in Asia and Europe. Yet, it is precisely these differences that create possibilities for positive complementarity and contribute to the dynamic possibility of opportunities for Asian countries in terms of technology leapfrogging and energy security. They also highlight the barriers to technology partnerships in the governmental, financial and technical spheres.

For easier reference, this book also provides a glossary of terms used. Readers may also wish to refer to the agenda and list of participants in the appendices.

Chapter 2

Technology: What Kind of Energy is Sustainable for Various Consumption Needs?

2

....

RELATIVE ABUNDANCE OF RENEWABLE RESOURCES IN ASIA AND EUROPE AND THE FUTURE DEMAND FOR RENEWABLE TECHNOLOGIES

Peter Danielsson
President
EUROPEAN RENEWABLE ENERGIES FEDERATION (EREF), SWEDEN

Abstract

In Europe and in many other parts of the world, energy consumption has reached unsustainable levels. As such, efforts must be made both to expand the use of renewable energy and to reduce the total level of energy consumption.

If there are any pertinent driving forces for this, they would be the need to reduce harmful emissions; to increase sustainable energy supply, security, poverty, eradication and access to dignity for billions of people – the ending of a vicious circle of exploitation of scarce natural resources for inefficient energy use.

Most European nations belong to the relatively small group of wealthy countries enjoying a comparatively high standard of living. They comprise of approximately 20% of the world's population, producing 80% of the world's GNP, while at the same time, consuming 60% of the world's energy, Ironically, more than half of the world's population, or close to 3 billion people, have almost no access to energy services – 1.2 billion live in Asia.

There is, however, enough renewable energy flow worldwide to meet all demands. Renewable energies in general now provide some 14% of the world's primary energy and is mostly covered by traditional biomass. In the field of electricity, where renewables account for 20% worldwide, it is mostly hydropower which is used as source. We need a rapid and courageous worldwide change towards an energy-efficient, Renewable Energy Systems (RES) powered energy.

Asia already offers a set of successful initiatives and examples of how renewables can be promoted. Some countries have set national targets for the future share of renewable energy. Targets are an excellent strategy to demonstrate political willingness and create a stimulating investment climate for the private sector.

Financing schemes, adapted to regional situations, in particular microfinance systems, demonstrate how small-scale installations of renewables could become affordable to the population.

Before even asking the question of what kind of renewable energy source would be appropriate for which region, it should be preceded by the question: why should Asia and Europe invest further and faster in renewables?

When comparing Asia and Europe in this context, differences are obvious. So where does one start?

In a sustainable society, the power and access to power must be distributed and concentrated power must be minimised. As such, the inequality in different areas and different levels of the economy must be flattened out over the long term - whether we are thinking of the differences in economic power between nations, genders or others. This is especially true in the context of energy usage.

The other crucial issue is, of course, the environment. A sustainable society is based on a sustainable use of resources and a healthy environment. We cannot allow for the destruction of forests and land for short-sighted economic revenues. As fossil fuels will eventually become obsolete, in a sustainable society, oil, coal and gas might be reserved and used sparingly for the common good, perhaps as input materials for specialised purposes. Clearly, ecological preservation must take precedence in the long term over economic concerns.

The question then becomes: what quantity and sources of energy do we need? And what does sustainability mean with respect to energy?

Defining Global Sustainable Energy Futures

To start with the latter: The World Commission on Environment and Development (WCED) made the first concerted international effort to define sustainable development in its 1987 report "Our Common Future" (also known as the Brundtland Commission report, after its chairwoman, former Norwegian Prime Minister and current Director-General of the World Health Organisation (WHO), Dr. Gro Harlem Brundtland). The WCED, which included 23 members from 22 countries, was formed by the United Nations in 1984, and for three years studied the conflicts between growing global environmental problems and the needs of less-developed nations.

The WCED defined sustainable development as:

"Meeting the needs of the present without compromising the ability of future generations to meet their own needs." (WCED 1987: 43)

The European and Western economy in general relies heavily on fossil energy. Energy consumption has reached unsustainable levels, at least in the medium term perspective, and as such, efforts must be made both to expand the use of renewable energy and to reduce the total level of energy consumption. This transition will require an enormous effort. In Asia, where the need for energy is rapidly increasing from a relatively low level, the focus should be on investments in renewable energy.

If there is one driving force in the different regions of the world, it is the need to reduce harmful emissions and to increase sustainable energy supply security. Another key driving force is poverty eradication, access to dignity for billions of people and the ending of a vicious circle of exploitation of scarce natural resources for inefficient energy use.

Ministers from more than 120 states at the international conference for the promotion of renewables in Bonn in June 2004[1] decided on a statement about the rationale for the expansion of renewable energies and energy efficiency based on key sustainable development priorities:

[1] *International Conference for Renewable Energies, Bonn, Germany, 1-4 June 2004*

- Opportunities for poverty eradication and development, for global security in the world; renewable energies contribute to satisfying the energy needs of the poor in rural and remote regions.

- Protecting human health and the environment, in particular preventing global warming induced by humans through energy-related activities.

- Strengthening the local economic base by capturing local renewable energy resources (biomass, hydro, wind, solar, geothermal), reducing dependency on fossil fuel imports, enabling technology development and creating new jobs.

Renewable Energy Potential

To answer the question as to which renewable energy source would be the most appropriate, one could address this very briefly by answering that solar energy is the most abundant primary energy resource worldwide.

According to assumptions on annual clear sky radiance, annual average sky clearance and available land area, the annual Solar Energy Potential in Asia and Europe is given in Table 1.[2]

Table 1: Minimum and Maximum Solar Energy Potential in Various Regions

Region	Minimum Exajoules[3]	Maximum Exajoules
Western Europe	25	914
Central and Eastern Europe	4	154
Former Soviet Union	199	8655
Pacific Asia	41	994
South Asia	38	1339
East Asia	115	4135

At present, the total world production of electricity not including biomass is 15,476 TWh (terrawatthours) per year (approximately 56 Exajoules). Thus, a minimal fraction of the amount of solar resources that is theoretically available worldwide.

[2] *Excerpt from table in Potential of Renewable Energy, page 8*
[3] *1 Exajoule corresponds to 278 TWh*

One can unequivocally say that there is sufficient renewable energy flow worldwide to meet current demands. We would indeed only need a tiny amount from the overall "umbrella" of solar energy to meet our demands. The future use and extent of solar energy depends on the availability of "efficient and low cost technologies, effective energy storage technologies and high-efficiency end-use technologies."[4] At present, solar as a primary energy source only covers, together with geothermal, less than 0.6% of the world's total electricity production of 15,476 TWh, calculated on the basis of TWh generated, not on the basis of primary energy.[5] Since the technologies are still quite expensive, there is more use of solar energy in Europe with less favourable "solar" conditions, such as in Germany and Austria in Europe.

Renewable energy provides approximately 14% of the world's primary energy and is mostly covered by traditional uses of biomass. For electricity production, where renewables account for approximately 20% worldwide, the main source is hydropower.[6]

Our natural ecology is being destroyed or endangered as a result of our existing use of energy and other resources. According to the United Nations Environment Programme (UNEP) GEO 2000 report, the time for a rational, well-planned transition to sustainable systems is "quickly disappearing". "Full-scale emergencies now exist in the use of water and land resources, forest destruction has gone too far to prevent irreversible damage in many areas, and urban air pollution is reaching crisis dimensions in many of the mega cities of the developing world. The current and overwhelmingly unsustainable use of energy–or the demand for energy–is intimately tied to all of these emergencies".[7] Therefore we need a rapid and courageous worldwide change towards an energy system based on energy-efficiency and renewables.

[4] *Potential of Renewable Energy, page 8*

[5] *See UNDP World Energy assessment, overview: 2004 Update (Thomas B Johansson et ali) Figure 6, page 28*

[6] *The potentials of Renewable Energy, Thematic Background Paper , International Conference for Renewable Energies, June 2004, Bonn, executive summary*

[7] *Klaus Töpfer, Executive Director, UNEP, First word to UNEP "Natural Selection, Evolving Choices for Renewable Energy Technology and Policy"*

Sources of renewable energy exist in the form of direct and indirect solar radiation, the heat of the earth (geothermal energy), and the gravitational effects of the moon that creates the tides. Direct solar radiation striking the earth also drives the global weather system and photosynthesis. This, in turn, creates the wind and waves, as well as biomass (plant and animal matter). The energy in falling water may also be considered a renewable energy source but only if the local environmental impacts are sustainable.

Generally, new large-scale hydropower schemes are not considered a source of renewable energy due to their substantial environmental impacts.

Renewable energy can be converted to many other energy forms. Electricity can be generated from solar, wind, biomass, geothermal, hydropower, and ocean resources. Heat can be generated from solar-thermal and geothermal sources, while biofuels such as ethanol and methane can be obtained from combinations of renewable sources.

(UNEP "Natural Selection, Evolving Choices for Renewable Energy Technology and Policy", page 4).

EU Strategies for Renewables

The countries of the European Union have committed themselves to major changes in their energy systems, predominately based on the Kyoto Protocol obligations and via the goal of improving the security of energy supply to reduce harmful emissions and to increase energy efficiency and the use of renewable energies. Despite many success stories in numerous European countries and concerning different renewable energy sources and support models, Europe must drastically increase overall efforts in the coming years. A considerable amount of success is "eaten up" by increased energy consumption even in times of economic slow- down due to an increased use of energy in private households and especially an increased use of cooling systems. Some countries have excellent supportive or directing legislation for one renewable while neglecting others. One example is in Sweden, where a well-designed CO_2 tax led directly to significant substitution of biomass for fossil fuels for district heating. But at the same time, wind power development is hampered in Sweden by an inefficient and complicated support system.

According to the energy scenarios used by the European Commission when developing acidification and ozone strategies, total EU emissions of carbon dioxide will continue to rise by about 9% over the coming years. This is contradictory to the commitments of the EU and its member countries under the Kyoto Protocol, which requires them to reduce emissions by 8% during the first commitment period (2008-2012). If the total energy used - and especially the part generated from fossil fuels - is overestimated, the estimated cost of reducing emissions to a certain level will also be exaggerated. Moreover, the possibilities of reduction will be underestimated, thus weakening the setting of interim environmental quality targets.[8]

Moreover, indicative targets set by the European Union to reach its CO_2 emission targets by promoting and increasing the use of renewables for electricity consumption will probably not be reached unless many more efforts are undertaken by the EU and its 25 member states. The European Renewable Energies Federation recently reviewed progress on renewables (Table 2) in a regular report on "Missing Targets".

[8] *An Alternative Energy Scenario for the European Union*, SENCO,23A Inglis Rd,Colchester, Essex CO3 3HU, UK.,Published by The European Federation for Transport & Environment, The Swedish NGO Secretariat on Acid Rain, and The European Environmental Bureau EEB

Table 2: Current and Predicted Share of Renewables in Annual Electricity Consumption in the EU-15

	1999	2002	2003	2010	2010	2010
	Actual	Actual	Actual	EU targets	Optimistic scenario[a]	Realistic scenario[b]
	%	%	%	%	%	%
Austria	71.9	64.5	57	78.1	61	58
Belgium	1	1	1.2	6.0	6	3
Denmark	13	20	not yet avail.	29	24	22
Germany	6	7.6 [d]	7.5 [d] (7.9 [e])	12.5	15	12
Finland	24	23 [f]	not yet avail.	31.5	29[g]	25
France	15	16.7	14.1 [f]	21	19	18
Greece	10	8.4 [h]	not yet avail.	20.1	14.5	12
Ireland	5	4.8	not yet avail.	13.2	11	8
Italy	17	18.3 [j]	17.6 [j]	22.0	17-20	17
Luxemburg	3	2.4	2.6	5.7	5	4
Netherlands	2	2.7	5.2	9.0	7	6
Portugal	36	20.4 [h]	37.5 [i]	39.0	37	34
Spain	19	16.7 [h]	23.3 [i]	29.4	30	24
Sweden	52	48	41 [h]	60.0	60	55
United Kingdom	2	2.9	not yet avail.	10.0	10	7
EU-15	14,5	14,8	not yet avail.	22	20,4	17,8

a) Based on the assumption that all goes according to national plans, including all legal and administrative instruments for its execution enforced and no modifications threatening planning.
b) Business as usual, based on real world in respective countries, assumptions according to reality.
c) German values for 2002 and 2003 based on calculations.
d) Not corrected for average hydro and wind year.
e) Included biomass share of waste incineration.
f) Preliminary or estimated figure, the result for 2001 was 23,3 and for 2000 24,9 %.
g) Finnish Government has according to its report to the EC lowered its 2010 target to 26 percent.
h) Value is dependent on hydropower: this year was a dry year; for 2010 an average year is assumed.
i) Value is dependent on hydropower: this year was a wet year; for 2010 an average year is assumed.
j) Renewable national production related consumption, excluding 13 TWh/year imports and industrial waste.

In its May 2004 report, the European Commission also underlined the lack of ambition and follow-through on targets in many EU-15 member states. The member states have not pursued renewables and energy efficiency aggressively enough to contribute to sustainable development and emission reduction goals.

Matching Technologies and Sources to Regional Needs

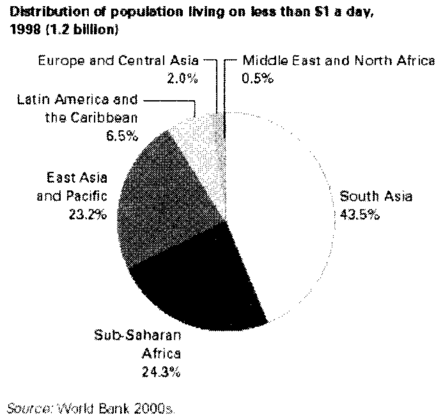
The question of the best choice of renewable energy technologies for different regions, in this case, in Asia or in Europe, however, cannot be answered in general terms. It should follow some general principles and be based on the natural availability and conditions for the different sources such as biomass, wind, geothermal and water power as main sources together with solar energy for the coming 10 to 20 years as well as social traditions under the umbrella of clear political support, environmental and social sustainability, such as evaluation and guidance criteria and a level playing field approach[9]. Most European nations belong to the relatively small group of wealthy countries enjoying comparatively high material standards of living, comprising approximately 20% of the world's population, producing 80% of the world's GNP, while at the same time consuming 60% of the world's energy. However, more than half of the world's population, or close to 3 billion people, have almost no access to modern energy services in the form of electricity or comparable services on which to rely for their everyday needs.

For the vast majority of these people, energy choices are extremely limited. The rural poor in developing countries often depend on traditional fuels such as wood, charcoal, dung and crop residues, usually burned directly or in appliances that are inefficient. For many families, this energy barely meets basic cooking, heating and lighting requirements, let alone the needs of income-generating activities.

The aforementioned 2004 Bonn Conference also emphasised the related suffering of those without access to modern energy services, especially of women and children, due to the time-consuming and labour-intensive process of gathering and transporting firewood and other increasingly scarce

[9] *Indeed, (1) the viability of renewable energy technology is limited by intermittent and site-specific nature of sources of renewables;*
(2) There is a need for training to secure sustainability and follow-through. Both limitations can nonetheless be mitigated. See UNEP "Natural Selection-,Evolving Choices for Renewable Energy Technology and Policy", page 8.

Figure 1



Source: World Development Report 2000/2001

energy sources and using these resources in an unhealthy way. Indoor air pollution from combustion without proper ventilation and other health hazards are thereby imposed on the poor in addition to the loss of time and energy for other activities.

In Asia alone, the variety of regional differences is vast. The needs of a growing population must be managed in different ways but following the same pattern towards democratic development and more humane distribution of energy sources and technologies.

Asia-Pacific Region Energy Trends and Developments

The Asia-Pacific region, with huge poverty problems, has more than half of the total world population and therefore has apparently more and urgent problems than the EU-15 or even the EU-25. Of the more than 2.8 billion people worldwide which have no or insufficient access to modern energy, 1.2 billion live in Asia.

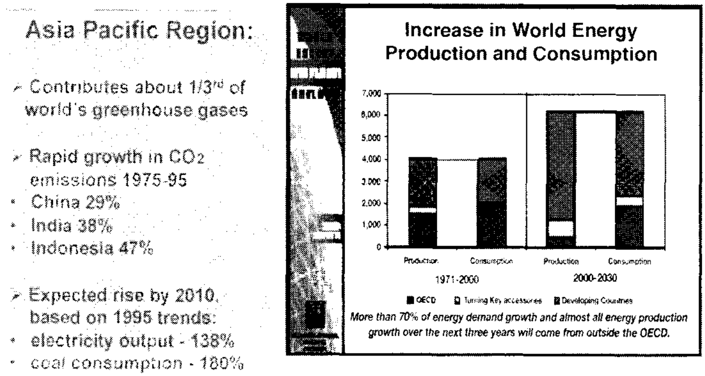
The increasing burden for many Asian countries economies to spend almost the same amount of money for the import of fossil fuels as the amount of development aid received from donor countries perverts completely the idea of encouraging self-autonomy and economic progress by development aid.

According to the World Bank, the per capita energy consumption in Asia is rising, and most Asian countries have large needs for energy supply. Most countries and/or regions face significant challenges in providing rural electrification and an important part of the Asian population depends on traditional biomass-based energy sources.[10]

[10] *The World Bank (2001) Asia Alternative Energy Programme Status Report No. 9, December, Washngton D.C*

Turning to the issue of climate change, many of the adverse effects of a changing climate, such as sea-level rise, are likely to be experienced most dramatically in Asian countries. Asian countries increasingly add to the problem of climate change with rising emission figures due to increased energy consumption, as shown in Figure 2.

Figure 2



(Sources: Table on the left: Renewable Energy in Asia-Pacific, World Renewable Energy Policy and Strategy Forum, and June 13-15, 2002 Berlin, Germany by Dr Jürgen Bischoff, Director, Asian and Pacific Centre for Transfer of Technology (APCTT), New Delhi, and United Nations 2000, New York: State of the environment in Asia and in the Pacific -
Table on the right: IEA, Asia Pacific Energy Market Outlook, Prospects and Challenges)

The International Energy Agency (IEA) has also called for more efforts with respect to rapidly growing energy consumption in Asia as well and is quite pessimistic about the possibilities for reductions in fossil fuel consumption in the coming decades, especially crude oil consumption until 2030, as shown in figure 3 & figure 4.

The apparent obligation of Asian governments for the coming decade lies in increasing access to—and improving the reliability of—modern energy services, especially in rural areas but also in the mega-cities and the suburban and peripheral areas. At the same time, such changes need to occur without dramatically raising GHG (greenhouse gas) emissions or hampering development. Both energy efficiency and renewable energies should be central elements of strategies for sustainable energy systems in the various countries and regions.

Figure 3

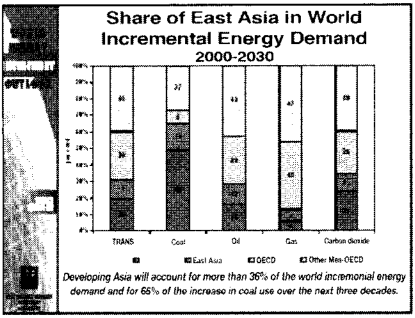
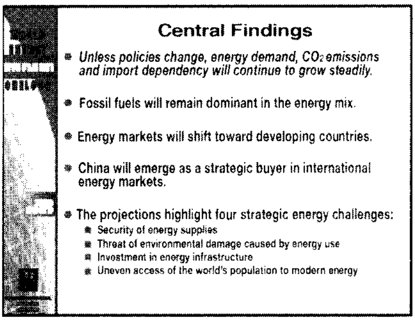


Figure 4



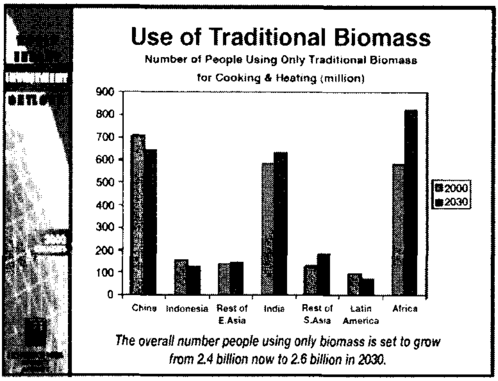
There are already many networks and NGO projects on renewables in Asia. For example ENSIGN, an Asia-Pacific Development Centre/ (APDC)/UNDP project launched in 1996, combined energy services and corresponding income-generating activities in the form of micro-enterprises for the poor, and employed micro-credit mechnisms to finance such enterprises. Eight Asian developing countries participated in the project: India, Indonesia, Mongolia, Myanmar, Nepal, the Philippines, Sri Lanka and Vietnam (UNDP-APDC/APENPLAN, 1998)[11] . The Grameen Bank in Bangladesh used its well-established micro-lending scheme for many renewable energy projects that supported rural electrification and heating systems.

Asia already offers a set of successful initiatives and institutions to promote renewables. Some countries have set national targets for the future share of renewable energy. Targets are an excellent strategy to demonstrate political willingness and create a stimulating investment climate for the private sector.

Some countries in Asia are also starting to establish institutional or regulatory frameworks to better facilitate investments in renewables. Financing schemes that are adapted to regional situations, in particular micro-finance systems, demonstrate how small-scale installations of renewables can become affordable to the population.

[11] *See this and many more examples in: Energy and Poverty Reduction: The role of women as a target group, by Elizabeth W. Cecelski, Director for Research and Advocacy, ENERGIA-International Network on Women & Sustainable Energy, www.energia.org; Paper presented at the Debate on Sustainable Energy in Danish Development Assistance, Copenhagen, Landstingssalen, Christiansborg, September 2000*

Figure 5



(Source: IEA, Asia Pacific Energy Market Outlook, Prospects and Challenges)

During the preparatory conference in Asia for the Bonn Conference in June 2004, the "Bangkok Statement on Renewable Energy" was published. The statement includes a call for government leadership to foster the creation of markets for renewable energy. It was argued that these markets should provide long-term regulatory and price stability, reduce transaction costs associated with project preparation, and encourage cost reduction, reparability and sustainability through increased local manufacturing and local management. They should also allow non-discriminatory grid access for renewable energy, ensure its preferred use in appropriate off-grid applications, and address issues of fuel security for biomass projects. Delegates also called for the promotion of global co-operation in the field of technological development and increased investment in renewable energy in the Asia-Pacific region.

Availability of different Renewable Resources and Technologies in Asia

Biomass

Often biomass is labelled as the energy source of the poor and desperate for Asia or the developing world in general: it is seen as a so-called "non-commercial" energy source, and includes wood, cow-dung, twigs and agricultural waste. Non-commercial energy in many developing countries constitutes more than half of the total energy used, leading to rapid degradation of the natural heritage.[12] This trend can be changed by more efficient use of these traditional biomass resources and also by the introduction of commercial modern biomass technologies for production of electricity, heat, gaseous, and liquid fuels:

[12] *Wolfgang Sachs, Renewable Energies a s a matter of equity between North and South, Presentation at the World Renewable Energy Policy & Strategy Forum. Berlin, June, 2002*

- Bio-energy can be produced in a wide variety of processes using a num ber of technologies to meet consumption needs at many different scales.

- Biomass is renewable and carbon-neutral, but only if it is grown at the same rate it is harvested.

- Biomass is the only class of renewables that can supply energy in all its different forms or carriers - as heat, liquid, gas, or electricity.

- Biomass resources may not always be sufficiently reliable to ensure a continuous supply, since availability is influenced by natural events such as weather.

- Political pressure to reduce atmospheric carbon emissions may create new market opportunities.

Since cooking is the main energy requirement in poor rural areas, any strategy for better energy supply must tackle the issue of poor women and to integrate an important part of improvement of the use of traditional fuels by improved biomass stoves and fuels or better management of biomass supplies.[13] It is known and obvious that such a gender-orientated strategy would improve family health, both by reducing smoke and indoor air pollution, and by decreasing women's and children's workload in wood fuel collection, improving time for education.

Wind Energy

Wind has become a major supplier worldwide. It is estimated that the total available and technically recoverable wind resource in the world today is equivalent to four times the world's total electricity consumption in 1998.[14] India has become one of the international front-runners in wind turbine development and installations.

Photovoltaics

Approximately 400,000-800,000 photovoltaic (PV) systems have been installed worldwide, to power everything from large grid-connected power

[13] see Elizabeth W. Cecelski
[14] *UNEP, page 8*

stations and roof-top residential systems, to small-scale, stand-alone units for rural use. PV is currently the most economically competitive in remote sites away from electricity grids, and where only relatively small amounts of power are required–typically less than 10 kW. However, the market for residential and commercial grid connected systems is also growing as costs decline.

The amount of power from a PV array is directly proportional to the intensity of the light hitting the array. Even on cloudy days, PV systems can still provide electricity as long as there is some solar radiation.

One interesting example of PV installation and usage in Asia is Grameen Shakti in Bangladesh, which had installed 1244 solar systems by August 1999 with a total installed capacity of over 55 kW and reached a sales volume of 100 systems per month. With a plan to install a total of 6000 systems within the next three years, Shakti will expand its network of 19 branch offices in rural Bangladesh. A PV system customer pays 25% of the system cost as down payment and the remaining 75% over two years with an 8% service charge. Following the Grameen philosophy of many years, the PV systems marketed are also directed at generating micro-entrepreneurs and household income-generating activities.

As a result of electricity generation, the following benefits will accrue:

- Extended working hours;
- extended selling and shopping hours;
- increased income in micro-enterprises led by women, including basket-making, electronic repairs, carpentry workshop, tailoring, food stores, fish net weaving; and,
- development of local technical expertise for selling, maintaining and servicing the solar power systems.[15]

Solar Thermal

Over 62 million squares metres of solar heating collectors have been installed worldwide with China as the leading country. This technology can supply 30-

[15] *FAO (Food and Agricultural Organisation of the United Nations), Environment and Natural Resources Service, Sustainable Development Department, Solar Photovoltaics for sustainable agriculture and rural development, Rome 2000, page 36*

40% of the heat needed for hot water and heating of houses in most of the cold regions of the world. For the needs in more temperate areas, much higher figures can be achieved. Consequently much of the present use of fossil energy or other systems used for water heating could be replaced by solar thermal systems.

Hydropower

Micro- or small-scale hydropower has an increasing value as a component of new energy policies in many Asian countries. Decentralised micro-hydro schemes (defined as plants between 10 kW and 100 kW) are a particularly attractive option in many rural areas. Water is a traditional source of power in some parts of Nepal, Sri Lanka and many other Asian countries. In China, there exist tens of thousands of plants in the "micro" range [16], and significant numbers are also operated in countries such as Nepal, Sri Lanka, Pakistan and Vietnam. These experiences demonstrate that micro-hydro can be profitable in financial terms and can exhibit strong positive impacts on the lives of poor people.

Support Models and Policies: Leveling the Playing Field for Renewables

Major driving forces for the development and commercialisation of renewables are the supporting legal and administrative structures, and especially the planning environment. There must be clear short and long-term targets for reduction of dependence on fossil fuels accompanied by targeted increases in renewables and efficiency at both the national and regional levels. These supporting legal instruments, policies and institutions must also be linked with social planning. In Europe there are regions with excellent wind conditions but extremely low development of wind energy, such as in Ireland, due to a lack of appropriate support mechanisms. At the same time, there are regions with more average wind conditions that have experienced rapid growth in wind power, such as in Germany.

Supportive models which aim at reaching a level playing field with the conventional (generally large-scale) energy sector should follow sustainability principles and create regional and social added value. It should therefore be underlined and taken as a guiding principle that renewables are not merely

[16] *Already in 1979, the total generating capacity of all small plants was 6300 MW, with 40,000 stations built in the period from 1975 to 1979, having an average size of 85 kW (Ueli Meier and St. Gallen, 1985).*

a costly luxury for wealthy countries, but a significant small-scale industry with beneficial job-creation capability, as demonstrated in the European experience, but also an increasingly cost-efficient sustainable development tool with considerable spin-off benefits for less-affluent countries and regions.

Often, major obstacles are created by traditional big utilities, especially when facing small, but lively and growing competition from small- and medium-sized renewable electricity producers. France and Sweden provide examples of such obstacles, with both countries having significant existing investments and political-economic power bases in the nuclear industry as well as large-scale hydropower. It comes back to the question of how to create a level playing field and the need for clear and reliable policy in the respective state to allow independent, decentralised growth in the renewables sector.

In Asia, it is paramount to develop a good environment for micro-financing, grassroots networking, training and education of the population in installation, repair and maintenance of renewables technologies.

The choice of renewable technologies will vary significantly based on locations and energy needs, be it densely populated areas or isolated areas, areas with good grid connections and areas without grid access.

In Europe, for example, **urban areas** represent the largest group of energy consumers. Several large urban areas across Europe have demonstrated the integration of sustainable energy concepts, including renewable energies. It has been shown that improved living conditions, as well as qualifications and regeneration of declining industrial areas are objectives that can be linked to renewabales implementation, as in the international framework of Agenda 21 for sustainable development. Urban renewables integration requires planning from decision-makers for sustainable energy strategies at short-, medium- and long-term perspectives in order to provide clear signals to the private sector and those facilitating investment. Integrated concepts should cover all main commodities, public services and building standards, which include energy efficiency and renewable energy systems.

Apart from isolated or very difficult urban conditions in some Central and Eastern European regions with structural crises following industrial decline and major infrastructure failure because of outdated and deteriorating networks and facilities, the question of energy management is not related with the same intensity to the question of energy supply needs or improvement of basic living conditions but to the question of sustainable modernisation and emission reducing energy supply in a socially positive or adequate environment.

On the contrary, mega cities in Asia do face strong energy demand in poor and often desperate living conditions. There is not a big difference between the slums of mega cities without access to infrastructure of the organised parts of the same town or the apparently different world afflicted by the absence of energy in rural areas. Both are deprived of energy and human dignity.

The need for a rapid change from fossil to renewable energy in the world is obvious. The energy source is available. The fundamental question for humanity is to wake up and make the efforts necessary to make the changes needed. Legal and other limitations must be eliminated. Effective support systems must be established. The vision of a sustainable and thriving world must be the general focus.

....

COMMERCIALISATION OF RENEWABLE ENERGY TECHNOLOGIES FOR VARIOUS CONSUMPTION NEEDS

Jiahua Pan
Senior Research Fellow and Executive Director
CHINESE ACADEMY OF SOCIAL SCIENCES, CHINA

Abstract

Can renewable energy technologies meet various consumption needs? It may be argued that without commercial viability, renewable energy technologies cannot compete with conventional energy technologies in this respect. The following issues are to be examined in this paper: (1) the types of renewable energy technologies needed in relation to consumption needs; (2) whether these technologies are commercially viable; (3) the extent to which these technologies can supply the energy needed for industrialisation and economic development in developing countries; (4) policy implications of commercialising renewable energy technologies; and, (5) the role of Asia-Europe co-operation on technological development, diffusion and transfer.

The evaluation will concentrate on market potential rather than technological potential, as some of the renewable energy technologies are yet to be commercial. This examination will be made in the context of the specific consumption needs of a major developing country like China in its current period of high economic growth rates and rapid industrialisation. Asia-Europe co-operation on renewable energy technologies can speed up the process of commercialisation through demonstration, direct investment, joint venture,

Build-Operate-Transfer (BOT), financial aid and capacity building (both technological know-how and institutional).

Renewable Energy Technologies

There are numerous renewable energy technologies that are either already commercialised or show a likelihood to be in the commercial market in the foreseeable future. Major categories of renewable energy technologies include biomass (for use under traditional or advanced technologies), solar, wind and hydropower. Longer-term technological potentials of renewable energy resources in theory would be able to meet global consumption needs (Table 1). Total commercial energy consumption in 2001 for the world is only about 10% of the total technical potential from renewable energy supply. While some of the technologies are already competitive such as large-scale hydropower and to a lesser extent wind power, others such as solar photovoltaic (PV) are yet to be commercially viable for substitution of conventional energy technologies. It is also important to note that new and renewable energy technologies must be evaluated in a horizon as far as 2050 since the capital stock turnover rate, especially in the energy supply sector, is very low.

Table 1: Long Term Technical Potential for Renewable Energy Supply (EJ/yr)[a]

Type of renewable energy	Long term technical potential
Hydropower	>130
Geothermal	>20
Wind power	>130
Ocean	>20
Solar	>2600
Biomass	>1300
Total renewable	>4200
Total primary energy consumption, 2001[b]	425.7
Total energy demand in 2100[c]	515-4620

Note:
a: EJ: exajoules, 1 EJ = 1018 Joules = 23.88 million tonne of oil equivalent (Mtoe)
b: IEA, 2003, p.78. This may be an underestimate as non-commercial energy consumption is not included in the total.
c: IPCC, 2000. p.15, Table SPM-2a. Results for all 6 scenario families.

Bio-energy

Biomass stores energy fixed from the sun through photosynthesis. Traditionally it is the major source of energy for use and still it constitutes the largest share of renewable energy under use, in particular in developing countries. In China, for example, many types of new and renewable energy resources are being tapped for use. However, over 98% of the renewable energy resources are conventional, i.e. biomass and hydropower (Zhou & Wang, 2002, p. 425). Solar, wind and geothermal powers are still at a very early and experimental stage (Table 2).

Table 2: The Use of Renewable Energy in China, 2002

	Amount	Million toe	Share
Small Hydropower	31.0 GW, 103.7 TWh	37.80	11.5%
Biofuels	279.8 mtc	279.80	85.3%
Bio-gas (household)	11.1m; 3.7b m^3	2.64	0.8%
Bio-gas (large and medium sizes)	1300; 1.0b m^3	0.71	0.2%
Bagasse electricity	800 MW, 2000 GWh	0.75	0,2%
Geothermal direct use	0.6 mtce	0.60	0,2%
Geothermal electricity	28 MW, 140 GWh	0.05	0,0%
Solar water heater	40 million m^2	4.86	1.5%
Solar stove	478,000	0.24	0.1%
Solar PV	25 MW, 140 GWh	0.02	0,0%
Wind power	460 MW, 1245 GWh	0.44	0,1%
Total		327.91	100%

(Source: Qinghua, 2004, p. 13. Only small hydropowers are included here. The number for total hydro is some 30 times larger in China. In 2004, hydro electricity reached 328.0 billion KWh, accounting for 15.0% of total electricity consumption in China (China Statistical Bulletin, 2005).)

Globally, biomass has an annual primary production of approximately 220 billion oven-dry tonnes (odt) or 4,500 EJ (1 EJ = 10^{18} Joules). Of this, 270 EJ/yr might become available for bio-energy on a sustainable basis, depending on the economics of production and use as well as the availability of suitable land. In addition to dedicated energy crops, biomass resources include agricultural and forestry residues, landfill gas and municipal solid wastes. Since biomass is widely distributed, it has good potential to provide rural areas with a renewable source of energy (WEC, 2000).

Energy Cropping

A number of annual and perennial species with high efficiency properties can be converted into heat, electricity or transport fuels with neutral or near-neutral carbon emissions. High yielding short-rotation forest crops can give stored energy equivalents of over 400 GJ/ha/yr at commercial scale, leading to very positive input/output energy balances of the overall system.

Gasification of Biomass

Biofuels are generally easier to gasify than coal and development of efficient BIGCC (biomass integrated gasification combined cycle) systems is nearing commercial realisation. Capital investment for a high pressure, direct gasification combined-cycle plant is expected to fall from more than $US2000/kW at present to around $US1100/kW by 2030, while operating costs, including fuel supply, are expected to decline from 3.98 c/kWh to 3.12 c/kWh. By way of comparison, capital costs for the traditional combustion boiler/steam turbine technology is predicted to fall from the present US$1965/kW to US$1100/kW during the same period, with current operating costs of 5.50 c/kWh (reflecting the poor fuel efficiency compared with gasification) expected to fall to 3.87 c/kWh.

Liquid Biofuels

Ethanol production by using fermentation techniques is commercially undertaken on a large-scale in Brazil from sugar cane, and in the United States (US) from maize and other grains. It is used as a straight fuel and/or as an oxygenate with gasoline at blends that tend to vary between 5% and 22%. Ethanol production costs in Brazil have decreased dramatically in the past 20 years, and are now in the range of $0.25/litre (Macedo 2004). In Sweden, production of biofuels from woody biomass (short rotation forests or forest residues) was estimated to cost $0.22/litre for methanol and $0.54/litre for ethanol (Metz et al., 2001, p. 245). However, the energy density (MJ/l) of methanol is only about 50% that of petrol and about 65% for ethanol.

Wind Power

The global theoretical wind potential is on the order of 480,000 TWh/yr, assuming that about 310^7 km^2 (27%) of the earth's land surface is exposed to a mean annual wind speed higher than 5.1 m/s at 10 metres above ground (WEC, 1994). Assuming that for practical reasons, just 4% of that land area could be used, wind power production potential is estimated at some 20,000 TWh/yr, which is greater than the entire global production of electricity of 16,129 TWh in 2002 (IEA 2004).

Solar Energy

An estimation of solar energy potential based on available land in various regions gives 1,575 to 49,837 EJ/yr. Even the lowest estimate exceeds current global energy use by a factor of four. The amount of solar radiation intercepted by the Earth may be high but the market potential for capture is low because of: (1) the current relative high costs; (2) time variation from daily and seasonal fluctuations, and hence the need for energy storage. The maximum solar flux at the surface is about 1 kW/m^2 compared to the annual average of 0.2 kW/m^2 for a given point; (3) geographical variation, i.e. areas near the equator receive approximately twice the annual solar radiation than at 60° latitudes; and, (4) diffuse character with low power such that large-scale generation from direct solar energy can require significant amounts of equipment and land even with solar concentrating techniques.

Photovoltaics (PV)

The trend of PV investment costs is gradually converging towards the classical learning curves experienced with other renewable technologies (WEA, 2000). Although present generating costs are relatively high (20 - 40c/kWh), solar power has proven competitive in niche markets. Photovoltaics can often be deployed at the point of electricity use (e.g. in buildings) and this can give a competitive advantage over power from central power stations as it helps to offset higher costs.

Solar Thermal

Solar panels for water heating can be competitive in the market with other means of water heating. By the end of 2003, solar water heaters in China exceeded 50 million m^2 and by 2020 are projected to reach 270 million m^2 (ZERI, 2004). In Europe, 1 million m^2 of flat plate solar collectors were installed in 1997, anticipated to rise to 5 million m^2 by 2005. Combined PV/solar thermal collectors are under development with an anticipated saving in system costs. However, the production costs remain high at $0.18-0.20/kWh, assuming an 8% discount rate and a 10-year lifetime. Capital costs are projected to fall from US$4000/kW to $2500 by 2030 (Metz, 2001, pp. 247-9).

Hydropower

Large-scale hydropower has been a major source of power supply that has long been competitive with fossil fuel energy sources when used to provide baseload (as opposed to peak) power. Numerous small (<10 MW), mini (<1 MW) and micro (<100 kW) scale hydro schemes with low environmental impacts continue to be developed globally. The experiences in China demonstrate that hydropower development is a dominant source for rural electrification and takes a significant share of total electricity generation (CERA, 2003). From 1980 to 2002, electricity generating capacity from hydropower increased from 20.3 GW to 86.0 GW, but hydropower generation increased from 58 TWh to 275 TWh, accounting for 1/6 of the national total electricity production.

Consumption Needs

With an understanding of the available energy technologies, we must have a look at the consumption needs for energy. Table 3 gives an overall picture of commercial energy supply, total greenhouse gases (GHG) emissions and emissions by sector for 2001. Major sectors include public electricity and heat production, which is mainly related to the buildings sector, manufacturing industries and construction and transport.

Table 3: Total Commercial Primary Energy Supply, CO_2 Emissions from Fuel Combustion Total and Per Capita and Sector Shares, 2001

	Unit	World	OECD total	Non Annex I total
Total primary energy supply	mtoe	10165	5333	4168
Total emissions	$MtCO_2$	9925	5581	3753
Per capita emissions	$kgCO_2$	3881	10988	1871
Public electricity and heat production	%	34.8	35.2	36.9
Other energy industries	%	5.2	5.2	6.5
Manufacturing industries and construction	%	18.1	14.9	24.3
Transport	%	23.9	26.8	16.2
Other sectors	%	14.0	14.6	13.7
Unallocated auto producers	%	4.0	3.2	2.5

Note: OECD: Organisation for Economic Co-operation and Development, Non-Annexe I countries: countries that are not included in the list of Annexe I. Annexe I countries are industrialised ones while non Annexe I countries are in general developing countries. Please note that OECD and Non-Annexe I total do not equal to World total, as economies in transition countries (Former Soviet Union and Eastern Europe) are not included. mtce: million tonnes of coal equivalent.
(Source: IEA, 2003.)

Buildings

Global projections of primary energy use for the buildings sector show a doubling, from 103 EJ to 208 EJ, between 1990 and 2020 in a baseline scenario (Metz et al, 2001, p. 183). The most rapid growth is seen in the commercial buildings sector, which is projected to grow at an average rate of 2.6% per year.

Space Heating

Space heating is the largest end-use in developed countries as a whole, although its share is less significant in some warmer developed countries such as Australia. Space heating has a much smaller share among end-uses overall in most developing countries, with the exception of the northern half of China, Korea, parts of Argentina and a few other South American countries.

Water Heating, Refrigeration, Space Cooling and Lighting

The above end-uses constitute the next largest residential energy uses, respectively, in most developed countries. In developing countries, cooking and water heating dominate, followed by lighting, small household appliances and refrigerators.

Transportation

According to the International Energy Agency (IEA) statistics, the transport sector's share of world CO_2 emissions increased from about 19% in 1971 to 24% in 2001 (IEA, 2003, p.125). Almost all of the carbon emitted from this sector comes from petroleum fuels. Alternative energy sources have not yet played a significant role in the world's transport systems, with the exception of the widespread use of ethanol from sugarcane in Brazil.

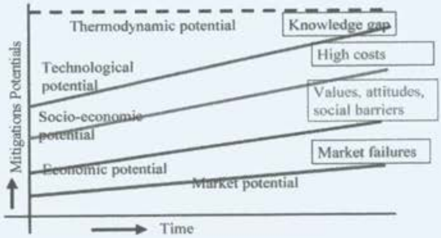
Industry

Among the industrial sectors, manufacturing and construction constitute the biggest share of energy consumption. This is particularly the case for rapidly industrialising countries like China. For the first half of 2004 in China, total electricity production amounted to 1001.72 billion kWh, of which industrial sectors consumed 75.3%, with the service sector 11.1%, residential sector 10.8% and agriculture 2.8%.

According to IEA (1998) projections, consumption needs for electricity will more than double during the period between 1995 and 2020. The share of renewables (hydro plus renewables) will drop from 20.3% in 1995 to 16.6% in 2020. Renewables are projected to account for less than 1.6% of the total electricity in 2020. In Europe, however, the share of renewable electricity is in general increasing (See Table 2 in Danielsson, 2005-this volume). The governments in Europe plan for an even larger share for 2010. In China, the target for renewable energy development is even more ambitious (ZERI, 2004). The generation capacity for wind power is projected to increase from 560 MW in 2003 to 20,000 MW in 2020. Even for the expensive solar PV, generation capacity is to be increased from the current 50 MW to 1000 MW in 2020.

Market Potentials

Figure 1: Barriers to achieving various levels of mitigations pontentials



Renewable energy technological potentials do not easily translate into reality. In most cases, market potentials can only be realised with significant promotional policies or support mechanisms. The Inter-governmental Panel on Climate Change (IPCC) (Metz et al, 2001) makes a distinction among different potentials, from market potential at the lowest end up to the theoretical or physical potential at the upper limit (Figure 1).

To move from market potential to economic potential, economic benefits including both private and public elements have to be included. Then social values and attitudes have to be changed in order to reach socio-economic potential. Physical potential can be several times bigger than market potential. Table 3 shows that hydropower potential in economic terms is only 17.5% of theoretical level on average for the world. The figure for Asia is only 11.8%.

For commercialisation of renewable energy technologies, the biggest barrier comes from cost and to a lesser extent is related to physical characteristics. In the transport sector, for example, hydrogen is clearly the cleanest and most efficient fuel choice for fuel cells, but there is no hydrogen infrastructure and on-board storage still presents technical and economic challenges. While fuel cell costs have been reduced by approximately an order of magnitude, they are still nearly ten times as expensive per kW as spark ignition engines.

Ethanol production from maize and other grains in the US, from sugar cane in Brazil, and biodiesel from oilseed rape in Europe, are being commercially produced, but are subject to commodity price fluctuations and government support. The relatively low energy yields per hectare for many oil crops (around 60 to 80 GJ/ha/yr for oil) compared with crops grown for cellulose or starch/sugar (200–300 GJ/ha/yr), has led to the US National Research

Council advising against any further research investment in this technology (NRC, 1999). Full fuel cycle emissions and production costs remain high in some cases. Problems associated with biogas range from odour complaints to heavy metal contamination of the decomposed residue. Also, large-scale composting requires mechanical aeration which can be energy intensive (40-70 kW/t of waste).

Table 4: Annual Large Hydroelectric Development Potential (TWh/yr) (World Atlas, 1999)

	Theoretical potential	Technical potential	Economic potential	EconomicPotential as share of Technical Potential
	(a)	(b)	(c)	(c) /(a)
Africa	3,307	1,896	815	24.6
North America	5,817	1,509	912	15.7
Latin America	7,533	2,868	1,198	15.9
Asia (excluding	15,823	4,287	1,868	11.8
former USSR)				
Australasia	591	201	106	17.9
Europe	3,128	1,190	774	24.7
Former USSR	3,583	1,992	1,288	35.9
World	39,784	13,945	6,964	17.5

Wind power supplies around 0.1% of total global electricity but, because of its intermittent nature and relatively recent emergence, accounts for only 0.3% of the global installed generation capacity. Installed wind generation capacity has increased by an average of 25% annually over the last decade, reaching 13,000 MW by 2000, and is expected to increase to 30,000 MW by 2005. The cost of wind turbines continues to fall, with the trend following the classic learning curve, based on which further reductions are projected (WEC, 2000). In high wind areas, wind power is competitive with other forms of electricity generation. However, wind power is in general yet to be competitive with conventional fossil fuels, even hydro and nuclear power. Table 5 summarises the experiences in China, showing that the cost from wind power can be more than twice that of coal-fired electricity (in Chinese Renminbi-RMB).

Table 5: Comparable Cost Advantage of Wind Power (RMB/kWh)

Location	Geographic location and resources	Wind power	Coal electricity	Wind/coal
Xinjiang	West inland, rich in coal, oil and wind	0.70	0.32	2.18
Inner Mongolia	Northern inland, rich in coal and wind	0.71	0.35	2.20
Liaoning	North East Cost, rich in coal, medium in wind	0.95	0.45	2.11
Shandong	East coast, coal and wind medium	0.80	0.45	1.78
Zhejiang	South east coast, no coal, medium wind	0.79	0.50	1.56
Fujian	South east coast, poor in coal and rich in wind	0.79	0.55	1.43
Guangdong	Southern coast, poor in coal and medium in wind	0.77	0.60	1.32

(Source: Zhou and Wang, 2002. p. 458.)

Large-scale hydropower plant development can have high environmental and social costs, such as loss of fertile land, methane generation from flooded vegetation and displacement of local communities. As a result of the construction of the 18,200 MW Three Gorges dam in China, 1.2 million people have been moved to other locations. Another limitation to further development of this technology is the high up front capital investment which the recently privatised power industries are unlikely to accept because of the low rates of return.

Making Use of Renewable Energy Technologies

Renewable energy technologies are available and some of them are commercially viable in the market. In particular, some of the new and renewable energy technologies can be complementary to conventional technologies in terms of providing power during peak load periods. In this respect, for large base load power, large-scale hydropower shows great potential despite its problems.

Household and Remote Energy Supply

Photovoltaic systems are being increasingly used in rural off-grid locations, especially in developing countries, to provide electricity to areas not yet connected to the power infrastructure or to offset fossil fuel generated electricity. These systems are most commonly used to provide electricity for lighting, but are also used for water pumping, refrigeration, evaporative cooling, ventilation, air conditioning, and powering various electronic devices. Water heating by solar brings about cost advantages over other means of energy uses. In China, millions of solar panels have been installed in rural and urban houses and apartment buildings. This as a matter of fact reflects that the enlargement of the scale of economy is bringing down production costs, which in return increases affordability.

While bio-diesel and ethanol can substitute for diesel and petrol, the biggest constraints come from the availability of land for biomass production, particularly in developing countries where food production from land has a higher priority. As such, continuous improvements in conventional small-scale biomass technologies not only lead to increased efficiency but also make the systems easier to operate. Such practices in China include bio-gas at either the household level or community level. Animal wastes from livestock farms have to be treated before they can be disposed to the fields as fertiliser. Bio-gas production from large livestock farms can produce methane gas for cooking for hundreds of households or even for electricity generation.

Industrial Supply

Evidently, bio-energy, solar or even wind power technologies cannot provide large-scale energy at the commercial level. Although their theoretical or technological potentials are huge, no renewable technologies other than large-scale hydropower have been able to economically meet the high consumption needs by large users such as industries and urban centers. Large hydropower where available may represent a chance for development. This is particularly true in developing countries which are gradually entering into the stage where energy-intensive industries are being rapidly developed.

The Case of Hydropower in China

In China after the year 2000, electricity demand has been growing at over 15% annually. Newly installed capacity for electricity generation for 2004 amounts to 37 GW, while 137 GW capacity is under construction (State Power Grid Company, 2004). One could not imagine that solar PV or even wind power could provide such huge volumes of capacity in such a short period of time. However, the aggressive hydropower development plan in China plays an important role.

According to the fifth national survey on hydropower during the period between 1977 and 1980 (Zhou et al, 2003, p. 426), theoretical capacity for hydropower amounts to 676 GW, with an annual generation of 5.92 trillion kWh. However, only 55.9% of the generation capacity is technically feasible and the realisable production per annum is only 32.4% of the theoretical total (Table 6).

The number of sites for large hydropower stations is small, accounting for 17.5% of the total with unit capacity larger than 500 kW, but the amount of electricity generation per annum is 94.8% of the total annual production. Small hydropower (unit capacity smaller than 500 kW) is in general large in numbers and widely spread, but the total generation capacity is somewhat negligible, only at 5% of the total. Medium to large-scale hydropower can meet the electricity demands for industrial development and urban consumption. Small to medium-sized hydropower stations are insufficient to shoulder industrial and urban load, but they do have the advantage of electricity generation for remote villages and townships.

Table 6: Hydropower Development in China

	Number of hydropower stations	Installable capacity	Electricity generation	Note
	Unit	Million kW	Billion kWh/a	Unit
Theoretical level	Na	676	5,920	
Technically feasible level	11103	378	1,920	>500kW
Large hydro	1946	357	1,820	>10,000kW
Medium sized	9157	22	100	between 500-10,000kW
Small hydro	>40,000	23	72	<500, in use
Technically feasible total		75		<500

(Source: Zhou & Wang, 2002, pp.332-334; Zhou et al. , 2003, pp.426-428.)

The results from hydropower are also impressive. In 2004, 15.0% out of 2187.0 billion kWh electricity generation came from hydro-energy in China.

Policy Environment

As many of the renewable energy technologies are yet to be commercially viable, environmentally-friendly policy support is required to promote commercialisation of renewable energy technologies.

There are a number of reasons behind such policy initiatives, including mitigation of climate change, pollution control, concern over the depletion of exhaustible resources, and poverty alleviation. This would suggest that early actions are necessary due to lock-in effects, which has two implications. First, early investments and early applications are extremely important in determining which technologies will be most promising in the future. Second, learning and lock-in make technology transfer more difficult. Learning is much more dependent on successful building and using of technology than on instruction manuals. Furthermore, technological productivity is highly dependent upon complementary networks of suppliers, services and training, which can be difficult to replicate in another country or region.

There are multiple government-driven pathways for the adoption of renewable energy technologies. Through regulation of energy markets, environmental regulations, energy efficiency standards and market-based initiatives such as energy and emission taxes, governments can induce technology changes and influence the level of innovations. Important examples of government policies on energy supply include the Clean Air Act in the USA, the Non Fossil Fuel Obligation in the UK, the Feed-in-Law in Germany, the Alcohol Transport Fuel Program in Brazil, and utility deregulation that began in the UK and has now been adopted in the USA, Norway, Argentina and many other countries. Voluntary agreements or initiatives implemented by the manufacturing industry including energy supply sections can be also drivers of technological change and innovation.

Policies can also be directed at consumers. Some environmentally conscientious consumers may be willing to pay a higher price for renewable energy uses. For example, wind power is purchased by many households in Europe at higher prices than coal fired power. From a policy perspective, a progressive tax on emissions may have a positive impact on the promotion of renewable energy technologies. Similar to an income tax, the tax rate would rise as the level of electricity consumption rises. For consumption lower than basic needs level, exemptions may be granted, or even subsidies might be applied. If the consumption is at the basic needs level, a normal or basic rate could be employed. As consumption increases above this level, higher rates would be levied. For such a tax mechanism, the following purposes are kept in mind: (1) reduction of luxurious and wasteful consumptions; (2) raising resources for low-carbon development; and, (3) the provision of a strong market signal to carbon emitters for efficient and effective carbon reductions.

Many of these policies have been used in China, but there was no systematic legislation promoting the development of renewable energy in China until recently. This situation came to an end when the Standing Committee of the People's Congress passed the People's Republic of China Renewable Energy Law at its 14th Session on 28th February 2005, which will take effect on the 1st January 2006. Articles of the Law stipulate that development and use of renewable energy sources will be the priority areas for energy development. Electricity from renewable energy sources will not be restricted to access to the power grid. A special fund for renewable energy development has been established to support research and development, renewable energy development in rural and remote areas and resource survey and promotion of localised equipment production. Cross-subsidy is allowed by the utilities for use of electricity from renewable energy. Tax relief, preferential loan and capital grants are also made available for development of renewable energy.

Renewable energy technologies must be assessed with respect to consumption needs. Solar energy can be used for heating and electricity. Solar panels for household water heating are commercially competitive but solar PV is too expensive and unstable for large-scale market application. Wind farms can generate competitive electricity but there are also constraints such as the variation of wind speed and occupation of land surface areas. Hydropower can perform in the market as well as fossil fuel energy but long distance power transmission is required. Biomass can be used for direct cooking, power generation, bio-gas and ethanol.

Theoretical potentials of renewable energy technologies could be larger than the actual human demand, but owing to constraints and barriers, these technological potentials cannot be realised. Nevertheless, there exists a huge scope for the commercialisation of renewable energy technologies to meet various consumption needs. For remote off-grid small-scale users, solar, wind, biomass and small hydropower can be even more competitive than conventional large-scale supply of thermo-power.

Solar water heating and bio-gas for cooking in rural villages and small townships are often the most appropriate technologies though not the most advanced. Due to being large in numbers of households, total energy supply can be substantial from such scale production and use of renewable energy. In addition, electricity from solar PV, wind, biomass and small hydropower can be connected to the regional power grid. However, for large consumption needs, by industries and urban centers, large hydro development is the most commercially competitive renewable technology for large-scale electricity generation.

Given the rapid increase in demand for a large and stable supply of electricity in rapidly industrialising countries like China, small scale renewable energy technologies cannot provide an immediate solution. In this regard, the technological potential of medium and large hydropowers can play a significant role in powering the industrialisation process in China. Also, nuclear power should also be included in the electricity generation mix. However, in the long-term, all the countries including those in the process of industrialising should shift to new and renewable energy technologies. As the capability in terms of technological development and financial sources is rather limited in developing countries, Asia-Europe co-operation on renewable energy technologies is critical. In the short run for instance, financial and technological assistance from developed countries to the rapidly industrialising countries can help meet energy needs not only for large consumers in the industrial and urban sector but also for small in particular remote users by way of renewable energy technologies development. In the longer run, joint technological development between developed and developing countries may be more effective than a simple transfer of renewable energy technologies considering the lock-in effect.

To make renewable energy technologies and energy efficiency measures commercially viable, some policy initiatives are often necessary. One policy example is a progressive tax on energy consumption. For example, if one consumes more than a certain level, the price can be set at twice the normal level. A second policy option is to provide direct subsidies for renewables and efficiency until the markets become mature. A third policy option can be direct regulation, such as requiring the power grid operators to buy a fixed proportion of renewable technologies. However, these policy initiatives are not mutually exclusive with respect to energy efficiency, renewables and low carbon technologies. Asia-Europe co-operation on renewable energy technologies can speed up the process of commercialisation through demonstration, direct investment, joint venture, BOT, financial aid and capacity building (both technological know-how and institutional).

References

CERA (China Energy Research Association), 2003. Energy Policy Studies. June 2003. Beijing, China.

IEA (International energy Agency): 1998. World Energy Outlook 1998 update. IEA/OECD, Paris.

IEA, 2003: CO2 Emissions from Fuel Combustion, 1971 - 2001. Paris: Organisation for Economic Cooperation and Development (2003 edition).

IEA 2004, World Electricity Production Statistics. www.iea.org

IPCC (Intergovernmental Panel on Climate Change): 2000. Special Report on Emissions Scenarios. Cambridge: Cambridge University Press.

Macedo, Isaias, 2004. Current Status of the Brazilian Ethanol Programme. University of Campinas, Brazil.

Metz, B., O. Davidson, R. Swart, and J. Pan, (eds.) Climate Change 2001: mitigation. Cambridge: Cambridge University Press. Pp 752.

NRC(National Research Council), 1999. Review of Research Strategy for Biomass Derived Transportation Fuels. National Academy Press, Washington D.C., 60pp.

Pan, J., 2002, An analytical framework for human development, with empirical data', Social Sciences in China, No. 6 (in Chinese), pp. 9–17. 200

Pan, J., 2004, 'Meeting human development goals with low emissions, IDS Bulletin, vol 35: 3. pp. 90-97. Institute of Development Studies, published in the UK.

Qinghua, 2004. China Energy Prospect 2004. Nuclear and New Energy Technologies, Qinghua Unversity Press. Beijng. 72pp.
WEC (World Energy Council), 2000. Survey of Energy Resources. World Energy Council, London.

World Atlas, 1998. 1998 World Atlas & Industry Guide. The International Journal on Hydropower and Dams. Aqua-Media International. Sutton, UK.

ZERI (Zhejiang Energy Research Institute), 2004. Current Status of Renewable Energy Development and Targets in China. Zhejiang Energy Research Institute, 11 August 2004. Zhejiang.

Zhou, F. and Y. Wang, 2002. Fifty years of Energy in China. China Electric Power Publishing, Beijing. 71pp.

Zhou, D., Dai, Y. Yi, C., Guo, Y. and Zhu, Y.: 2003, China's Sustainable Energy Scenarios in 2020, China Environmental Science Press, Beijing, August 2003

Chapter 3

From an Idea to a Market: Sustaining the Technology Innovation Process

3

CLIMATE, ENERGY AND INNOVATION: MOVING FROM THEORY TO PRACTICE

Prof. Michael Grubb*
Policy Director
The Carbon Trust, United Kingdom

Abstract

The achievement of major reductions in greenhouse gas (GHG) emissions will require far-reaching technological changes if they are to be achieved at an acceptable cost to society. Indeed, at present this seems one of the few issues on which there is wide international agreement in relation to climate change. There are, however, disagreements among policy analysts as to how to promote technological change in order to support the goal of climate stabilisation. There are also practical institutional challenges in devising and successfully implementing policies to support the required innovation, both at national and international levels. This paper assesses the role of technological innovation in addressing climate change goals and considers some of the major policy implications in terms of providing incentives and platforms for innovation. In terms of technology options, special reference is made to small and medium-scale renewable energy technologies as key components in the long-term decarbonisation of energy systems. In terms of policies and institutions, the situation in the United Kingdom (UK) is highlighted as it offers an interesting example of institutional innovation through the public-private partnerships that underlie the UK climate change strategy and support new policy frameworks for stimulating technological innovation.

* *Francis X. Johnson (Stockholm Environment Institute) drafted, edited, and contributed to this paper (with the permission of the author) based on the presentation by the author at the Asia-Europe Environment Forum 3rd Roundtable along with additional material provided by the author.*

There is a strong scientific consensus behind projections which show that global energy-related carbon dioxide (CO_2) emissions will at least double by mid-century in a "business-as-usual" scenario lacking major mitigation measures. Stabilising greenhouse gas concentrations at almost any level will ultimately require significant reductions compared to current emissions levels. Stabilisation implies that a radical transformation of energy systems is a question of when and how, not whether (Edmonds et al, 2001). Some governments, such as the UK, have already proposed that major emission reductions be achieved by mid-century, on the order of 50-60% compared to current levels. Meeting such challenging targets without incurring excessive costs will clearly require a significant amount of technological innovation.

In assessing climate mitigation strategies, it is important to address renewable energy in the appropriate context in terms of the theoretical and practical relationships between climate change, energy development and technology policies. These relationships can be evaluated in many different ways: through engineering-economic models, economic equilibrium models, backcasting scenarios, more qualitative policy analysis and many other approaches. Focusing on theories of innovation and technical change, a number of valuable insights are available through a combination of theoretical constructs and empirical evidence as to how markets can be "pushed" or "pulled" towards more efficient and less carbon intensive energy technologies and end-uses.

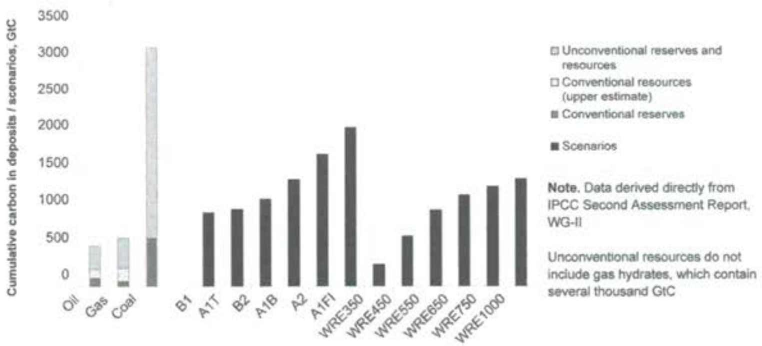
In addressing the role of technology in energy/climate issues, there is often a widespread belief among policy analysts that technology is the answer, yet a closer look often reveals a lot of confusion as to what the question was! In order to assess these issues in detail, it is necessary to look back along the chain of events through which new technologies come to the market and ask how and why they became commercially widespread and what elements of that market development might be replicable in some form for other technologies. The resulting analysis can provide useful insights on the applied challenges of innovation in actually delivering better technologies at commercial scale in national and global markets. The steps required in successful innovation processes pose a number of policy and institutional challenges. The innovation cycle also points to some important linkages between climate change, renewable energy and energy security in both a national and international context, and these linkages are also explored in more detail in this paper.

A Long-term View on Decarbonisation

Although there are several greenhouse gases, it is only carbon (as a by-product of combustion) that is inextricably linked to energy production and use. Even with advanced methods for carbon sequestration and storage, climate stabilisation and decarbonisation are highly correlated. A long-term view on fossil fuels reveals a basic relationship between energy resources, climate, and the entire timescale of sustainable development.

In Figure 1, the three bars on the left show the amount of carbon in different kinds of fossil fuel deposits. It is clear that there are vast amounts of carbon under the ground, plenty enough to fuel global economic development and also to do enormous damage to the atmosphere at the same time. However, it is rather interesting to note that conventional oil reserves have about 100 billion tons of carbon, which is equivalent to about 30 years or so of the present generation. Gas has about 80 billion tonnes of carbon. The really big deposits of carbon are in coal, on the order of several times that of oil and gas combined, suggesting that substitution for coal is more important for climate stabilisation than substitution for oil or gas.

Figure 1: Carbon in Fossil Fuel Resources vs Carbon under Various IPCC Scenarios



The twelve blue bars on the right in Figure 1 are simply projections of carbon emitted under all kinds of different IPCC scenarios. The graph illustrates the magnitude of the scenarios that make the climate change scientists really worried because those scenarios involve emitting far, far more carbon than exists in petroleum, oil and gas reserves combined. Analysing fossil fuels from this long-term carbon perspective also underscores the timeframe through which different types of analysts view the problem. Energy economists tend to worry about the next two decades or so, especially since assumptions about discount rates will often render longer-term analysis of climate policy options economically irrelevant. Climate scientists do not use discount rates since they are looking at the physical system and are often thinking on a timeframe that is closer to one century. The reality of long-term fossil resources makes it clear that a revolutionary change in the structure of global energy supplies is needed in order to get on a path towards climate stabilisation by mid-century, which will have huge implications for carbon.

Unlike oil and gas, coal is largely located within countries of major demand expansion (like China and the US), although transport costs and environmental impacts may still be significant. In contrast, development of conventional oil resources is unlikely to more than double the presently proven conventional reserves and global production is widely expected to peak in the next 20 years or so. Natural gas is increasingly a fuel of choice but whilst global resources are at least comparable with oil, they are also mostly not near major demand centres and nearly half the world's potential reserves are considered as "stranded". Nevertheless, a quarter of global gas is now internationally traded, and the ongoing development of both pipeline and liquefied natural gas (LNG) is leading towards a global market that should stabilise prices and increase access. Limits on Uranium reserves do not pose significant constraints on plausible nuclear expansion out to mid century.

Similarly, most renewable energy sources are very large in terms of physical flows, and although various constraints limit what is feasible, the estimated global potential for tidal, wave and hydro are comparable to the scale of global electricity consumption, whilst most estimates of practicable wind and solar resources are substantially greater still (Figure 2 summarises various estimates). As with natural gas, key issues for delivery include the systems and the fact that (with the minor exceptions of direct solar heating and lighting, and geothermal heating) all but one - biomass - can only produce primary electricity.

Set against a typical "Business As Usual" projection - a world that pays no deliberate attention to global carbon and in which emissions double from the present 7 GtC/yr to 14 GtC/yr by mid-century - Pacala and Socolow (2004) suggest thinking about the problem in terms of rapid expansion of seven "wedges" of alternate technologies, each of which displaces about 1 GtC/yr by 2050. Seven such "wedges" would stabilise emissions to 2050; consistent with CO_2-equivalent doubling of pre-industrial concentrations (Figure 3).

Figure 2: Global Renewable Energy Potential and Current Energy Demand (Neuhoff (2005))

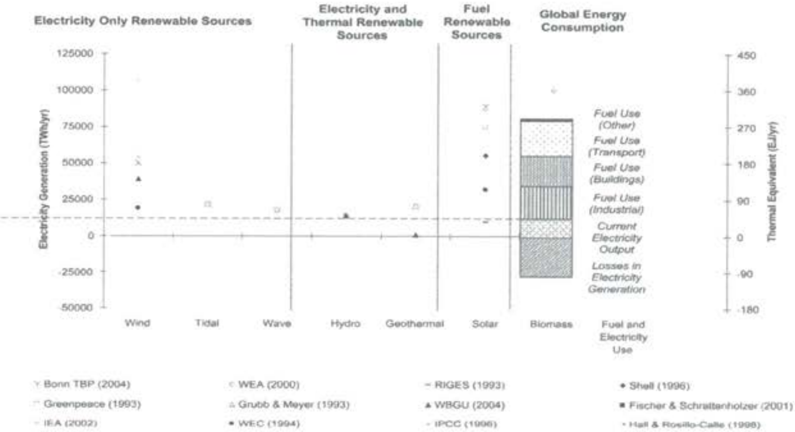
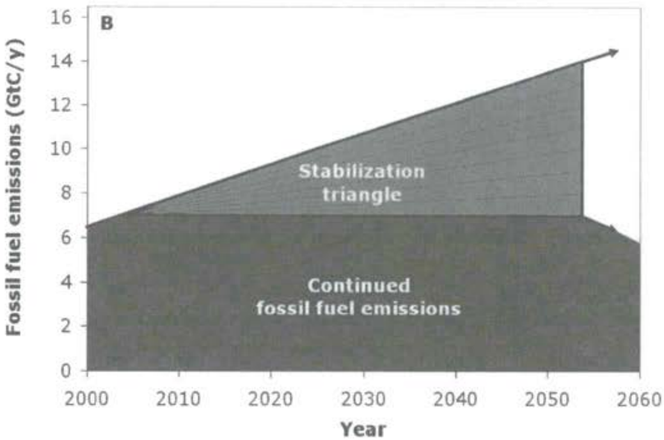


Figure 3: The Princeton "Stabilisation Triangle"



(Source: Pacala and Socolow (2004))

Notes: Compared to "business as usual" case (doubling of CO_2 emissions, from 7 GtC/yr to 14 GtC/yr, by mid-century) stabilisation requires a "stabilisation triangle" that grows to 7 GtC/yr by mid-century. This can be conveniently divided into seven "wedges" of avoided emissions, each of which grows linearly from zero to 1 GtC/y after 50 years. The wedge is useful in quantifying options with big impacts on global carbon emissions.

Potential wedges come in many forms, ranging from improvements in efficiency for automobiles, appliances, and power plants, to greater shares in energy supply for nuclear energy, renewable energy, and carbon capture and storage, to enlargement of bio-carbon stocks through management of forests and soils. Pacala and Socolow state that essentially all of these "wedge" technologies are already deployed somewhere and what is required is a "scaling-up" of deployment rather than any major technological breakthroughs.

The wedge analogy is obviously a tremendous simplification, since it is designed to emphasise the issue of scale in combination with the major decarbonising technology measures or options. Pacala and Socolow acknowledge that every wedge is likely to be difficult to accomplish in practice because the required scale-up is extremely large, and such a scale-up may introduce serious environmental and social problems that are not present at the current more limited scale of deployment. The role of technological innovation can be seen in some respects as being complementary to the process of scaling up and takes on greater significance when viewed in a societal context – given the variety of applications, the diversity of energy end-user requirements, and the types of energy services appropriate for the different levels of socio-economic development in different regions of the world.

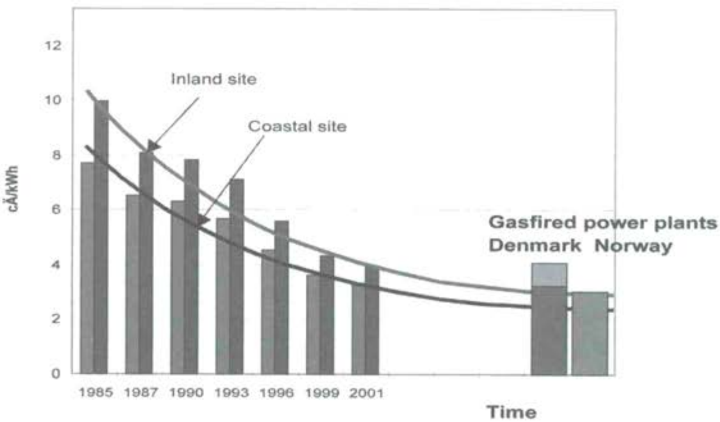
The "Technology-Push" vs "Demand-Pull" Debate: Significance and Evidence

Turning to technology innovation in the context of the climate policy debate, one finds two polarised views about technology innovation processes. The "technology-push" view holds that the primary emphasis should be on development of low-GHG technologies, typically through publicly funded R&D programmes. The opposing "market-pull" view holds that technological change is primarily a product of economic incentives and must come from the business sector. In the climate context, this view gives priority to regulatory measures such as technology standards or GHG emission caps. Thus, divergent perspectives on the process of technology change lead to a significantly different set of policy prescriptions.

The argument about technology change processes seems to be mostly between different western schools of thought, and itself reflects the tendency of western policy analysts – and the underlying economic theories upon which the policy analysis is based – to draw a sharp distinction between the role of the state (and of regulation as its main tool of implementation) and the role of the market (and of private industry as the implementer). It is possible that Asian policy analysts and researchers, accustomed to more intimate and less formal relationships between state and industry, are more likely to accept the need for – and perhaps find ways to implement - a more integrated approach.

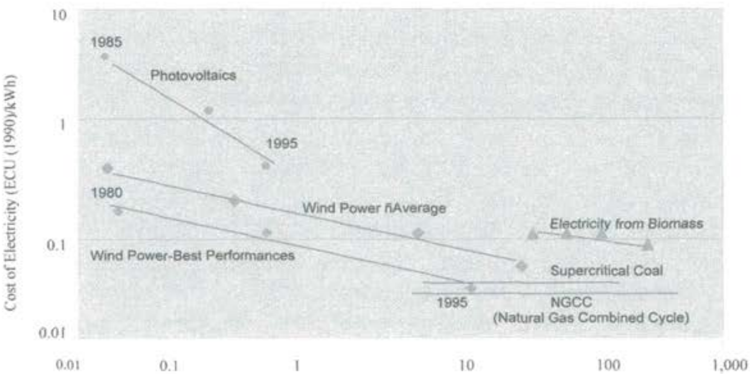
There is some empirical evidence to support the existence of rapid learning processes in the deployment of renewable energy technologies, giving some credence to the aforementioned importance of scaling up. Wind energy development during the past two decades offers perhaps the most classic example. Figure 4 shows the declining cost of wind energy in Denmark as the industry expanded at about 25%/year, first domestically and then internationally. Costs roughly halved during the 1990s and wind energy now appears competitive with conventional power generation at good sites around much of Europe. The technology improved dramatically, but in evolutionary ways clearly associated with the build-up of the industry.

Figure 4: Cost Reductions for Wind Energy in Denmark (Morthurst, 2005)



There is, in fact, empirical evidence for many renewable energy technologies linking technology cost reductions to increased use, through a variety of learning processes. Figure 5 illustrates historic "learning curves" for various electricity technologies; a doubling of production volume has typically been associated with cost reductions of 10-25% during the initial phases of commercialisation and deployment.

Figure 5: Historic Energy Technology Learning Curve Data (McDonald and Schrattenholzer, 1999)



Projecting technology costs into the future is necessarily uncertain, but analysis that combines engineering assessments with experience curve data does provide some interesting insights. There appears to be a diversity of very low carbon options that have medium-term potential costs broadly around 5-7 c/kWh; carbon capture with storage, modular nuclear, advanced biomass, fuel cell technologies and offshore renewables all fall into this range. All these options draw upon known technologies; major breakthroughs do not seem needed in power generation. Paths to very low carbon electricity systems within decades seem achievable if we can develop the associated industries at scale (Grubb M., J. Koehler, D. Anderson, 2002).

The situation for transport is more complex. The main options are biofuels, electricity, and hydrogen, the last two only helping if produced from very low net CO_2 energy sources. There do appear to be a range of options that could start to compete with oil. Cost reductions in Brazil have made its ethanol competitive at oil prices above US$30/barrel and advanced cellulosic technologies for ethanol production might be similarly competitive. Vehicles fuelled with biofuels, low carbon electricity, and low-carbon hydrogen could all co-exist in a long-term transition to low-carbon transport, but both the economics and pathways appear more complex and potentially more costly than for electricity.

Another cost projection analysis, conducted by the International Institute for Applied Systems Analysis (IIASA) (Gritzevski and Nakicenovic, 2002), shows that either kind of global energy future will require huge investment and learning, and it cannot be assumed a priori that the carbon-intensive paths will be cheaper – they will just be very, very different in terms of the technologies, systems and resources employed.

Equivalent results, in a different format, are produced by Papanathsiou and Anderson (2002), who produce a probability density of the net costs of renewables-intensive futures and find these to be widely distributed about the zero point. In other words, given learning-by-doing at uncertain rates, renewable-intensive futures may be either cheaper or more expensive than carbon-intensive futures, depending on the choice of learning parameters, but there is not a priori basis for expecting them to be more expensive.

A Closer Look at Energy-Environmental Innovation Processes and Policies

The debate between "supply push" and "demand pull" needs to be resolved by recognising that innovation is a complex phenomenon which in reality encompasses both perspectives. While engineers tend to focus upon R&D, economists tend to break innovation down into three components: invention, innovation, and diffusion – but even this is inadequate. There appear to be at least six distinct stages to energy technology innovation in a market economy:

- Basic research and development;
- technology-specific research, development and demonstration;
- market demonstration of technologies to show to potential purchasers and users that the technology works in real-world applications and tests, and demonstrates its performance, viability and potential market;
- commercialisation – either adoption of the technology by established firms or the establishment of firms based around the technology;
- market accumulation in which the use of the technology expands in scale often through accumulation of niche or protected markets; and,
- diffusion on a large scale.

The chain is not necessarily linear - for example, university spin-out companies may well be established to conduct market demonstration. Furthermore, there is continuous feedback across the different stages. Each stage involves technology improvement and cost reduction, but the principal barriers and driving forces change across the different stages. "Technology-push" elements dominate early stage research, whilst "market-pull" is increasingly important as technologies evolve along the chain.

In practice, innovation processes vary radically across different industrial sectors. For example, Information technology and pharmaceuticals are both characterised by high degrees of innovation, with rapid technological change financed by private investment amounting typically to 10-20% of sector turnover (Neuhoff, 2005). However this offers a dramatic contrast with power generation, where the same fundamental technology has dominated for almost a century and private sector R&D has fallen sharply with privatisation of energy industries to the point where it is under 0.4% of turnover (Margolis and Kammen, 1999).

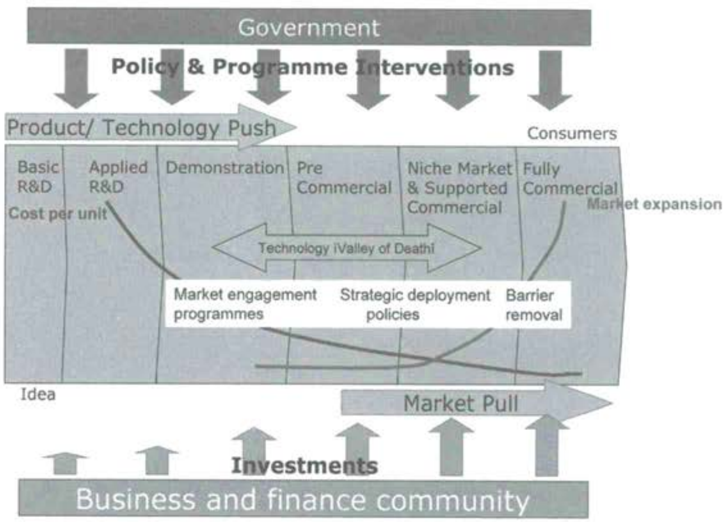
There may be several reasons for the low inherent innovation-intensity in the power generation sector. Processing large amounts of energy often requires big capital investment and long timescales, thereby increasing risk and deterring private finance; each stage in the innovation chain can take a decade, and diffusion is equally slow. Furthermore, the R&D-intensive sectors such as IT and pharmaceuticals are ones in which competition is essentially about product differentiation (e.g. faster computers, more effective drugs) whereas innovation in power generation is basically about efficiency and price in delivering the same product. Product differentiation often means a new product that captures public imagination, commands a large market and carries a price premium. In contrast, price-based competition has dramatically less scope for offsetting big risks against the prospect of huge rewards.

Thus, climate technology policy is seeking radical innovation in one of the least innovative sectors in the whole economy. The incentives for low-carbon innovation, whose value depends upon uncertain government policies to internalise carbon costs, are weaker still. Public R&D does not appear sufficient to address such problems. Global public sector energy R&D expenditure has halved since the mid 1980s (Margolis and Kammen, 1999) not only because the perceived oil crisis receded but because several expensive forays into large-scale energy technologies failed to deliver commercial products

(Cohen and Noll, 1991). There appear to be some intrinsic obstacles to technologies successfully crossing from publicly-funded demonstration to commercial viability: the result is the well-documented "technology valley of death", in the central stages of the innovation chain (Murphy and Edwards, 2003).

To foster technologies right across the innovation chain requires policies that bridge this "technology valley of death" and, where successful, carry technologies into the large-scale diffusion phase. Figure 6 indicates three such classes of policies, combined with a generic need for "internalisation": *Market engagement programmes* move a "trial technology" from public R&D funding to engagement with the private sector; *Strategic deployment policies* build market scale and thereby buy-down the cost of technologies; and, *barrier removal* aims to establish a "level playing field" through removal of regulatory and institutional barriers that favour incumbent technologies. In addition, internalisation policies may operate in different ways at many stages of the innovation chain. The classic examples, towards the end of the chain, are emission cap-and-trade or emission taxes, which aim to internalise environmental damages from incumbent technologies and thereby improve the economics of alternatives.

Figure 6: Activities for Spanning the Innovation Chain



Perhaps the most controversial area lies in the terrain where technologies are proven and in principal commercially available, yet they remain trapped in the cycle of small volume and hence high costs. The response here is policies for "strategic deployment" – policies that, in one way or another, support the larger scale deployment of these emergent technologies, in view of the strategic advantages to be gained by building up these industries and "buying down" the cost curve. Strategic deployment generally requires regulation to incentivise adoption of technologies that would otherwise be uneconomic, so as to secure the benefits of learning-by-doing and other scale economies. Consumers generally bear the costs and it generally involves direct government intervention, and thus strategic deployment is more controversial and may meet with objections from economists because although there is empirical support, there is not a strong basis in economic theory.

The classic examples are policies to support renewable energy deployment, notably:

- *Feed-in tariffs,* as adopted particularly in continental Europe which mandate a specific (premium) price to be paid for electricity generated from renewable sources such as wind energy;

- *renewable obligations,* known in North America as *portfolio standards* which require utilities to source a certain percentage of their electricity from renewable sources generally through systems of tradable certificates; and,

- *other technology or fuel* mandates, such as the long-standing requirement in Brazil for cars to run entirely or partly on ethanol.

There are, of course, many pros and cons to these different policies, and although it is difficult to generalise, it is instructive to consider historical cases as well as fundamental aspects of the general learning process.

Development of the wind industry in Denmark and the biofuels industry in Brazil both required sustained government support over decades. The Danish subsidies totalled $1.3bn, while Danish wind companies now earn more than that each year (Carbon Trust, 2003). At current oil prices, Brazil may soon similarly recoup its investment in biofuel technology.

The learning investment required for other supply technologies may be greater. Global studies by the International Energy Agency (IEA) (2002) estimate that learning investments totalling $400bn over the next three decades could deliver low carbon electricity systems globally. This is less than a tenth of the sectors' projected needs for generation investment over the same period, and the IEA's "alternative" high efficiency, low carbon scenario requires less total cumulative investment because the reduced electricity demand also reduces the need for infrastructure.

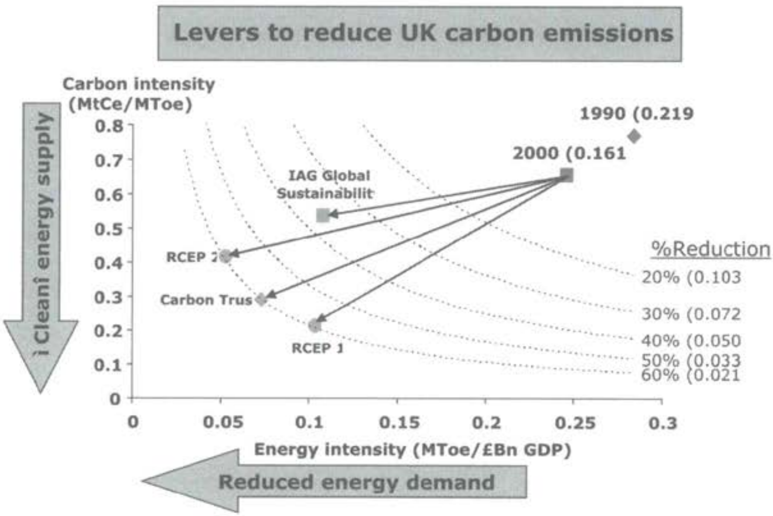
The earlier stage of most transport options precludes such quantification. However, the potential cost of bio-energy development is dwarfed by the £235bn annual agricultural subsidies in the Organisation for Economic Co-operation and Development (OECD) (OECD, 2004), whilst efforts to maintain oil supplies in the face of declining reserves are projected to require $3 trillion investment to 2030, with a growing proportion going to develop and convert higher carbon resources (IEA, 2003c). Development of gas and coal supply systems is projected to require similar investment. In total, the IEA projected that the energy sector will require $16 trillion investment over the coming three decades, irrespective of carbon constraints.

Given the significant level of energy sector investment that will be required in the coming decades, economically sound public policy would be aimed at directing, or re-directing, the investments towards the "wedge" technologies that provide the greatest emissions savings over the long-term. The direction of such investment lies primarily in the hands of private industry, and in the power sector, the market players and the transactions they undertake tend to be quite large. Consequently, in order to have a significant impact and be cost-effective, climate strategies must aim to devise modest incentives that can tip technology investments in favour of decarbonisation paths. The UK climate strategy is particularly instructive, as it is one of the few national climate strategies that has explicitly taken a long-term view while at the same time providing a platform for public-private partnerships.

Institutional Innovation in National Climate Policy: The UK Example

With the publication of the 2003 Energy White Paper, the UK embarked on an ambitious plan to reduce carbon emissions by 60% by 2050 through a combination of energy efficiency in the short term and renewables in the long term. Figure 7 shows alternative paths for reaching different targets based on combinations of demand-side energy efficiency improvements (horizontal axis) and supply-side decarbonisation (vertical axis). The curves are isoquants for various levels of carbon emissions reductions, and the four vectors are different trajectories derived from different combinations of the technology options and driven by different assumptions about economic growth. The analyses have made it clear that it is not a question of renewables vs. efficiency – the radical transformations implied by a 60% reduction in emissions will certainly require both. It was a fortunate accident for the UK that the climate strategy was launched on the premise of these two equally important pillars, although it remains to be seen whether the same emphasis can be sustained through consistent policy mechanisms that are implemented and updated over the long-term.

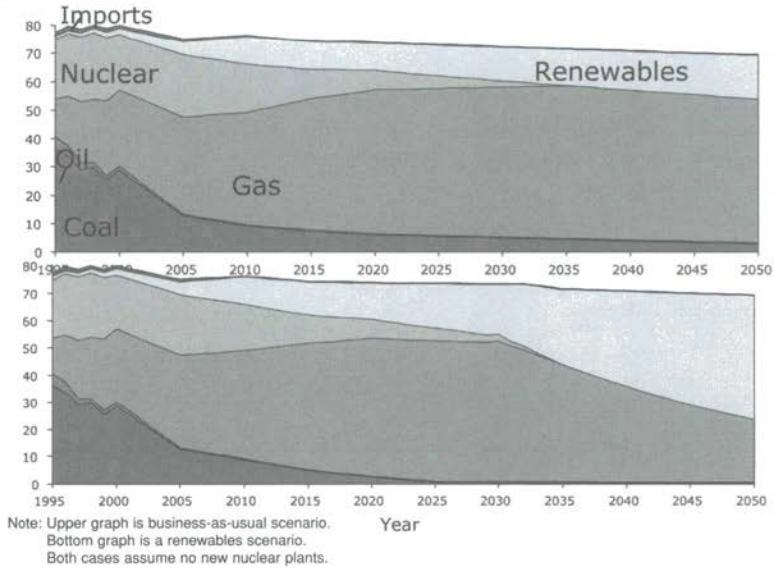
Figure 7: Alternative UK Climate Strategies Based on Combinations of Reductions in Energy Intensity (Energy Efficiency Improvements) and Carbon Intensity (Supply Decarbonisation)



Note: Figures in brackets show UK carbon intensity (MtC/£Bn), Scenarios show 2050 projections
(Source: RCEP 1998, DTI EP68 GDP growth forecasts; Carbon Trust 2003; IAG "Long-term GHG Reductions in the UK", Feb 2002)

The long-term perspective taken in the UK climate strategy demonstrates again the inter-related nature of energy-carbon-climate issues when they are viewed on something closer to a century-long time scale. The radical transformation in the energy sector implied by a 60% reduction in carbon emissions can play out in many different ways and thus is not so radical in the sense of being tied to one main divergent path. In fact, the opposite turns out to be the case in looking at the electricity sector in the UK. The two graphs in Figure 8 compare the expected evolution of the supply mix in a business-as-usual scenario (upper graph) and a 60% carbon emissions reduction scenario (Carbon Trust, 2003).

Figure 8



(Source: Carbon Trust (2003))

The comparison illustrates a new twist to the notion of energy security, as opposed to the oil, transport and Middle East obsession on which the energy security debates tend to focus. As in many countries, the UK has an electricity system which is moving towards being dominated by one source rather than another: it used to be coal in the UK but all the projections show that it would become totally dominated by natural gas in a business-as-usual scenario, as shown in Figure 8. And the top bar actually even assumes a certain amount of policy effort aimed at promoting renewable energy. As the bottom graph shows, a much more balanced portfolio of electricity sources emerges in the carbon reductions scenario. A more diverse system is more robust, other things being equal, and consequently the analysis suggests that the electricity sector will become more robust in the UK if the climate strategy is followed. Another way of saying this is simply that energy security will be improved.

Returning to the issue of policies and institutions, an interesting example of institutional innovation is found in the UK of the type of public-private partnership that might provide a useful model for both national and international climate strategies. The Carbon Trust is a government-funded not-for-profit company that's been set up to help UK businesses meet its carbon targets and to build a competitive low-carbon industry sector. It reflects a consensus between business and government on support for the UK climate change programme, and its Board includes representatives from business, government, NGOs, research organisations, and trade unions. It runs programmes on both new technologies and market deployment with quite close inter-linkages, and it has a flexible structure that allows for faster adaptation to market changes. It was launched with a budget of about 50 million GBP per year and is expected to double to 100 million GBP per year within the next few years. What is most interesting about the Carbon Trust is its broad acceptance – there is no real division between environmental and business goals. It is recognised that the private sector is absolutely central to solving energy-environment problems and also that government and businesses need to work together to most effectively address both the environmental objectives and the competitive business goals. The Carbon Trust focuses on identifying the suite of technology options that meet both objectives and then supporting their development and/or deployment in the most cost-effective manner.

Strategies for International Co-operation

Moving from national to international co-operation on energy-carbon-climate issues is, of course, a complicated step as the slow process in Kyoto has illustrated. There are, nevertheless, some basic characteristics to look for in international co-operation strategies, depending on the domain in which they operate which can be referred to as the strategy type. Three main types of strategies for international co-operation can be envisioned. The first is the most obvious and the one that most analysts agree on, albeit not to the same level: publicly-funded R&D. The second might be termed "International public-private partnerships for incubation and acceleration". The third is "International agreements on strategic deployment and barrier removal".

There is wide scope for beneficial international collaboration in publicly funded R&D for innovation in low-GHG emission and sequestration technologies as well as adaptation technologies. However, critics – especially economists – can point to long lists of government-sponsored technology failures, some of them astonishingly expensive, due to phenomena that social scientists well recognise in terms of institutional capture. As one cynic put it, "governments are bad at picking winners, but losers are good at picking governments".

Some of the institutional problems in public R&D may be amplified in the context of international technology programmes, where the goal of co-operation among countries is bedevilled by unavoidable issues of international rivalry. Every government would like its own industry/technology to receive support from international sources, especially if there is a significant prospect of it delivering commercial success, and is reluctant to spend on technologies of other countries. In addition, as technology nears commercial applicability, issues of intellectual property can become highly sensitive, leading to the reverse of co-operation as participants seek funding from the common pool whilst holding back their most commercially valuable ideas from public scrutiny. As a result, the easiest focus for international technology programmes is often technologies, such as fusion power, that no one realistically expects to be commercially viable in the foreseeable future.

The second type of international co-ordination would be around the creation and acceleration of industrial involvement in low carbon technologies. Drawing on domestic "market-engagement" analogies, these would probably require some co-financing of operations that helped either to "incubate" new technology companies to the point where they could go to international venture capital markets for support, or at least help to "de-risk" technologies through large scale field trials perhaps in several countries.

If the competitive dilemmas of international financing of such close-to-market activities prove too great, another approach to explore could be based around mutual commitment to actions, rather than actual mutual funding. For example, the UK Carbon Trust has proposed a "stepping stones" agreement in which different countries agree to take lead responsibility for nurturing certain technology areas, particularly with reference to the mid stages of the innovation chain. Obviously, the technology areas would be differentiated according to national interests and comparative advantage. For example, the US might take a leading role with respect to sequestration; the UK take the lead on marine renewables, perhaps Japan would have a leading role on various categories of energy efficient technologies.

The third class of international agreements could address the later stages of the innovation chain, concerning scale-up, large-scale learning-by-doing and diffusion policies. Examples of technologies ready for this stage include:

- Advanced technologies (e.g. gasification) for generating electricity from coal and biomass - a suite of technologies whose accelerated deployment will bring higher efficiency, reduced emissions and compatibility with CO_2 capture and storage technologies;
- Advanced low-energy building technologies, where the markets are impeded by numerous barriers associated with the construction indus try and rental markets; and,
- The more advanced primary renewables, notably photovoltaics (PVS), where potential scale economies remain large and wind-energy, where onshore deployment involves local learning and is a significant contribution to emission reductions, and offshore deployment remains a major stimulus to related industrial innovation.

The scale involved, and the need for facility siting and economic sustainability, may make this beyond the scope of public-only finance except in limited circumstances. The most obvious example is the World Bank-UNDP-UNEP Global Environmental Facility and associated World Bank and other carbon-related funds. These are not explicit technology programmes but have made a significant effort to promote technology development in certain areas (such as biomass energy development and solar PV).

The major issues for strategic deployment, however, involve national legislation. An international agreement would need to focus either on technology deployment targets or on the specific regulatory mechanisms (such as feed-in tariffs or renewable portfolio standards) that would support deployment. An additional – or softer – version of such agreements would be to focus on barrier removal. Some barriers – such as adverse subsidies that support fossil fuel technologies - are easy to identify, but politically difficult to remove (attempts have been made through various forums, including the United Nations Framework Convention on Climate Change (UNFCCC)). Others may be quite subtle and concern the regulatory specifics of electricity markets, for example.

Other more general barriers impede the diffusion of more advanced technologies in many developing countries (IPCC, 2000). This topic has received more international attention in the climate change negotiations than other aspects, and the Kyoto Protocol embodies stronger language than its parent UNFCCC on the need for all countries to foster "enabling environments" for private sector investment in environmentally sound technologies and establishes a standing Expert Group on Technology Transfer (EGTT). Agreements on barrier removal may be a modest, but useful complement to other measures and - perhaps more easily than some others - could readily be built upon existing international climate negotiation processes.

Table 1 attempts to summarise the various options, according to the classification developed in this paper.

Table 1: Options for International Technology Co-operation

Option	Objectives
Public technology R&D agreements	
Clean Energy R&D Fund	To provide specific R&D support to technologies whose high development cost cannot readily be borne by public funds in a single country
Clean Energy Demonstration Fund	To provide development and demonstration support to technologies with global applications but where economic development benefits are primarily local, avoiding international intellectual property rights (IPR) concerns
Marketisation funds and agreements	
Clean Energy Venture Capital Fund	Provide venture and development capital for smaller firms with climate related technological innovations
Climate Technology Leaders Fund	Offer an investment incentive to large companies to differentiate themselves within their sector by virtue of their adoption of leading-edge, higher-risk technologies
"Stepping stones" agreement	Agree on differentiated steps that countries would take to nurture technologies appropriate to their

	interests through the central stages of the innovation chain
Market standards, penetration and diffusion agreements	
Strategic deployment agreement	Agree on national targets or measures for deployment of low-carbon technologies that are commercialised but not yet cost-competitive and need to build up scale economies
Barrier removal agreement	Remove barriers to more rapid penetration of low carbon technologies, for example, adverse subsidies or regulatory impediments
International investor initiative	Mobilise mainstream institutional investors (such as pension funds) behind deployment of leading technologies or selective investment based upon carbon performance of companies
Technology transfer agreements	International agreement, as already developed under the UNFCCC/Kyoto Protocol and the associated EGTT with emphasis upon accelerating north-south dissemination of clean technologies. The existing process and EGTT mandate covers needs assessment; technology information; enabling environments; capacity-building and specific technology transfer mechanisms (Yamin and Depledge, 2004)

The main point is to emphasise that calls for international technology agreements, as a solution to climate change, need to be better defined. There are in fact many options, appropriate to different stages and aspects of the problem. Each of the nine options in Table 1 has merit; each has problems and limitations; each could usefully be explored further. International technology co-operation is an area with important potential but simply calling for technology co-operation as a solution to climate change is not adequate: what matters is the detail, as to which stage of the innovation chain agreements might address, which instruments would be employed, what kinds of technologies might benefit and the form that agreements might take – as well as their political viability and ultimate impact. That, most immediately, is the international challenge of low carbon technology.

Conclusions

There are indeed technologies that hold the *promise* of tackling climate change, not through any single "silver bullet" but through a potentially rich portfolio of options matched to the various major sectors of energy production, conversion, and use. An added benefit of such portfolios that tends to be overlooked is that they make the energy system more robust through the diversification of technologies and applications. However, a considerable amount of innovation will be required to sift through the many options, improve performance and deliver them on a large scale.

It is important to remember that the need for innovation is not synonymous with public technology R&D expenditure, nor with the hope for blue-skies breakthroughs – the innovation process is much more complex, and much more interesting. Technologies and systems have to evolve through many stages to build viable and cost-effective low carbon industries out of the seeds – mostly already planted - of low carbon ideas. Engagement with, and investment by, the private sector is critical, but the effective transfer of publicly-funded ideas into the private sector industries remains a big challenge.

Although measures of "carbon pricing" (cap & trade, taxes) offer an important element in securing low carbon investment, adequate innovation will not emerge simply through this route. Energy production industries are overwhelmingly oriented towards fossil fuels and the conversion and end-use sectors – particularly power generation and buildings – are some of the least innovative sectors in modern economies. Changing this will require active policies that span the innovation chain. To put it more simply, carbon pricing is necessary, but not sufficient.

This paper has outlined the additional complexities in considering international technology-oriented responses. The main point is a call for clarity: there are many different possible kinds of technology cooperation, and some are more credible, and more useful, than others. The challenge now is to identify which approaches might offer a realistic, substantive contribution to solving the climate problem.

In relation to international politics, a better understanding of technological innovation may offer a very important contribution to the international process. The current US administration as well as many major multinational companies have stressed the importance of technology as a response to climate change. Many others, led by the EU, have stressed the need for real emission constraints. Both are right, but the current Kyoto system reflects only the latter. Kyoto has a missing element; and addressing that could offer a constructive basis for political engagement.

References

Carbon Trust, "Building Options for UK Renewable Energy", Oct 2003, www.thecarbontrust.co.uk

Cohen L.R., R.G. Noll, "The Technology Pork Barrel", (Brookings Institutions Press, Washington DC 1991).

Gritsevsky A., and N. Nakicenovic (2002): Modelling uncertainty of induced technological change. In: Grübler, A., Nakicenovic, N., Nordhaus,W.D. (eds).Technological change and the environment. Resources for the Future,Washington DC, USA, 251-279.

Grubb M., J.Koehler, D.Anderson (2002), "Induced Technical Change In Energy/Environmental Modelling: Analytic Approaches and Policy Implications", Ann.Rev.En.Env., 27: 271-308.

IEA (2003c) World Investment Outlook, OECD/IEA, Paris.

IEA (2002) CO2 emissions from fuel combustion, OECD/IEA, Paris.

IPCC, Climate Change 2001: The IPCC Third Assessment Report, CUP, 2001

IPCC (2000), Methodological and Technologies Issues in Technology Transfer, IPCC Special Report, IPCC/WMO, Geneva,.

Margolis R., D. Kammen (1999), Science, 285:690-692.

Morthurst P.E. (2005) "Wind Energy in Denmark," Riso National Laboratory

Murphy L., P. Edwards (2003), "Bridging the Valley of Death: Transitioning from Public to Private Sector Financing" (National Renewable Energy Lab, Golden, Colorado).

Nakicenovic N., et al. (2000), Intergovernmental Panel on Climate Change Special Report on Emissions Scenarios (Cambridge University Press, Cambridge, 2000).

Neuhoff K. (2005), "Large Scale Deployment of Renewables for Electricity Generation", Oxford Review of Economic Policy, vol.21 no.2

OECD, "Biomass and Agriculture: Sustainability, Markets and Policies", (OECD, Paris, 2004).

Pacala S. and R. Socolow (2004), "Stabilisation Wedges: Solving the Climate Problem for the Next 50 years with Current Technologies," Science, 305 (5686), pp. 968-972, August 13, 2004, and its Supporting Online Material.

Papathanasiou, D and D. Anderson (2001), "Uncertainties in Responding to Climate Change: On the Economic Value of Technology Policies for Reducing Costs and Creating Options", The Energy Journal, 23, No. 3: 79-114

Yamin F. and J.Depledge (2004), The International Climate Change Regime: A Guide to Rules, Institutions and Procedures, Cambridge University Press, UK.

....

MARKET MECHANISMS AND THE USE OF RENEWABLES IN THE POWER SECTORS OF ASIA AND EUROPE

Guido Alfredo A. Delgado
Former President
NATIONAL POWER CORPORATION, THE PHILIPPINES

Abstract

There are tremendous renewable energy (RE) resources around the world which when tapped for power generation could contribute a significant component to the application of a Clean Development Mechanism (CDM).

In Europe, and in other more developed economies, governments have made strategic commitments in fostering the use of cleaner burning fuels and sealed in place financial tools and policies that put RE technology on par, or at the very least, in competing mode with traditional energy resources.

On the other hand, Asia and other developing nations, paint a different picture. There are no concrete policy statements and programmes supporting RE technology, or if there are, the vision has been greatly impaired owing to various factors such as but not limited to: poverty and the lack of capital fund, a helpless reliance on grant-based development assistance programmes, lack of financial incentives, product unawareness and immaturity of the market. Owing largely, perhaps, to the convenience and cheaper initial cost of using traditional energy resources, RE technology does not stand a chance, if at all, in competition with traditional energy sources as demands for it have not been properly advanced. The development of RE technology which would have

spelled the broader use of international CDM mechanisms has, therefore, really been difficult in the region.

An Overview of the Global Renewables Market

Despite the growing interest in renewables, they remain a small segment with 13.8% of the world's total primary energy supply as shown in Table 1 made by the International Energy Agency (IEA) based in France by the turn of the century. Among which, more than two-thirds is from combustible renewables and wastes (CRW), as illustrated in Figure 1.

Table 1: Key Regional Renewables Indicators (2000)

	TPES*	Of which Total Renewables	Share of Total Renewables in TPES	Share of the Main Fuel Categories in Total Renewables		
				Hydro	Geothermal, Solar, Wind, etc.	Combustible Renewables and Waste
	Mtoe	Mtoe	%	%	%	%
Africa	508	259	50.9	2.3	0.2	97.5
Latin America	456	127	27.9	37.3	1.3	61.3
Asia**	1 123	332	34.0	4.0	3.3	92.7
China***	1 158	234	20.2	8.2	0.0	91.8
Non-OECD Europe	95	9	9.9	46.1	0.9	53.0
Former USSR	921	30	3.3	65.5	0.2	34.3
Middle East	380	3	0.8	41.3	22.7	35.9
OECD	5 317	329	6.2	34.4	10.8	54.8
World	**9 958**	**1 372**	**13.8**	**16.5**	**3.7**	**79.8**

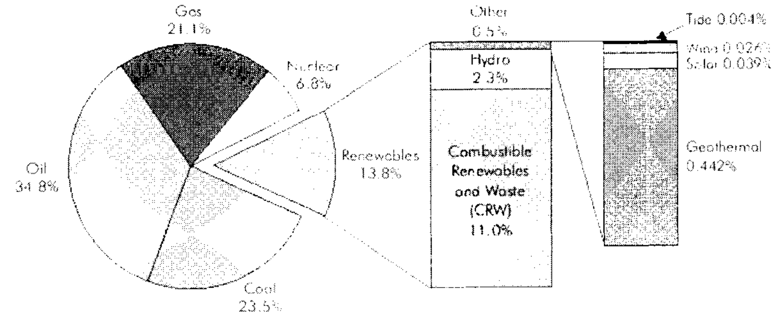
* Total Primary Energy Supply calculated using the physical energy content methodology.
** Asia excludes China
*** China includes People's Republic of China and Hong Kong, China

(Source: IEA, 2004)

The supply deficit or total absence of electricity in developing countries like Africa, Latin America and Asia explains the high share of combustible renewables forming the bulk of consumption where its mainly residential sectors resort to alternative energy sources such as biomass.

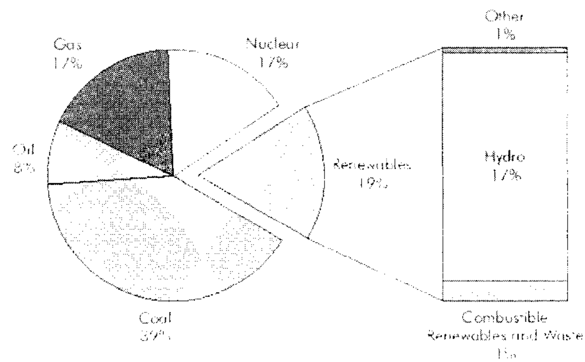
Relevant for these purposes, Figure 2 shows a profile of the world's electricity supply as of 2000.

Figure 1: World Fuel Shares in TPES (2000)



(Source: International Energy Agency)

Figure 2: Renewables in Electricity Production



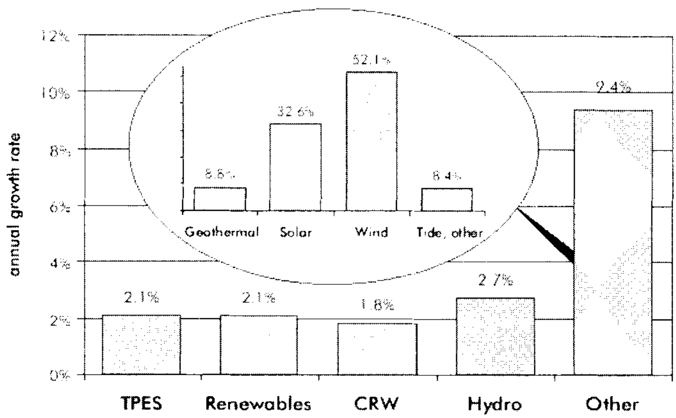
(Source: International Energy Agency)

If the world's experience during the last 30 years of the 20th century is to be used as a gauge, the future for renewables looks bright. IEA reported that from 1971 to 2000, the annual growth of RE supply grew by an average of 2.1%, with wind and solar energy taking the lead, as shown in Figure 3.

Much of the growth in the development of solar, wind, tidal and other forms of new renewable sources of energy happened in the developed countries, particularly Europe.

Again, the IEA projected that renewables would grow at 1.3% annually if the present government policies are allowed to continue and there are no major breakthroughs in technologies. This rate is below the projected 1.7% overall growth of the total energy demand over the next 30 years, mainly because of a slowdown in the growth of CRW (to 0.8% p.a.) as households in developing countries would have progressively shifted from traditional biomass to "modern" forms of energy like fossil fuel. Figure 4 shows IEA's world demand projections.

Figure 3: Annual Growth of Renewables Supply (1971-2000)

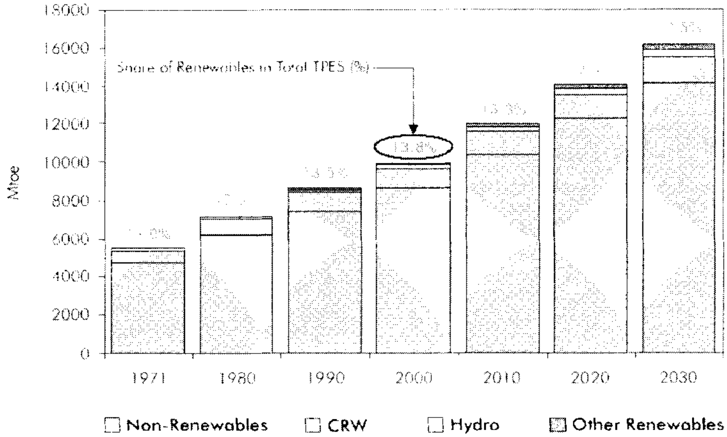


(Source: International Energy Agency)

- By 2030, about 2.6 billion people, mostly in developing countries, will continue to rely on traditional biomass for cooking and heating.
- In the OECD, the share of renewables has and will continue to increase from 6.4% in 2000 to a projected 8% in 2030. Most renewables will be used for power generation (72% in 2000, 75% in 2030).

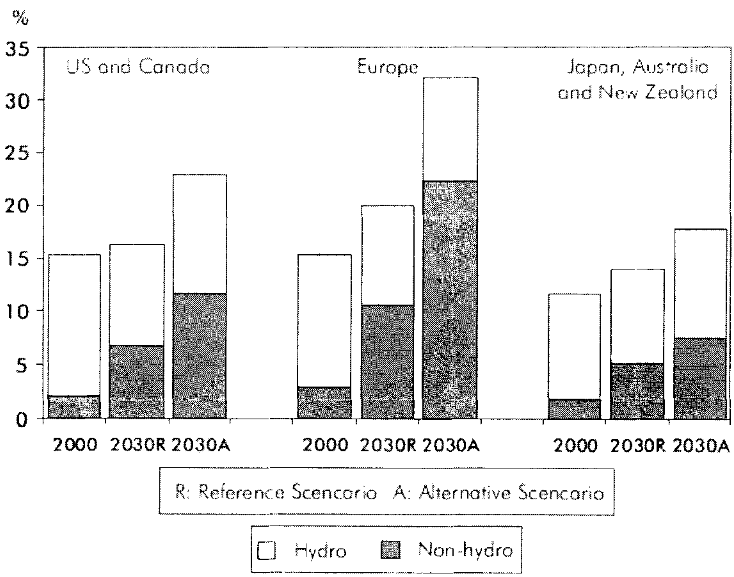
IEA offers a second scenario (Figure 5) which considers the impact of implementation of a range of new energy and environment policies now under consideration in OECD countries. In this scenario, non-hydro renewables are projected to grow by some 4% per annum between 2000 and 2030, compared to 2.7% p.a. in the "reference scenario". The share of renewables, including hydropower in electricity generation, increases substantially from 14.7% in 2000, to 17.6% in 2010 and 25.4% in 2030.

Figure 4: World Total Primal Energy Supply



(Source: International Energy Agency)

Figure 5: Share of Renewables in OECD Electricity Generation



(Source: International Energy Agency)

The substantial difference between the two scenarios highlights the potential impact of new government policies on the future mix of primary energy. Out of the following recently culled news reports, the key message, i.e. strong support from governments to develop and deploy renewables in the given countries is clear.

- Britain has set its goal to generate 20% of its power requirements from renewable sources by 2020; while Scotland, with an ambitious target of 40%, has a state-of-the-art centre tapping the vast powers of the Atlantic and the North Sea. It boasts of an output more than enough to meet the needs of its 5 million inhabitants.

- Denmark, with diminishing sites for windmills, has gone offshore. Its largest-yet windmills in Horn Rev near Eshjerg and Roendsand near Nysted have a total generating capacity of 325.6 MW, with two new parks coming up in 2009 with a projected capacity of 400 MW. Presently, these serve as a technology display window enough to entice other countries to buy from Danish producers. Meantime, Britain and Germany are not far behind as each plan to build off-shore turbine parks projected to generate 7000 MW and 2000 MW respectively, by 2010.

- In Germany, the "Bavaria Solarpark", capable of generating 10 MW using 57,600 photovoltaic panels, is now being interconnected to the grid; commercial operations will start this December.

- The growing PV market has encouraged a leading Japanese supplier to expand annual production capacity of PV cells and modules in its two factories from 90 MW to 135 MW by April 2005. The company aims to establish a production system with an annual capacity of 230 MW by 2006, investing 3.3 billion yen in new equipment. It has reported PV sales more than twice over that of 2003. Meanwhile, 100-meter-tall wind turbines have sprouted up all over the Shimokita Peninsula in Aomori Prefecture. Another 44 turbines are set to come on stream in the four towns and villages in the peninsula by October 2006.

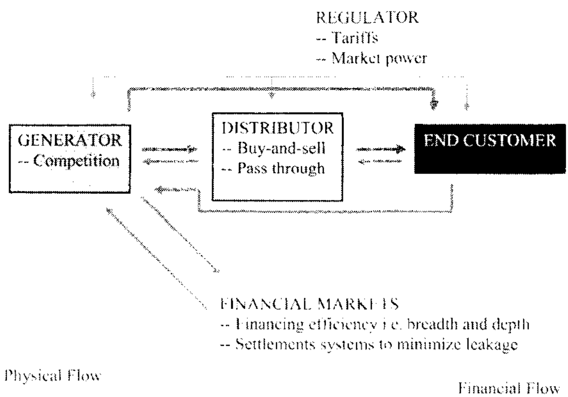
In this context, the challenge to the world renewable energy development would be how to encourage developing countries, which are expected to need higher generating capacities to fuel their economic and social growth to consider renewable sources of energy as a viable option.

How to encourage developing countries to consider renewable sources of energy as a viable option to upstart their economy and growth remains the biggest challenge to RE development.

Market Structure and Mechanisms

The physical flow of electricity from the generation sector down to the end-customers is practically the same anywhere in the world (Figure 6): power generators produce electricity at high voltage, e.g. 500 kV, which in turn pass through a network of transmission lines, transformers that bring down the voltage useful to the end-user – in the case of American households, for example, 110 volts and for Europe, 220 volts.

Figure 6: The Market Mechanism



What varies from country to country is the ownership structure among the various industry players – generation, transmission and distribution companies – and with it, the financial flows and corresponding government regulations. The interplay of these factors determine the tariff structures and ultimately, the viability and financeability of a given power project.

Renewable Energy and the Challenge of Financing Tools

Renewable energy (RE) could serve a significant portion of the growing power needs of Asia. Many factors underscore the need for policies mandating inclusion of RE into the energy mix of Asian economies:

- The continued existence of significant populations situated far from electricity grids;
- the continued high levels of fuel importation in the face of the rising costs of fossil fuels; and,
- the need and pressure to reduce greenhouse gasses worldwide.

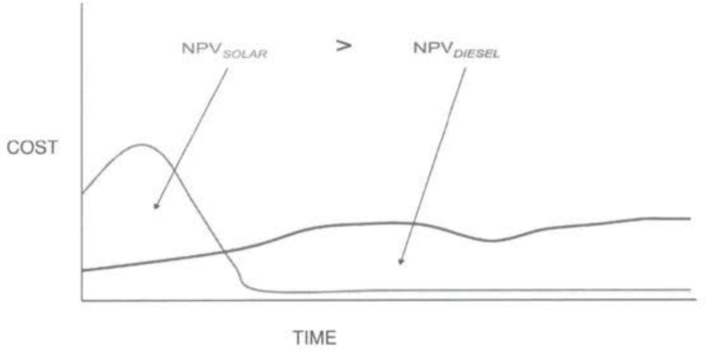
It is easy and politically fashionable to pronounce green energy as a fundamental policy objective. Yet, public pronouncements without resources will do little to make RE more viable in the region.

It is useful to survey the differences in RE dissemination within the energy sectors in Europe and in Asia. Comparing the two regions highlights a couple of significant issues and barriers to market-driven, widespread use of renewable energy technologies and in turn, brings into question some aspects of current CDM regimes. The following issues summarise some of the basic, underlying structural challenges which confront market-based RE development in Asia:

- General market resistance/hesitance to accept new RE acting as both cause and effect for RE development in Asia; this creates a higher development cost and slows entry to market of new RE.
- Financial market immaturity in Asia resulting in a lack of the right kind of financial tools to match different risk profiles of both buyers/proponents of RE projects and markets in general; financing tools must be created which address underlying market differences which help explain differing pace of renewables development.
- Lack of policy co-ordination to stimulate development of a broader slate of financing tools and to level the price playing field with traditional fuels.

All RE technologies carry a higher initial capital cost than that for almost any traditional or fossil fuel-based energy. An example is presented as Figure 7.

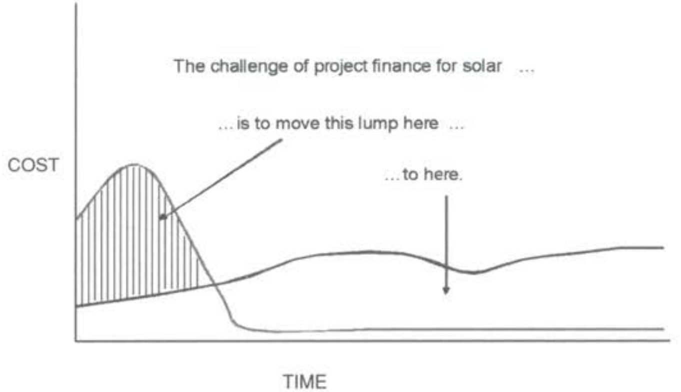
Figure 7: Cash Flow of Solar vs. Diesel



Note: NPV = Net Present Value

If Asia is to more broadly emulate the developed economies such as Europe in their growing use of RE, different financing tools need to be developed. Financially burdened Asian governments will not be able to directly finance substantial increases in RE usage, so market mechanisms must be fostered which supplement Asian government financial support and policies.

Figure 8: Cash Flow of Solar and Project Finance



Apparently, the objective should be to devise mechanisms which recognise the ongoing comparative cost-savings of REs and create financial tools which use this life-cycle cash savings to offset the initial higher capital outlay requirements for REs.

As currently proposed, Clean Development Mechanisms (CDMs) are designed to function as such market-based financing enhancement mechanisms to improve the "financeability" of marginal renewable energy and energy efficiency projects in comparison with competing, carbon-based energy production options. However, in Asia the challenge is not only the initial cost-disadvantage of RE vs. fossil fuels, but the broader issues noted above which must first be overcome in order for CDM to be truly effective in Asia.

Emphasising support for the optimal local renewable energy resource available (e.g. wind in the UK, France, Netherlands; wind and solar in Germany; wind, solar and geothermal in California; solar in Australia) governments in Europe and the US have made strategic commitments to fostering the use of cleaner burning fuels through market-based mechanisms which allow for customer demand to drive the application of tax-incentives and other financial incentives.

This assures that the right technology mix meets actual customer demand—and in turn has a demand generation benefit which further increases the utilisation of RE technologies with a minimum of government-intervention or technology selection.

Asian Realities

Owing to their geographic situations and zones, countries in Asia are endowed with immense solar energy potential and some places are also conducive to harnessing wind power. Moreover, given the level of dispersion of rural communities and the recent developments of alternative energy technologies, decentralised exploitation would be the best strategy. There are many regions that, due to their remoteness from classical energies, are still deprived of electricity supply.

In such a context, it is clear that decentralised generators are crucial to the development of these zones. Photovoltaic systems cater to most important local demand for low tension (less than 220 kW) in rural areas namely, village water supply, irrigation systems for small market gardens and electricity for community amenities.

Renewables in Asia are often forced to compete on the same footing as carbon power. Fossil fuels like coal receive substantial subsidies, including initial investments that are not factored into the true cost of power. The external cost, however, is not taken into account.

Users resist payment for small-scale energy. This has limited the use of renewables in the marketplace. In fact, to date, energy policy and financing mechanisms available in most Asian markets have tended to distort market demand and hinder the competitiveness of renewables through the use of direct and indirect subsidies for traditional, carbon-based power sources (especially coal, diesel and other heavy fuel oils) and a historic reliance on grant-based official development assistance–ironically, often from the very countries that are promoting CDM approaches (Europe, Japan, US). Yet, continued use of carbon-based power sources such as diesel further limits the country's ability to develop energy independence and create a sustainable energy regime.

Risk on investment in renewables requires some additional willingness on the part of government to invest in "market development" and pricing equality–including pricing in the cost of emissions, future costs of fuel, and market infrastructure creation.

Many Asian countries have to translate general policy statements supporting the use of renewable as a reliable energy component of its overall energy mix. Specifically, many have not implemented programme financial incentives designed to foster competitiveness of appropriate renewable energy technologies in the local marketplace and catalyse the acceptability and demand for renewables at the local level.

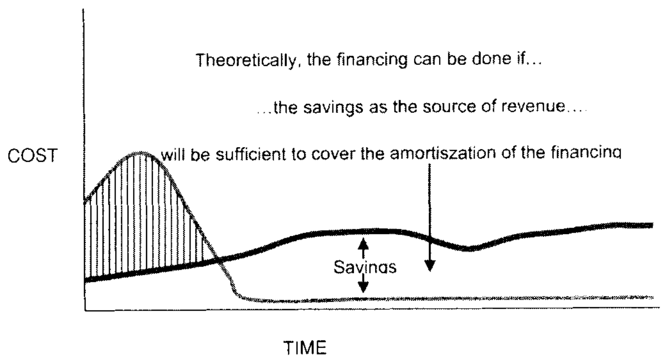
But, as will be noted, there is also a fundamental issue of maturity and flexibility of financial markets and the creditworthiness of end users/borrowers in Asia that make sourcing of financing difficult.

A Renewable Energy Financing Model

The major barrier hindering more widespread use of RE in Asia is the mismatch of currently available financing tools and techniques to the perceived risks and market immaturity in most Asian markets. This becomes especially apparent when comparing Asian markets with more developed markets in Europe.

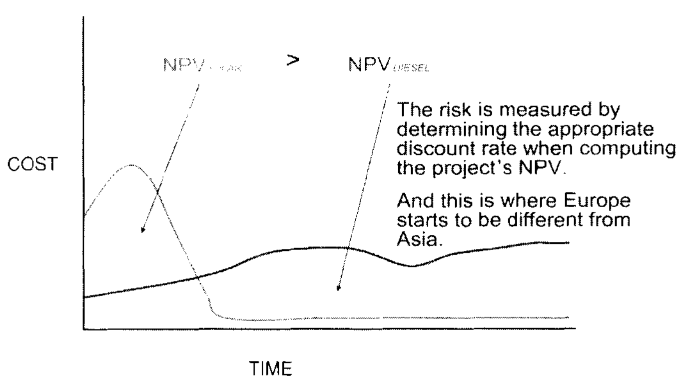
The structural difference between the traditional power sector and renewable energy power delivery leads to different financing requirements, especially in Asia where there is very little grid-tied renewable energy - which would involve a power distributor to help facilitate financial flows between generator and consumer. Creating a more regularised market for renewable energy would require better matching of the capital requirements for installing RE with the avoided-cost cash savings to be realised from the use of renewables in comparison with, for example, a diesel generator.

Figure 9: Source Of Revenue For Project Finance



The financial benefits of RE are derived from the avoided cost savings in operations and maintenance (O&M) requirements realised over the life of the systems. In most Asian markets, there are no financial tools which are recognise these "savings". Financing for RE could be brought into the mainstream if these savings could be utilised as a means to amortise the higher initial capital cost of renewable energies as in Figure 9.

Figure 10: The Riskiness Of The Revenues



In developed economies, the combination of government support, reasonable risk profiles of borrowers/implementers of RE and reasonable expectations of payment by end users of RE work together to make this possible. Financing mechanisms for solar projects are steadily broadening because it is perceived that the cash flows of RE will have a higher net present value than traditional fossil fuel based energy sources, as indicated in Figure 10.

This requires a broad acceptance of the risk profile of RE "revenues" by all the parties involved: energy developers who are willing to invest in a RE project due to confidence in the technology, availability of government financing incentives, mandates by the government for RE utilisation, financial institutions who have confidence in the technological reliability of solar, acceptance of the risk profiles of the various parties - end users, borrowers, etc. This means that the revenue and savings projections which might be expected are considered reliable to all parties. In turn this means that a broader range of financing tools can be developed which will increase affordability and market acceptance of renewable energies - which will in turn increase sales volumes for suppliers, thereby further lowering prices and further lowering the perceived risk of the revenues.

If, however, there is a perception of higher risk associated with the projected revenues, financing for renewables will be difficult to execute because the quantity of savings will no longer match the initial capital cost outlay sufficient to cover amortisation.

The European Experience

Figure 11: The Riskiness Of The Revenues

In Europe, there is growing acceptance of the various risks involved. In addition, the many risks expected of developing economies, as shown in Figure 11, are not major concerns in developed markets like Europe.

Europe continues to heavily promote the use of renewables. In 2002, the nations of Europe invested 5.8 billion Euros (approximately US$6.3 billion) to add 5871 MW of new wind power capacity. Installed wind power capacity in Europe grew by 33% to reach 23,056 MW.

According to a report produced by the European Wind Energy Association (EWEA), wind energy in Europe is now generating as much power as 20 million tonnes of coal in traditional power plants. Germany, Spain and Denmark accounted for 89% of the wind power capacity installed in Europe in 2002. Wind energy development in countries such as Norway and Poland added another 112 MW to the European total.

The success factors for RE projects in Europe are different from one country to another. An important factor is to verify the abundance of renewable energy available at the planned site, in this case wind, solar energy, waves, etc. Good resource sites are a prerequisite for high project revenues, which determine project profitability.

In Germany, the main success factors have been (a) the feed-in tariff which offers attractive remuneration and satisfactory security planning; and, (b) the wide spread application of the closed-end funds scheme that creates the possibility to involve local residents directly into this new market thus significantly reducing public objections.

In Spain, the success of renewables development can be attributed to its high energy potential, the stable legislative framework of electricity generation and the development of administrative procedures at regional level.

Factors facilitating renewable energy implementation in Europe include:

- Research, development and demonstration support;
- subsidies on investment and fiscal measures on investment;
- feed-in tariffs;
- bidding procedures;
- renewable portfolio standards (RPS)/quotas;

- green emissions credit certificates;
- negotiated agreements; and,
- regulatory and market framework.

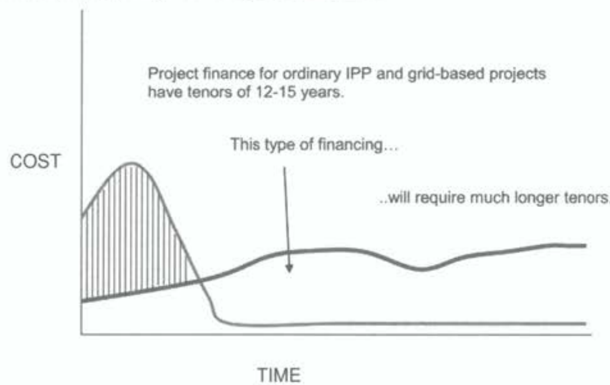
Challenges vis-a-vis the European Experience

The path that Asian countries should take has yet to be defined. The availability of financing for renewables in Asia, especially from financial markets and traditional lenders, is much more difficult - and costly - to structure. This is true for many types of financing and lending in Asia, but is particularly pronounced and difficult to overcome in renewable energy financing.

Country risks, technology risks, operational risks, and market risks are all considered much higher in Asia than Europe. As a result the riskiness of the revenues - of the savings benefit of using renewables vs traditional power sources - is considered much higher and hence financing is more costly.

As a result, renewables are installed much less frequently, supplier chains are much less developed resulting in poor maintenance/service. End user acceptance due to unfamiliarity and failure of systems is much lower and overall system costs higher. Within this context, a mechanism like CDM will be able to do little to catalyse widespread RE programmes due to the lack of underlying market maturity.

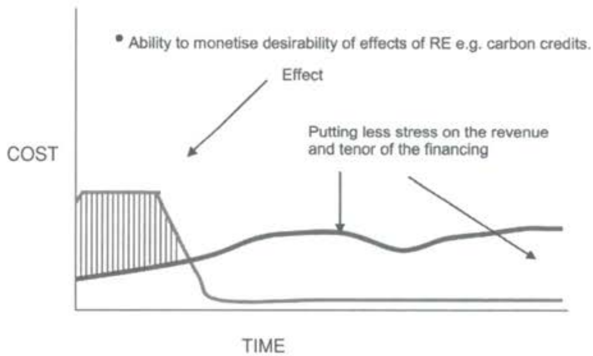
Figure 12: Availability Of Project Finance



One additional issue relating to riskiness of revenues is particularly germane to discussions of project financing for renewable energy programmes. The strength of the cash flow benefit to a renewable energy project is only realised over the life cycle of the renewable energy system itself. Most financing tools available for energy project finance are designed for tenors matched to the life cycle profiles of traditional fossil fuel energy technology (Figure 12).

The longer life cycles of most RE technologies mean that the revenue benefit accruing to their uses last much longer than traditional energy systems. In Europe, financing mechanisms are now being designed and implemented which better match the longer life cycles of RE. The longer financing tenors relies, however, heavily on the perception that longer financing life cycles are reasonable due to limited project risks as noted above.

Figure 13: Market Mechanisms

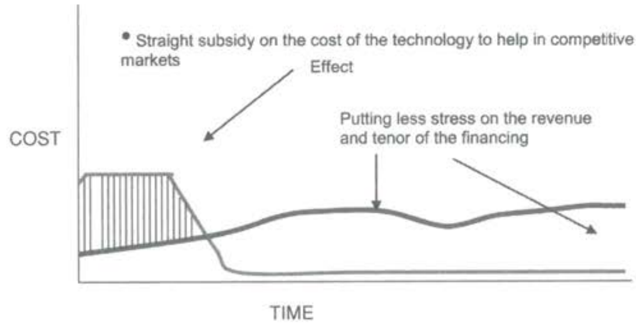


Market-based mechanisms are key to broader utilisation and acceptance of RE in Asia. The Clean Development Mechanism (CDM) is considered to have the broadest possible application in making project financing possible for RE. Using the CDM has the effect of shoring up the strength of the revenue stream over time.

It is available over the life of the RE project and helps to lower the initial capital cost profile of RE projects. Nonetheless, CDM alone especially in the current Asian context - will have only limited impact due to broader structural challenges which undercuts the financeability of RE projects.

CDM can be supplemented by straight subsidies dedicated to various stages of the RE industry. Again, the next effect in a financing context would be to lower the stress on the revenue stream. Subsidies in the developed world come in a variety of forms – to R&D firms/manufacturers, tax credits to buyers, rebates from utilities, etc. – and are effective as a complementary support mechanism when used in concert with other policy and financing tools.

Figure 14: Market Mechanisms Available

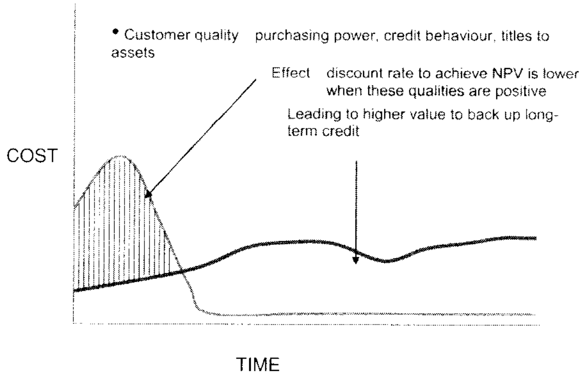


However, subsidies are a direct cost to the public sector (usually) and when, as in Asia, public sector finances are already limited, they may be difficult to translate broadly into developing markets without strong multilateral/donor support. Subsidies of RE are shown to be most effective as in Europe when utilised as a complement to mature financial markets which perceive the risk of RE project revenues as acceptable over the long term.

Perhaps most important to hindering or catalysing widespread acceptance of RE is the quality of the buyers of RE – whether private consumers purchasing household systems or industrial/institutional buyers and utilities purchasing RE for stand alone or grid-tied applications. The creditworthiness and behavior of the buyers must conform to the expectations of lenders/investors and must form the market foundation upon which the incremental tools noted above stand (CDM/Green Credits, subsidies/rebates, longer lending regimes/tenors).

Customer quality will dictate market-based financing tools. General purchasing power, credit history and behavior, asset base and access to asset titles will all influence the perception of lenders to the riskiness of the revenues and hence the cost of financing. Fundamental customer quality in Europe is generally much higher than in Asia - whether consumer or institutional/utility/public sector. This means lenders will maintain more conservative lending policies towards almost all potential buyers of RE.

Figure 15: Market Mechanisms Available



This is a well recognised issue in policy efforts to promote a market based approach to renewables. Some programmes, such as the World Bank's PV Supplier programme implemented in Sri Lanka, Indonesia and the Philippines, try to address the poor creditworthiness of small, individual buyers of RE through a mix of credit support, guarantees, and subsidies. But such programmes are still largely isolated examples and a broader RE utilisation will be dependent on addressing customer quality issues.

Ironically, ODA programmes are often a hindrance to RE development. Often, market based applications of RE face competition not from other business competitors based on normal cost-based competition but from particularised grant or low-cost financing based ODA programmes ostensibly designed to catalyse use of REs but in reality vehicles to force feed a particular national technology approach.

These programmes also focus very little on creating an atmosphere of sustainability for the technologies installed and do not require full cost-recovery and user-payment schemes for technology installation. As such, installed systems are often left to fail due to little community/consumer buy-in, thereby creating an additional barrier to market entry—consumer mistrust of anything but diesel-based electricity.

Summary

When one reviews the state of development of energy sector utilisation in Asia and Europe and compares the actual implementation experience for RE projects between the two regions, one can discern the following themes:

- European countries have developed relatively clearer policy and financial regimes to stimulate market acceptance of RE.

  Many policy regimes in Asian countries are still being developed or are not backed up by clear financial incentives (tax breaks, rebates, investment incentives).

- These policies are premised on the smooth functioning and creative adaptability of the financial markets to new opportunities created out of these policies.

  Financial markets in Asia are less capable of offering financial instruments, such as bond flotations for public utilities, which could be used to support RE financing.

- The financial markets in most of the European countries are mature and well developed and can adjust quickly to the different risk elements which might be introduced by a RE project.

  Asian financial markets have not been as quick to adapt to nascent RE-related opportunities, driven largely by the issues previously discussed.

- Project proponents in Europe are often more creditworthy than in Asia.

- The use of CDM-like mechanisms such as Green Credits can effectively address those risk and cost issues which differentiate RE vs traditional energy solutions.

  CDM in Asia has been slow to develop due to lack of market maturity related to all of the issues above, and will likely continue to be slow in future development.

The lack of market maturity for RE in Asia of–both financial markets and end-user/project markets–creates risk of under-utilisation of CDM tools for projects in Asia for some years to come. The objective should be to devise mechanisms which recognise the ongoing comparative cost-savings of REs and create financial tools which use this life-cycle cash savings to offset the initial higher capital outlay requirements for REs.

A number of institutional barriers hinder the development of a robust RE market which in turn limits the opportunities for CDM project financing deals. A few examples suffice to highlight some of these issues:

- **Complexity of risk coverage.** In Asia, project financing requires several layers of cascading guarantees, which can be done theoretically, but requires participation by many different institutions. The perceived risks to be covered in Asia include political risk, repayment risk, regulatory risk, performance risk and technology risk (because of lack of awareness).

  In Europe, because of the stable regulatory environment the only risks to be covered are repayment risk and performance risk, which are relatively easy. Repayment risk is covered through standard credit evaluation procedures. Performance risks are covered through simple extended product warranties, relatively inexpensive credible service agreements and reliable recourse process in case of default.

- **Availability of affordable debt instruments.** In Europe (and in the US), the municipal and other public bond markets offer access to relatively inexpensive debt. These markets also offer reliable methods (to other financial institution) of verifying customer credit. These bond markets have now become accessible for solar projects. In Asia, such instruments either do not exist (depending on the country) or are extremely complex and costly.

- **Cost of equity.** In Europe (and in the US), the return expectations for equity are priced based on overall market risk, which is generally perceived as limited, and only have to factor in repayment risk. In Asia, there is frequently a perception of higher political and regulatory risks which require that the return on equity to consider these external, but real, risks.

- **Regulatory environment.** In Europe and the US, net metering rules have been standardised and are predictable. In Asia this is non existent. Buy down incentives that factor in environmental benefits and power reliability (and capacity issues) have been institutionalised. Again, this is not the case in Asia.

- **Environmental attributes.** These have been monetised in Europe and the US. For example, a kWh of solar produced electricity can be "sold" for 0.55 Euros for 20-25 years. In Europe and other developed economies, there is a renewable energy portfolio standard that requires the electric service providers to install a minimum amount of RE MW capacity (or a certain amount of percentage of TPES from RE) by certain target dates. They can do this by either directly installing RE systems or by buying RE certificates in the market created.

The going rate in the US is about $150 per MWh. Failure to comply will require the electric (and gas) service providers to pay $300 per MWh, in addition to other penalties. This revenue, which is over and above the revenue from energy sale and the buy down incentives, makes solar project financing attractive.

Another example that can be given is that the New York Power Authority (NYPA) called a bid wherein the successful bidder will own and operate a 3 MW system for twenty years in return for which NYPA will pay 5 cents/kWh for energy, $180,000 per year for capacity (approximately 5 cents/kWh for solar capacity) and $200 per MWh for renewable energy certificates. Such incentive programmes do not yet exist in Asia and are widespread in various forms in Europe.

Countries must implement additional policy and fiscal incentive support which could catalyse a more reliable renewables market and create a level playing field for renewable energy to compete with conventional energies in marketplace. This means, of course, developing market driven financing mechanisms which enable buyers of RE to finance their systems over longer periods and which can supplement the benefit to be derived by CDM and other "green credit" mechanisms.

In Europe and other developed economies, there exist numerous creditworthy buyers of energy projects who are able to consider purchase of renewable energy systems based on an array of established financing tools and also whose buying decisions are influenced by the supplemental benefit of green credits or other CDM-like tools as well as various tax and fiscal/rebate incentives.

Although geographical location greatly affects the availability of potential RE and project proposals, many countries in Asia have experienced difficulty in commercialisation due to market distortion. The major reasons for the sluggish pace of commercialisation of RE technology in Southeast Asia as compared to other countries include: lack of energy data in specific sites, high initial costs, lack of access to financing, low public awareness, lack of working units, no local manufacturers and distributors, no clear financial and fiscal incentives, and generally a low level of technology awareness.

Energy data are needed for the reliable estimation of renewable power in a country. Such data are needed to enable governments, multilateral development banks, private developers, and others to determine the priority that should be given to renewables and to identify areas that may be suitable for development. The installed demonstration projects are also found to be expensive. If provided with cheaper costs of renewable energy systems, resurgence of interest in investments may be expected.

The public plays a very crucial role in the development of renewable technology. Unlike in Europe, there is a low level of public awareness in developing countries in the usefulness of technology due, in part, to the lack of working units. If there are available units, some are not working due to technical problems thus giving technology a bad image. These problems include faulty designs, inappropriate system components, poor spare part supply, and the like. Insufficient expertise and technical know-how to design, operate, and maintain the system is also rampant in the Asian developing countries.

Only a number of Asian countries have policies that support the development of renewable energy. On the contrary, some of them give more priority to the development of conventional energy sources, thus there is limited funding and incentives for renewable energy development. If these data are looked into, and with the help of investors, lenders, and developers, governments in these countries may yet be able to focus on developing RE technology that can contribute power generation for its electrification programmes.

References

AFP dispatch published in The Australian, August 16, 2004

AFP dispatch published by Taipei Times, August 16, 2004

Asia-Europe Environment Forum–2nd Roundtable Summary Discussion. 2004. Korea

BOGACH, V. Susan et.al. (2000) The Asian Alternative Energy Programme: Partnership for Innovation. Washington D.C.

CABRERA, M.I. & T. Lefevre. (2002). Wind Power in Europe. Center for Energy Resources Development, Bangkok, Thailand www.asem-greenippnetwork.net/dsp

CARTER, Andria Y. (2003). WorldWater Launches Water System. The Trenton Business: New Jersey

European Commission-Energy Homepage. europa.eu.int/comm/energy/index

European Conference for Renewable energy 'Intelligent Policy Options' .2004. Berlin, Germany

European Wind Energy Homepage. www.ewea.org

Europe's New Power. www.tol.cz

The Feasibility of CDM Projects in Asia. www.renewingindia.org

FORTIN, Pierre et. al. (2003). Towards a Renewable and Sustainable Energy Future:Renewable Energies Working Together. Canadian Hydropower Association

Good News for California Power Supply Situation in Summer 2002 and Beyond According to the New Henwood Study. 2004, Primedia Business Magazines & Media, Inc. www.itron.com

Green Energy for Europe. 1998. Europe Business Review

HERRMAN, John. (2003). Water Management: WorldWater–a project that puts the community in-charge. ICT Update

IEA. (2004). World Energy Outlook, International Energy Agency.

JAMES & James. (2000). The Future for Distributed Power in Asia: Cogeneration and On-site Power Production. www.acg-asia.com

KIRBY, Alex. (2004). Fossil Fuel Subsidies 'must end'. BBC News Online

KOOIJMAN-VAN DIJK, Annemarije L. (2003) ECN, The Netherlands www.asem-greenippnetwork.net/dsp

MARTINOT, Eric. 2004. Global Renewable Energy Markets and Policies. Maryland, USA

MEDEIROS, Martin F. (2002) Commercialising Early-Stage Technologies–A Brief Overview of Technology Transfer Issues for Entrepreneurs.

MITCHELL, Catherine. (2003). Renewable Energy Issues: Politic, Sustainability, Security, and Competition. www.europeanenergyfair.com

MOST D. et. al. (2002). Wind Power in Europe. IIP, Universitat Karlsruhe, Germany www.asem-greenippnetwork.net/dsp

Philippine Energy Plan. 2004. Department of Energy, Philippines. www.doe.gov.ph

Policy Recommendations for Renewable Energies. 2004. Bonn, Germany

Power for the People: Renewable Energy in Developing Countries. www.ausaid.gov.au

The Renewable Energy Certificate System. www.recs.org

Renewable Electricity in Europe. 2004. Energy Research Institute, The Netherlands

Renewable Energy in the European Union. www.climnet.org

Renewable Energy in Industrialised Countries. 1996. Renewable Energy Annual 1996

RIDER, Gill. (1999). Europe's Changing Energy Landscape. Accenture European Utilities Group. Outlook Journal

RIORDAN, Teresa. (2003). Solar-Energy company offers technology to limit blackouts. International Herald Tribune/Business Page

SOKONA, Youba. (____). Using Renewable Energy in Africa: How should Africa and Asia co-operate? ENDA Energy Programme www.enda.sn/energie/reafrica.html

SolarAccess.com, August 18,2004

Solar Energy Systems for the 21st Century. www.worldwater.com

Subsequent Events–California's Energy Crisis. www.eia.gov

TANABE, Yasuo. 2004. Energy Challenge in Asia. Seoul, Korea

YOKOBORI, Keiichi. (____). Survey of Energy Resources.

....

INNOVATION TECHNOLOGY FOR RENEWABLES: SUPPORT MECHANISM, POLICY AND FINANCE INSTRUMENTS LESSONS FROM ASIA AND EUROPE

Dr. Dörte Fouquet
European & International Law Specialist (Energy & Environment)

and

Senior Partner
KUHBIER LAW FIRM, BELGIUM

Abstract

Economic rapid increase of renewable energies requires strong political commitment, clear legal rules, ensuring investor's confidence and awareness of the need to get the market prices on the overall electricity market right and to internalise externalities. The following paper gives an overview on different support schemes, on typical failures and on best practices, in Asia and in Europe.[1]

[1] *A more detailed review on different support schemes can be found in the recently published document: Reflections on a Possible Unified EU Financial Support Scheme for Renewable Energy Systems (RES): A Comparison of Minimum-Price and Quota Systems and an Analysis of Market Conditions, by EREF (European Renewable Energies Federation) and the World Watch Institute, Authors: Dörte Fouquet, Claudia Grotz, Janet Sawin, Nikos Vassilakos, Brussels and Washington, DC January 2005, www.eref-europe.org*

Financing for renewables is often regarded as a difficult and problematic business. However, the common opinion that there exist automatic problems when addressing financing of renewables is not necessarily valid. A problem arises only when the energy sector in general in the respective region or country is chaotic, anarchic, or uncontrolled, dominated by often subsidised traditional power suppliers and lacking any ambition, or political willingness to really "go for it", or lacking any targets or any approach towards a level playing field for renewables. Financing and organising financial support for renewables in the energy sector is also different from non-renewable, conventional power plant construction. A lot of training and creativity and awareness building are required in all public and private financial institutions and governments need to respond to the specific characteristics of the renewable sector. Renewable Energy Systems (RES) requires "new thinking, new risk-management approaches and new forms of capital" [2].

Because of increasingly outdated energy supply facilities, especially and also in Europe, the European as well as the world energy capacity in general must be renewed or re-enforced during the next decades with a considerable amount of capital required. The International Energy Agency (IEA) has pointed out in its World Energy Investment Outlook 2003–that US$16 trillion would be needed worldwide in the energy sector over the next 30 years to maintain, replace and expand infrastructure.[3] One may not agree that some of the priorities identified by the IEA, such as increased amount of investment required for oil and gas exploration and infrastructure, are helpful and one may regard this more as an obstacle towards a new sustainable energy structure. But one may realistically consider the fact that billions of dollars will be spent in numerous energy sectors, particularly as the oil prices remain high and the concern over energy security has caught the world's attention. Diversifying the supply of energy sources by increasing the share of renewables' share in energy mix rather than exploiting and relying on more sources of oil has been recognised as a promising solution to not only the energy security issue but also to the changing climate.

Renewable energy sources will have to compete for the capital needed and the investment decisions to be taken. Sound supportive legislative models for RES in general must help to find and ensure the necessary financing for RES-

[2] *Virginia Sonntag-O'Brien, Eric Usher: Mobilising Finance For Renewable Energies, Thematic Background Paper 6,January 2004, Editing: Secretariat of the International Conference for Renewable Energies, Bonn 2004, page 4*

[3] *IEA World Energy Investment Outlook, 2003, Insights, Paris 2003, page 25*

based systems in the energy market against the background of a still absent level playing field.

As Professor Mohssen Massarrat underlined in 2002, the world needs a "Strategic Alliance for Entering the Renewable Energy Age". It is clear that "transition to a new order requires an all-embracing strategy, which must essentially take persistent account of three criteria; it also requires new political alliances".[4]

The strategy's three criteria are:

(a) Effectiveness and low transaction costs;

(b) benefits for the producer and the demand side in the sense of a win-win strategy, through social acceptability, minimisation of conflict, potential and planning security; and,

(c) compatibility with market regulation mechanisms.

We are facing a considerable and growing business sector worldwide: "Renewable energy is, in fact, a multi-billion dollar industry and the most dynamic sector of the global energy market. Globally installed renewable energy capacity is expected to more than double over the next ten years from approximately 130 GW in 2003 to 300 GW in 2013".[5] The IEA underlines that the five largest countries in the world outside the OECD – China, Russia, Indonesia and Brazil- will need about a third of global electricity investment; transition economies and developing countries will account for about 60% [6].

Why Support Renewables?

The purposes of facilitating sustainable development of energy supply are multi-faceted, including for the sake of protecting our climate, nature and the environment; for reducing the costs of energy supply to the national economy in the long run; for conflict-prevention over fossil fuels by enhanced energy security and promoting the further development of technologies; and, for the generation of electricity from renewable energy

[4] *See Prof. Dr. Mohssen Massarrat, University of Osnabrück, Department of Social Sciences, paper "entitled "Strategic Alliance for Entering the Renewable Energy Age", presented during the World-Council-For-Renewable-Energy (WRCE) meeting in Bonn, June 2002*

[5] *Virginia Sonntag-O'Brien, Eric Usher: Mobilising Finance For Renewable Energies ,Thematic Background Paper,January 2004, Editing: Secretariat of the International Conference for Renewable Energies, Bonn 2004, page 1*

[6] *IEA World Energy Investment Outlook, 2003, page 28*

sources. Perhaps one of the best legal descriptions currently available in national legislation is the wording of the first paragraph of Article 1 of the modified German Renewable Energy Sources Act of July 21st, 2004. The article sets a target to increase the percentage of renewable energy sources in power supply to at least 12.5% by 2010 and to at least 20% by 2020 [7].

One of the main questions raised in the field of energy law is why do renewables need support models to enter the market at all? Apart from some technologies, such as photovoltaics, they represent established technical maturity/advantage and a state of development which has long passed initial pilot phases.

It is clear that many countries and regions have a system in the energy sector which is closer to a stronghold of former national/public utilities working on a pseudo-liberalised action field and often with even more strength and economic power than before liberalisation. Entrenched monopolies and oligopolies keep competitors out. Private barriers to trade replace many that were previously created by the state. There are almost paradoxical situations in some countries concerning the energy market situation. In Germany, for example, the opening of the European energy market created a situation where some former large utilities became stronger and the concentration of market power is extreme. Although Germany fully liberalised its energy system, the consequence was not an increase in competition but a decrease in companies active in the German market and an increase in concentration of power in the hands of a few big utilities. After liberalisation, 80% of the German market is dominated by four big utilities, E.ON, RWE, Vattenfall and EnBW.[8] From approximately 900 communal power suppliers, more than 190 have given at least a minority share of 10% to the big utilities, E.ON and RWE. Via these shares the big suppliers ensure that they supply the communal supply companies and that those do not invest in their own new production capacities[9].

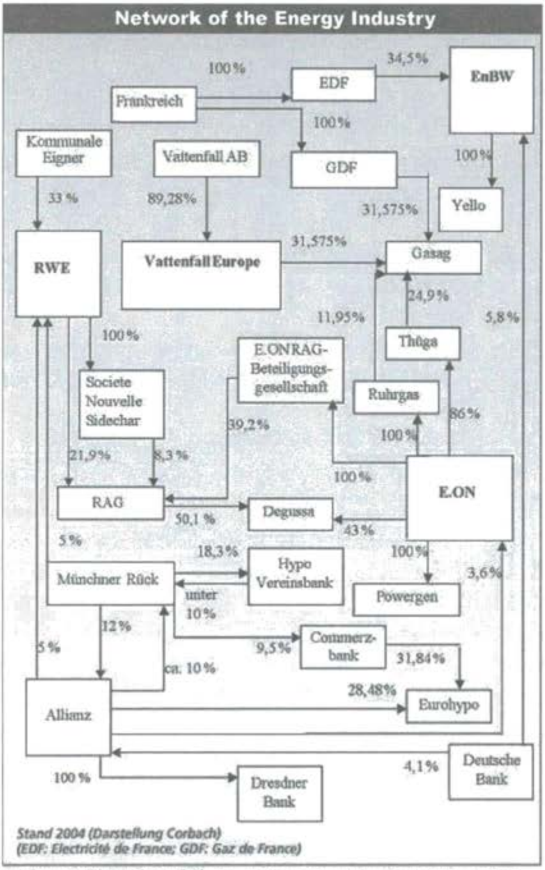
[7] *See full text of the English version of the EEG on the webpage of the German Ministry for Environment www.bmu.de*

[8] *Strommärkte GDE - Grundlage der Elektrotechnik, Joana Tomaszewski, Peter Herbst, Alexander Boers, page 6*

[9] *Bund des Energieverbraucher, http://www.energienetz.de/*

The following figure underlines the inter linkage and dominance of the aforementioned big utilities and with major financial institutions:

Figure 1: Ownership relations in the German Power System



Quelle :Brand, Ruth/Corbach, Matthias (2005): Akteure der Energiepolitik, in: Reiche, Danyel, Grundlagen der Energiepolitik, Frankfurt am Main. S. 251-277.

Politics often failed in the recent past to acknowledge or recognise that enabling utilities to go shopping beyond their former boundaries of regional monopolies did not lead to an open market but to a concentration of power.

And as always, this has to do with money and the fact that some big utilities were less constrained before liberalisation than independent power producers, especially traditional communal power suppliers. Communal power suppliers in the past in Germany, for example, were obliged to return their benefits to the municipal budget pay for social services, such as health care, schools, theatres, sports.

Following liberalisation, they started without important reserve funds. But large existing utilities, especially those with nuclear power facilities, had an important amount of money in their accounts, especially including approximately €60 billion as tax free cash reserves for the future dismantling of nuclear power stations[10]. With these funds, the former big regional players went on a national and international shopping spree which subsequently led to market concentration. The then German Economics Minister, Dr. Werner Mueller, gave a waiver in 2002 to a merger between E.ON and Ruhrgas, the dominant national gas supplier, although it was obvious and acknowledged by the government that it violated the national cartel law. The waiver was justified on the grounds of national public interest. Recently it became apparent that one major German Regional bank may have given a very low interest loan to the new Finnish European Pressurised Water Reactor (EPR) Nuclear Power project, amounting to £1.95 billion for an interest rate of just 2.6%. The whole nuclear facility cost €3 billion.[11] A RES project would never get such cheap financing but would at least have to work with interest rates around 4% in Germany[12].

France is an another example where the national public utility acquired companies or important stakes in companies in their neighboring countries and especially in Central and Eastern Europe on an important scale.

It is estimated that harmful subsidies to the traditional fossil and nuclear sector amount to US$250 billion worldwide per year[13]. As long as this is the

[10] *A conservative sum which is based on estimates since no clear accounting concerning these funds is available in Germany. The amount was not questioned by the German utilities during the recent annulment case before the European Court of First Instance T - 92 / 02 Stadtwerke Schwäbisch Hall GmbH (Communal Power Supplier) et al. against Commission of the European Communities, seconded by: E.ON Kernkraft GmbH et al.. The case is on the side of the Communal power supplier presented by Dr. Dörte Fouquet.*

[11] *From minutes of the 19th Session of the Bayerischer Landtag, 29.6.2004, Bayerischer Landtag, 15. Wahlperiode, Plenarprotokoll, 15/19, page 1278.*

[12] *EREF filed in 2004 an official complaint to the European Commission underlining the above loan structure risk and further infringement of EC law, www.eref-europe.org.*

[13] *José Goldemberg, Thomas.B.Johansson, World Energy Assessment, Overview, 2004 update, United Nations Development Programme, UNDP 2004, page 72.*

case, and as long as other mechanisms such as internalisation of external costs are not achieved, compensatory support systems to the renewable sector will be necessary. That means also that it is not the renewable energy which is too expensive but the traditional energy which is made to be too cheap.

How to Support Renewables?

Incentives for renewables can be evaluated with the following factors:

- Important short- and medium-term increase of green electricity production - "delivery test";
- reliability of the system to ensure financial viability for investors;
- level playing field in the overall energy market strategy;
- abolition of harmful energy subsidies to the traditional sector;
- internalisation of external costs;
- clear planning and administrative structures in favour of RES; and,
- enforcement clarity.

Major schemes to promote RES include:

- Specific subsidies for research and development;
- capital investment or loans to investments;
- energy taxes with specific renewable promotional fund schemes attached to it;
- legislative RES production support models; and,

- specific international instruments after Kyoto–CDM and JI which will not be discussed intensively in this paper.[14]

Grid-related Legislative RES Support Models

Support models vary from country to country and from region to region. Normally there is a set of different support schemes in one country or region.

One should not advocate in general a single model in Asia or in Europe but what should always be asked is, which model will deliver rapid increase of share of renewables in the electricity market and under which circumstances.

Models with heavy administrative burdens and only little output in megawatts have not proved to be successful and should not be sustained by politics, due to high transition costs.

According to the World Watch Institute, there are five major categories of relevant policy mechanisms in favour of RES development:

- Regulations that govern capacity access to the market/electric grid and production or purchase obligations;
- financial incentives;
- industry standards, permitting and building codes;

[14] *Kyoto instruments*

Kyoto instruments CDM and JI provide a new source of finance for RE projects. Capacity Development is needed to help the mainstream financial community understand renewable energy project opportunities and risks.

Joint Implementation (JI) according to article 6 of the Kyoto Protocol. Under which falls projects for climate protection and they were done in co-operation with various parties. The reduction in emissions which were generated will be divided among the signatory states.

The Clean Development Mechanism (CDM) enables industrialised countries to contribute to their emissions reductions obligations. Organisations that are idealistically motivated are also implementing climate protection projects.

Emissions reductions have to be additional to any reduction that would have happened without the Kyoto Protocol. Article 12 of the Kyoto Protocol gives the following definition:

The purpose of the clean development mechanism shall be to assist Parties not included in Annex I in achieving sustainable development and in contributing to the ultimate objective of the Convention, and to assist Parties included in Annex I in achieving compliance with their quantified emission limitation and reduction commitments under Article 3. According to UNFCCC the value of the ERU/CER shall significantly improve the financial and/or commercial viability of the respective project activity.

- education and information dissemination; and,
- stakeholder participation.[15]

Europe can already look back at a history of support models for renewable energies. Some have worked excellently, some have not delivered enough growth up to now and some seem to provide merely lip service.

In a competitive marketplace, support models for renewables to enter the market independently are needed. Having underlined, the failed opening of the traditional energy market especially in Germany, one should now equally stress with all respect the efforts of three consecutive German governments (from the former conservative-liberal government under chancellor Kohl to the social democratic-green governments of chancellor Gerhard Schröder), and especially the German Parliament since the mid 1990s, which all have undertaken to ensure a rapid growth of independent power production in renewables, always with overwhelming support from most parties of the German Parliament. The recent Bonn Conference on Renewables can be seen as important international acknowledgement of this positive policy.

Currently in Europe, the majority of countries have installed feed-in systems (FIT). Denmark had abandoned this system in recent years but appears to be returning to it. Countries are currently applying FIT include especially Austria, Germany, France, Spain, the Netherlands, Greece and Portugal.

Belgium recently chose a mix between a feed-in and a quota system and will evaluate the rate of increased installed capacity within the coming years.

Main Principles and Examples of Different Support Mechanisms

In the European Union (EU), only minimum price systems, have clearly demonstrated the capability of increasing installed capacity. The minimum price system is characterised by a legally determined minimum price and a general duty to purchase "green" electricity by the grid operator or utility.

[15] *Janet L. Sawin, Christopher Flavin, National Policy Instruments: Policy Lessons for the Advancement & Diffusion of Renewable Energy Technologies Around the World Thematic Background Paper December 2003 , Bonn International Renewables Conference, page 2*

The major elements of the German feed-in law, for example, are:

- Priority connections to the grid for general electricity from plants generating electricity from renewable energy sources and from mine gas within the territory of the Federal Republic of Germany, including its exclusive economic zone (territorial application of this act);

- the priority purchase and transmission of, and payment for, such electricity by the grid system operators; and,

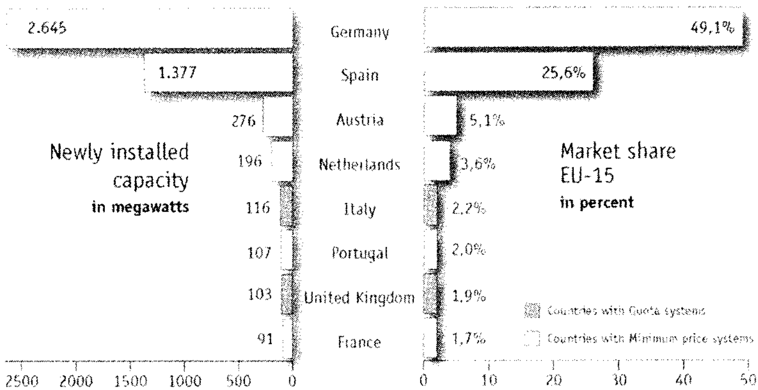
- the nation-wide equalisation scheme for the quantity of renewable electricity purchased and paid for.

Grid system operators shall immediately and as a priority, connect plants generating electricity from renewable energy sources to their systems and guarantee priority purchase and transmission of all electricity from renewable energy sources. The grid system operators shall pay fees -which differ depending on the source of RES electricity and the location of the installation - for electricity generated in plants exclusively using renewable energy sources.

The relevant upstream transmission system operator must pay for the quantity of energy which the grid system operator has purchased and paid for. He then transmits the supplementary payment for RES down to the final consumer.

Figure 2 underlines, the success of FIT systems is underlined:

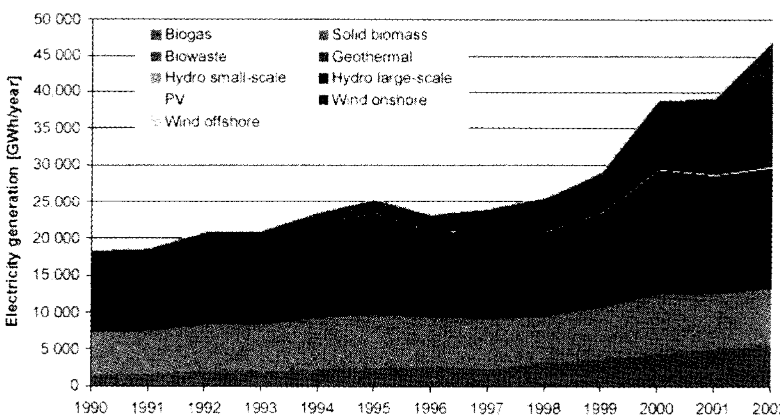
Figure 2: Overview Concerning the Annual Growth Rate for Wind Energy in EU_15



(Source: BWE, Bundesverband Windenergie)

According to EUROSTAT, the RES electricity market in Germany, 2002 performed as shown in Figure 3:

Figure 3: Electricity Generation (GWh/year), 1999-2002



In contrast, the key component of a quota scheme (generic renewables portfolio standard (RPS)) is the government regulation of a quantity or amount of electricity from renewable energies that should be provided, purchased or sold by a specified group of market participants. Allocating certificates controls compliance to the respective committed quantity, a RPS is a requirement for consumers or their retail suppliers (or, alternatively, electricity generators) to source a minimum percentage of their electricity consumption from eligible renewably-generated electricity. Recently, the following EU countries have adopted a RPS system: the UK, Belgium (Flanders, Wallonia) and Sweden. Finland has a voluntary green pricing system in place, similar to a RPS system. The reason for the UK to at least phase out its previous bidding model was that this tender system was inefficient to deliver.

The United Kingdom on the other hand relies in the logic of quota systems on following instruments, which have up to now not delivered enough output to reach the UK indicative targets for the increase for electricity consumption from renewables[16]:

- Obligatory targets with tradable green certificate system. The non-compliance "buy-out" price for 2003-2004 is set at £30.51/MWh (approximately €4.5 ct/kWh). This buy-out price will be annually adjusted in line with the retail price index.

- Climate Change Levy. Renewable electricity is exempted from the climate change levy on electricity of 0.43 p/kWh (approximately € 0.63 kWh).

- Grants schemes. Funds are reserved from the New Opportunities Fund for new capital grants for investments in energy crops/biomass power generation (at least £33m (€53m) over three years), for small-scale biomass/CHP heating (£3m or €5m) and planting grants for energy crops (£29m or €46m for a period of seven years).

The UK government recently opened a major initiative for more wind energy power installed; the outcome will have to be seen.

With bidding or tendering models, regenerative electricity producers compete in individual bidding rounds to cover a previously determined quantity con-

[16] *EREF report on missing targets 2004, see www.eref-europe.org*

tingent. The winning bidders then receive a fixed-term purchase guarantee for the electricity they generate.

The government awards power purchase contracts for a certain aggregate volume of eligible renewables-based electricity (RES-E) per tender to RES-E project developers who submit the lowest kWh bidding price. After UK recently discarded the tendering system, Ireland remained the only EU country applying this support mechanism.

Tender systems to buy a certain quantity of eligible RES-E tend to have a relatively modest RES-E stimulation impact because these do not provide certainty to RES-E project developers that their efforts to develop a project will be redeemed. Furthermore, the quantities tendered depend on short-term ad hoc decision-making. This political risk increases uncertainty to project developers. "Moreover, profit margins would be squeezed anyhow if a reversed auction procedure is opted for. In the latter procedure, the successful bidders obtain a purchasing power agreement on the basis of their asking price rather than the clearing price at which the last MWh for tender is traded. Except for the highest successful bidder, asking prices of awarded bidders will typically be lower than the tender clearing price."[17]

The tendering/quota models are state aid models. State aid for renewable energies as such is not harmful. But the fact has to be underlined, that in the public discussion it is still and often claimed that quota systems are closer to market principles than feed-in systems. This is not true. The European Court of Justice has ruled in its landmark decision of 13.03.2001 on the case Preussen Elektra versus Schleswag[18] (two German utilities, where one was the subsidiary company of the other) that the German feed-in law does not constitute state aid, since the state only sets clear rules to the market, and does not provide any money or other contribution within the framework of the German feed-in law.

Take Ireland's Electricity Regulation Act of 1999 with its Alternative Energy Requirement (AER) tendering system. It was submitted to the EU Commission for approval as state aid, which was granted. Operating subsidies to produce 500 MW of power from renewable sources are paid from the public purse.

[17] *J. C.Jansen, Policy support for renewable energy in the European Union, a review of the regulatory framework and suggestions for adjustment, ECN-03-113, October 2003, page 38*

[18] *C-379/98; for a short legal overview see the Author's text under http://www.wind-energie.de/informationen/europa/nationale-gesetzgebung/beihilfe-gutachten.htm*

Applicants bid prices per kilowatt-hour supplied and the successful ones are awarded power purchase agreements of up to 15 years. The last tendering round expired in 2002. In reality, there were serious delays in implementation.

Ultimately, the Irish government, which is also the major shareholder of the country's main power utility, the Electricity Supply Board (ESB), was able to announce in July 2003 that under the AER tendering system, all offshore "renewable energy power purchase contracts" were won by the Kish Consortium, a subsidiary of the ESB, against a large number of independent renewable power producers. The actual liberalisation of the Irish power market was weak in any case and this quota system further cemented its remoteness by means of state aid.

The average financial indicators needed to make a comparison of the economic efficiency of the feed-in and quota-based systems is not a serious approach for the simple reason that we now have a plethora of data for the feed-in system while the volume of corresponding data on quota-based systems is small and statistically unreliable.

Feed-in systems can establish economies of scale and reduce prices efficiently.

The EU Directive 2001/77/EU on the promotion of electricity produced from renewable energy sources in the internal electricity market has compelled the EU member states to raise the amount of renewably sourced energy in the power mix. European Renewable Energy Federation (EREF) just recently underlined the negative tendency in its regular report on the directive, that countries with quota systems will find it difficult to reach their clean power targets. And that means Europe as a whole will not achieve the target it has set itself for 2010[19].

This also endangers the EU's target to reduce CO_2 emissions. If at the same time, the looming increase in energy consumption in the community results in a further increase in CO_2 emissions in Europe, the drama will certainly worsen. The weakness of all other promotion systems increases the onus on the Commission and member states to meet the contractual obligations stipulated in the Directive and the commitment to the Kyoto Protocol by upholding the efficiency of the feed-in systems and pushing them even further.

[19] *EREF report on "Missing Targets 2004", www.eref-europe.org*

Renewable Energy Incentives

Some RES technologies such as photovoltaics and some specific applications, for example, for RES in remote areas would even need more than feed-in regulations, due to high production costs of these new technologies. Also, in order to secure loans, developers and their equity sponsors must present between 25% and 50% of the capital required for a project in the form of shareholder equity. As the risk (real or perceived) associated with a project increases, lenders will require that equity play a larger role in the financing structure. In other words, the higher the risk, the higher the amount of equity the lender will require in a project. This not only strains a developer's capital resources, it raises the cost of the entire project, since the cost of equity capital is always higher than the cost of debt capital. A variety of supporting models, instruments exist.

The following examples are taken from the Thematic Background Paper no. 6 for the Bonn International Conference on Renewables:

FIDEME Mezzanine Fund

FIDEME is a French €45 million public-private investment partnership, which provides mezzanine finance to renewable energy companies in France. The French Environment and Energy Management Agency (ADEME) provides both capital and a first loss guarantee, which increases the risk adjusted returns for investors and retail banks.

Community-owned Wind Funds

Tax-incentives and community-based collective investment in RE is growing in countries such as Germany, Denmark, Finland and Canada, especially in wind projects. In Germany, most commercial-scale wind turbines are financed by community-owned funds, a participation scheme that raises awareness and local acceptance and allows everyday citizens to make sound ethical investments. The funds receive tax benefits as all other investment funds.

ASTAE: Greening WB Energy Sector Portfolio

The Asia Alternative Energy Programme (ASTAE) was established by the World Bank in 1992 with the goal of "greening" World Bank lending to the power sector in Asia. The programme has been so successful that it has exceeded the target of increasing the share of alternative energy in its Asian power sector loan portfolio to 10%. In the financial year of 1999, the share was as high as 46.3%. Since its inception, ASTAE has developed a renewable energy lending portfolio in Asia of over US$1.3 billion. The GEF-supported Sri Lanka Energy Services Delivery project is a good example of an ASTAE programme supporting grid and off-grid RE and demand side management (DSM) services.

Rural Energy Enterprise Development

Initiated in 2000 by UNEP, E+Co and a number of country partners, backed by the UN Foundation, the Rural Energy Enterprise Development (REED) initiatives support sustainable energy enterprises that use clean, efficient, renewable and affordable energy technologies to provide energy services to rural and peri-urban customers in seven developing countries. REED offers rural energy entrepreneurs a combination of start-up financing, enterprise development services such as business planning, management structuring and financial planning, and assistance in securing later-stage financing. 25 enterprises financed to date in Ghana, Mali, Senegal, Tanzania, Zambia and Brazil include crop drying, charcoal production, bio-fuels, wind pumps, solar water heating and efficient cooking stoves.

World Bank Prototype Carbon Fund (PCF)

The PCF is similar to a closed end mutual fund, with objectives to supply high quality carbon offsets at a competitive price and to ensure that buyers and sellers receive a fair share of the value added. The negotiated price of the carbon offsets covers the cost of additional emissions reductions measures over the baseline technology, as well as a margin representing equitable benefit, shared between the investor and host government. As of late 2003, the PCF has been capitalised at $220 million USD.

State Renewable Energy Funds in the US

A number of US states have recently created funds to promote and develop renewable energy. The 15 states that have established renewable energy funds acquired more than $3.5 billion between 1998 and 2012[20]. This represents a growing trend by US states to support the development of renewable energy technologies. The US gives incentives in the field of wind energy, for example, via its federal production tax credit (PTC)[21] for wind power projects. While the federal PTC provides critical support to wind plants in the US, its so-called "double-dipping" provisions[22] may also diminish the value of – or make ineffectual – certain types of state wind power incentives. If not structured properly, state assistance programmes undercut the value of the federal PTC to wind plant owners. It is therefore, critical to determine which state incentives reduce the federal PTC and the magnitude of this reduction.[23]

With the globalised RE market, some countries especially from the developed world sometimes provide for export financial incentives in the field of RES technologies. The German government, for example, had already in 2002 presented its programme, Sustainable Energy for Development, reserving €1 billion over a period of five years for this objective.

Encouraged by the positive reaction to this programme, the German government introduced a budget line for a specific loan facility to be managed by Kreditanstalt für Wiederaufbau (KfW) Entwicklungs Bank adding for the period of 2005 to 2010, a further €500 million for low interest credits for developing countries.[24]

[20] *Information regarding US state renewable energy funds is based on "Case Studies of State Support for Renewable Energy", by the Lawrence Berkeley National Laboratory in collaboration with the Clean Energy Group. Access to the full document or individual case studies can be found at http://eetd.lbl.gov/ea/ems/cases/ . Several case studies are expected to be published each year.*

[21] *The federal PTC applies to business production and sale of wind-generated electricity and not wind-generated electricity that is used for the project owner's individual electricity demand.*

[22] *Ryan Wiser and Mark Bolinger, Troy Gagliano, Analysing the Interaction Between State Tax Incentives and the Federal Production Tax Credit for Wind Power, Environmental Energy Technologies Division National Conference of State Legislatures, Ernest Orlando Lawrence*

[23] *Ryan Wiser and Mark Bolinger, Troy Gagliano, Analysing the Interaction Between State Tax Incentives and the Federal Production Tax Credit for Wind Power, Environmental Energy Technologies Division National Conference of State Legislatures, Ernest Orlando Lawrence Berkeley National Laboratory,September 2002 -Download from: http://eetd.lbl.gov/EA/EMP/ LBNL-51465*

[24] *Speech by Heidemarie Wieczorek-Zeul, Minister for Technological Co-operation and Development, Bundesministerin für wirtschaftliche Zusammenarbeit und Entwicklung "Die Internationale Konferenz für Erneuerbare Energien - Ergebnisse und nächste Schritte" -Follow-Up-Conference, Gelsenkirchen, http://www.bmz.de/de/presse/reden/ministerin/rede20041207.html*

The following support targets are listed:

- Support for the export of technologies via sponsoring of information and counselling measures, marketing activities in the target markets, participation in specific trade fairs, contact meetings, feasibility studies, analytical studies concerning the target market, legal advice, pilot projects, events in German embassies for the presentation of know-how and transfer.

- Climate protection projects in the Baltic Sea region.

- Export initiative of DENA, the German Energy Agency (Deutsche Energieagentur) and of KfW Bank.

- Support to the Climate protection fund of the KfW Bank which cur rently has approximately €50m volume.

Support in the Developing World

Financing for Rural Areas

The lack of rural business financing in particular is one of the primary factors hindering the development of markets. There is a considerable lack of continuity of support schemes for rural areas in developing countries, be it concerning maintenance and repair knowledge and facilities of the installations or continued financial support beyond the first set up of an installation. Credit may be unavailable, too expensive or too limited in time to be usable. Unrealistic political promises or plans for rural electric grid extension can be serious barriers to expansion in the solar home system market, as households expect to be "connected" soon.

Lessons learnt are presented as follows:

- Donors support: a few donor programmes have effectively assisted rural renewable energy-based enterprises to build a sustainable and viable business.

- Weak local enabling business environment: rural energy enterprises face a high-risk, low-margin business with high transaction costs.

- Commercial banks and financial intermediaries are key decision-makers who must understand the technologies, particularly those associated with immature technologies and manage risks.

- Effect of demonstration: demonstration of viable business models that eventually show sustained profits for the enterprise is crucial to achieving market sustainability.[25]

A sound micro-financing scheme will certainly meet income generation in the rural area and return of investment. This has been proven in many projects in developing countries and one outstanding example is the experience of Grameen bank working in Bangladesh and other developing countries. Especially Grameen Shakti, an energy company under the Grameen Bank, that offers three year credits to consumers.

The Vietnam Women's Union offered similar credit to households. In Sri Lanka, Sarvodaya, a national micro-finance organisation, has offered credit on terms up to five years.

Eric Martinot provides the following examples that underline: small and mini grid infrastructure or stand-alone systems that can power small industries and provide substantial local income and jobs.[26]

- Villagers sew, dry seaweed and work with wood using around-the-clock power from a wind-solar-diesel hybrid on one Philippine island.

- Small local enterprises, such as a cycle repair shop and health clinics, receive power from solar and biomass village-scale mini grids in West Bengal in India.

- Remote fishing villages in Indonesia make ice to freeze fish, operate a chick hatching unit, grind corn and obtain potable water supplies using wind power.

- Women weave mats at night using the light from solar home systems in South Africa.

[25] *Eric Martinot et al. Renewable Energy in Developing Countries: Lessons for the Market, Renewable Energy World, issue July-August 2003*

[26] *See examples, Eric Martinot*

- Carpenters and welders work off small hydropower systems in Peru.

Martinot furthermore summarises the current development in the field of rural electrification and access to finances as following:

- Historically, affordability of rural energy has been addressed through government subsidies, donor programmes and private cash sales of small systems;

- new approaches to affordability are emerging, including vendor-supplied credit, micro-credit and rental models, but are still largely untested;

- credit risk is a serious concern, both for financiers and dealers, and makes credit sales challenging;

- lower-income rural households will need long-term credit or rental options; and,

- even with credit or rentals, lower-income groups will only benefit with targeted policies, including subsidy policies, justified by development goals.

Recommendations for Financial Institutions and Policymakers

The thematic background paper, "Mobilising Finance for Renewable Energies" for the Bonn Conference gave the following recommendations concerning financing of RES projects in developing countries:

GOALS	RECOMMENDATIONS FOR FINANCIAL INSTITUTIONS
New financial products	• Develop and test innovative financial products tailored to the RE sector
Develop/Improve/Expand risk management tools	• Extend existing energy insurance product lines with similar operations or facing similar risks to include standard RE projects and, where possible, prototype RE projects. • Change underwriting risk perceptions to increase the availability of risk transfer products; • Develop new underwriting rating methodologies. • Develop new risk management instruments to bundle heterogeneous risks; • Aggregate projects to create portfolios of scale and risk diversification • Develop new risk transfer markets through convergence of insurance and capital markets; • Develop the actuarial data sets needed to assess project risks.
Increase awareness, information, and skills	• Increase awareness and understanding of the threats of climate change and other environmental impacts of energy production and use. • Initiate and carry out more work on financing renewable energy. Develop the skills to evaluate renewable energy project risks and revenue streams. • Provide information to customers and clients on the opportunities in investing in RE. • Increase analyst coverage of listed RE companies

Recommendations specifically for developing countries

GOALS	RECOMMENDATIONS FOR POLICYMAKERS AND MULTI/BILATERAL INSTITUTIONS
Support business development	• Support companies that ensure reliable access to energy, provide local income generation, and improve living standards. • Help project developers fill the gaps along the finance continuum. This can be in the form of support for feasibility and due-diligence work, as well as for business planning
Support new risk capital approaches for enterprise development	• Support the creation of early-stage seed capital funds, providing capital and enterprise development services to innovative clean energy entrepreneurs. • Support local intermediary capacity as a more efficient way to deliver seed capital and to support SMEs with business development services
Support growth capital approaches that help proven SMEs scale up their businesses	• Finance growth capital funds using blended arrangements that buy down the risks and buy up the returns for commercial investors.
Improve access to, and affordability of, credit markets	• Provide credit enhancements to share the risks (guarantees) or buy down the financing cost (interest rate softening) of commercial loans.
Partner with the private sector	• Build effective financing partnerships with the private sector on a risk-sharing basis. This is necessary as long as the renewable energy industry in developing countries continues to rely on government and public funding

Many encouraging initiatives, programmes and legislative instruments have been developed in Asia and in Europe, to increase the use of renewable energy sources and to stimulate investment in this new and fast growing market.

Key factors for success include strong and sustainable political commitment, phasing out of harmful subsidies, good administrative procedures and shifting to environmental taxation and financing schemes.

Effective partnerships between private and public finance sectors and renewable energy industries, especially focusing on decentralised, small and medium-sized independent development are necessary.

A lot has still to be done to create a level playing field in the market. Binding targets for governments to increase RES electricity and energy efficiency, and are crucial elements for a sustainable policy. Dominant oligopolies on the energy market and barriers to grid access endanger validity and longevity of efforts in this field. Best practice inventories especially from experience in Asia can help to multiply efforts in an efficient way.

Chapter 4

Asia-Europe Platform: From Technology Transfer to Technology Exchange

4

WHAT WENT WELL, WHAT WENT WRONG: A REVIEW OF RENEWABLE ENERGY TECHNOLOGY TRANSFER SUCCESSES AND FAILURES IN ASIA

Robert Koh
General Manager
REGIONAL INSTITUTE OF ENVIRONMENTAL TECHNOLOGY
SINGAPORE

Abstract

The growing demand for energy through urban and industrial development in Asia means greater opportunity for Europe to promote the transfer and exchange of renewable technology as a viable alternative for energy supply.

In general, transfer and exchange of technology for renewables in Asia has been very encouraging. This may be attributable to a significant amount of renewable energy potential in Asia and strong support from governments to introduce foreign technologies that potentially serve for economic development. In addition, it has been agreed that modern use of renewable energy resources can produce both economic and development-related benefits. This opens multiple doors of opportunity for renewable technology suppliers if their business strategy for the Asian market can incorporate the end results of economic development: creation of wealth, employment, foreign investment, developing the local industry, research and development.

However, a number of barriers are hindering the process of renewable energy technology transfer between Asia and Europe, such as mismatched technologies, affordability and short-term business strategies.

The world consumes energy at a growing average rate of 2% annually for the last 200 years and this trend will continue in the near future. The share of fossil fuels in the total supply of conventional energy is about 90%.

The current pattern of rising conventional energy consumption cannot be sustained due to two reasons:

- Environmental consequences of heavy dependence on fossil fuels. Global warming has emerged as probably the most serious environmental threat ever faced by humankind. Urban air pollution and acid rain are also major problems associated with large-scale use of fossil fuels.

- Depletion of fossil fuels. There is no doubt that fossil fuels will eventually run out. We knew this from the first day we started to use them. Although we don't know when, we know it will come as long as we keep the pace of exploitation and usage of fossil fuels faster than their re-generation.

It is therefore, very critical that renewable energy technologies are promoted and used as an alternative so that global energy supplies can be placed on an environmentally sustainable path.

We must also acknowledge that the efforts of various government institutions, universities, NGOs and international development organisations have made tremendous growth in renewable energy technology applications, especially in Asia. However, there is still a lot of work to be done in order to make renewable energy solutions accessible, affordable and appropriate.

There is a need to further explore how the private sector can increase their contribution to the growth of renewables. One way is to review their successes and failures as well as determine and examine the key factors.

Renewable Energy: Potential Opportunity in Asia

Rapid economic development in Asia over the past decades has captured the world's attention; positively for the contribution to the world continued economic growth, negatively for the associated energy issues. Asian countries, including China, are currently using nearly one fourth of the world's total primary energy supply (TPES) with almost half of the world population (IEA, 2004). With the limited fossil fuel energy sources in the region, Asia will further suffer energy shortages, as the energy used per capita is increasing and a large number of rural people are becoming users of modern energy carriers. It is estimated by IEA that the energy consumption will be more than doubled by 2025 compared to the 2001 levels (DOE/EIA, 2004). In this context, developing renewable energy resources is a solution to the dilemma that Asia is encountering.

A brief look at highlighting potential renewable energy sources in some of the Asian countries namely in the ASEAN region, China and South Asia is stated. Additional information like barriers to greater renewable technology development and current application of renewables are also documented:

Cambodia

Hydropower: In terms of potential mini-, micro- and pico-hydropower in Cambodia, it is estimated that up to 300 MW has not been tapped and only 1 MW power has been utilised so far. Solar power is in abundant supply, especially solar energy for rural area applications, but developmental growth has been slow and to date only a single photovoltaics (PV) system at 300 kW has been installed. Biomass energy from animal and agricultural waste is virtually untapped and is estimated at 700 MW if such power is to be developed.

The main barriers of renewable energy development include the country's lack of enabling policy framework to encourage such development. In addition, key data on market characteristics are not easily available and, technological know-how and development financing are not available either.

Laos

Unfortunately, only 20% of villages and 35% of households in the whole country are supplied with grid electricity. Since 1997, to increase the supply of electricity, the government liberalised the development of small scale (100 kW and below) hydropower systems; this has encouraged local developers to produce such equipment. An ongoing project financed by the Japan International Co-operation Agency is being carried out to develop energy using photovoltaics; electrification and battery; and, pico-, hybrid- and micro- hydropower.

Myanmar

Approximately 67% of the country's total power consumption is supplied by biomass and hydropower. Myanmar is also one of the more active Asian countries in developing bio-gas systems for energy. Myanmar has a potential hydropower (potential) of about 108-900 MW. The estimated annual energy production stands at 366,000 GWh/y, and the installed hydropower capacity is about 360 MW, which is less than 1% of the total potential.

Potential wind energy is estimated at 365.1 TWh/y, while solar energy has a potential power supply equivalent to about 51,973.8 TWh/y. For geothermal energy development, there are about 93 suitable hot springs found and half of them have been investigated for development.

The development of renewable energy in Myanmar is prioritised as follows: hydropower, biomass, biological and thermo-chemical systems, solar photovoltaic systems, and lastly wind energy.

In Myanmar, the main barriers of development include the lack of awareness, high investment cost, lack of finance credit mechanism, low level of community organisation, and difficulties with maintenance and repair.

Malaysia

Under the Eighth Malaysian Plan (2001-2005), which provides the national vision and direction for the country's development, three fuel policies comprising of natural gas, oil and coal have been expanded to give domestic renewable energy sources (hydropower) the status of the country's fourth fuel.

Malaysia is probably one of the Asia's more advanced countries, in terms of development of renewable energy technologies. There are many home-grown companies that specialise in the assembling of biomass renewable energy co-generating plants and other similar equipment like solar collectors and PV modules. Likewise, local manufacturers are also producing biomass boilers which are marketed locally and abroad.

Most of these companies are making good business, acting as suppliers for government renewable energy projects for rural development. Other renewable energy technology applications in Malaysia include waste incineration energy recovery, small hydropower, wind turbines and bio-gas systems.

The Philippines

The Philippines aims to be the world's number one producer of geothermal energy and is currently the biggest wind energy producer in Southeast Asia. In general, renewable energy programmes are moving fast in its development, promotion, commercialisation and utilisation.

The current renewable energy development stands at 4449 MW and is expected to add another 4550 MW by 2012 to achieve the 9000 MW goal. The 2012 renewable energy development goal also aims to double the current hydropower capacity and also expand the contribution of biomass, solar, micro-hydropower and ocean energy development by 250 MW.

Thailand

Thailand is very active in promoting their renewable energy development. Currently, there are three main enabling instruments that facilitate such advancement. These include flexible financial assistance, soft loans and public awareness campaigns and development of renewable energy information centre.

There is an abundant renewable energy supply and these include solar, wind, agricultural residues, animal waste, municipal solid waste, agro-industrial waste water, hydropower and geothermal energy. To date, the total installed PV capacity is about 5.6 MW, of which, 95% is located in remote areas. A total of 192 kW of wind electricity has been installed and an additional capacity of 3.6 MW is expected by 2006.

Approximately 17 million tonnes of bagasse and rice husks are utilised as fuels for industrial heat and power requirements. There are approximately 2 MW of micro-hydro systems installed but only 50% are currently operational, while a total of about 2900 MW of mini-hydro systems have been installed.

Vietnam

Although Vietnam has been undergoing a shortage of supply of energy sources from the rapid economic boom, Vietnam intends to develop itself into a potential major net exporter of petroleum products and gas in the Asian-Pacific market. Building more coal-fired thermal power plants may be a short-term but definitely not a long-term solution, particularly if Vietnam is keen on the Clean Development Mechanism (CDM) under the Kyoto Protocol.

As a matter of fact, Vietnam is rich in renewable energy sources, such as hydropower, biomass and solar energy. It is estimated that the potential for small hydro (no more than 10 MW) is around 2000 MW, while biomass, mainly bagasse and rice husks, has an even larger potential due to its expanding production and the hope to be converted into liquid biomass, i.e. bio-fuels to be used for vehicle fuel. Out of this potential, only a small portion (assuming 100% in operation) has been exploited and used, for example, merely one-third of small hydro and marginal bagasse (mostly in-plant use with an exception of one grid-connected biomass-based power plant in Tay Ninh Province) has been developed. (ASTAE, 1999)

In addition, solar potential can be huge due to the good radiation levels, mostly in the southern and central regions. To provide a cost-effective energy solution to remote rural areas, solar PV systems are playing an increasingly important role in Vietnam.

However, without policy support, it is difficult for renewables to penetrate into the competitive market due to low income and poor public awareness in rural and remote areas. Government may take into account the following factors in the process of policy making:

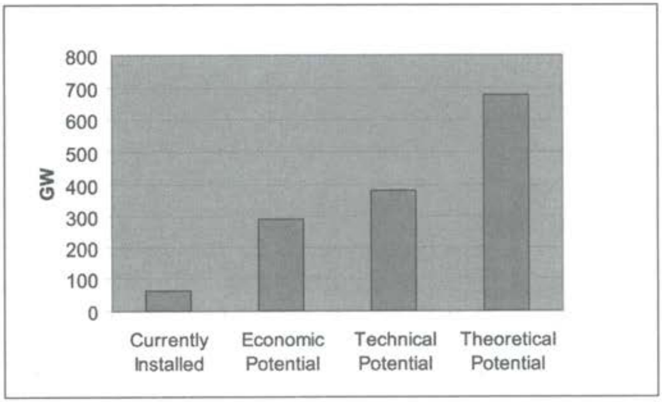
- Renewable energy development must take into consideration social, economic, environmental factors and public awareness.
- Government may support renewable energy projects based on average family incomes in rural and mountainous areas.
- 100% tax exemption for equipment importation.

China

Since its policy of opening up was initiated in 1978, China's economic development has been on the fast track, with 9.6% annual GDP growth, which was fueled largely by cheap domestic. However, using coal is not cheap any longer, due to its local, regional and global negative impacts. Oil is expensive as well since China has limited oil reserves, as is natural gas. The energy issue is becoming a security issue, particularly for the continuation of economic development. In addition, there are still around 60 million people without access to modern energy carriers, such as electricity.

China possesses vast potentials of various renewable energy sources such as hydropower, wind, solar, biomass and geothermal energy. As shown in Figure 1, the potential of hydropower is still huge.

Figure 1: Potential Hydropower Resources



(Source: Zhang, et al. 2000)

Another promising renewable source in China is biomass-based energy, given the fact that China has a potential of 700 million tonnes of coal equivalent. It is estimated that solar and wind energy, being portrayed as clean and modern energy carriers, are being more and more accepted in rural areas. To promote development of renewables, China has made a number of policies and promotional programmes, such as "New and Renewable Energy Project in Priority" approved by the State Council in 1995.

Moreover, a number of renewable energy technologies are arriving at or approaching to the commercialisation phase, as presented in Table 1.

Table 1: Phased Assessment of China's Renewable Energy Technology Development

Types of Technologies	Maturity and Development Phase			
	R&D	Demon-stration	Early Commer-cialization	Commer-cialized
Small hydropower				*
Solar water heater				*
Passive solar house				*
Solar stove				*
Solar drier		*		
Solar cell			*	
grid-connected wind turbines			*	
Small and mini wind turbines			*	
Geothermal power generation				*
Geothermal heating				*
Traditional bioenergy technology				*
Small methane tank				*
Large & medium methane tech			*	
Municipal Organic waste power generation		*		
Biomass gasification		*		
Other modern bioenergy techniques	*			
Wave power generation	*			
Tidal power generation			*	
Ocean thermal energy conversion	*			
New hydrogen manufacturing tech	*			
Hydrogen storage techniques	*			

(Source: Zhang, et al. 2000)

India

India identified economic development as high priority and therefore, industrial production drives the demand for energy. Consequently, to meet the industrial demand for power, renewable energy is considered to meet this need. Electricity from solar, wind and hydropower energy are also developed for power supply in rural areas.

India has also one of the biggest programmes of solar energy in the world. Many rural villages are using photovoltaics for their energy needs. For wind energy, India is expected to exceed its target of installing 1500 MW of wind power in the 2002-2007 period (Ministry of Non-Conventional Energy Sources, India). There are numerous incentives for wind producers in India to spur growth.

For hydropower, it is estimated that there are opportunities for large-scale hydroelectric plants with estimated potential of 150,000 MW.

South Asia

The South Asian countries consist of Bangladesh, Bhutan, India, the Maldives, Nepal, Pakistan, and Sri Lanka. The total commercial energy mix in 2001 includes 43% coal, 36% petroleum, 13% natural gas, 7% hydroelectricity, 2% nuclear and 0.1% "other".

Most of these countries faced rapid rising energy demand coupled with increasingly inadequate energy supplies. They rely heavily on biomass (i.e. animal waste and wood, etc.) for cooking and other domestic use.

Countries like Nepal, Bhutan, Sri Lanka and Pakistan rely on hydropower. Bangladesh uses thermal power plants for electricity (93%) but only about 20% of the population has access to electricity.

What Went Wrong: Barriers Restraining Renewables in Asia

Apart from funded projects, jointly developed by development banks, government bodies or institutional programmes, there is a need to promote more private sector participation to increase the growth of renewables in Asia. The challenges of success and failure experienced by the private sector should be reviewed and key factors should be identified and examined to see how the barriers can be overcome. At the same time, the factors which contributed to successful renewable energy implemented should also be highlighted and explored accordingly:

- Technology too advanced/complex: It is not surprising to hear that quite a number of renewable solutions from Europe were relatively too advanced to suit the present demand application in many parts of Asia, in particular the developing countries. Other than the main cities itself, many rural areas are still relying on very outdated modes of energy (traditional burning of wood for heating and cooking) and their standard of living is simply not able to accommodate the cost of even traditional technologies for using renewable energy sources. In addition, installed renewable systems may face the potential danger of not having competent experts to manage and maintain. European companies will have to put in place their own local expertise but such arrangement is heavily dependent on the return on investment of the project. Otherwise, they may face possible risk of high running cost and closure of the project eventually.

- Expensive (economically not justifiable): Increasingly, European companies interested to find new markets in Asia are experiencing the issue of cost in their business strategy. Besides the high exchange rates that make their business (hardware/services) relatively expensive in Asia, some Asian countries are also imposing tariffs to protect their own local companies. Another factor that adds to this barrier is that the majority of Asians live in non-urban areas and their modest lifestyle may not enable them to "pay" for the use of modern renewable systems. Government financial assistance, if available, is relied upon heavily. Again, the prospect of increase in European investment in renewable systems is also very dependent on the economic well being of the country.

- Minimum business plans/strategy: Despite numerous activities and events organised in Asia promoting European renewable technology, the real success is still far from satisfactory. Feedback from various organisers as well as relevant chambers of commerce testified that many visiting Europeans are not willing/ready to commit to longer-term business/project plans. Perhaps the market may not be financially attractive enough and therefore they see no reason to commit to other investment like setting up of local office/factories or invest in long-term business market research. Another possible reason is that Asia is also a place whereby enforcement of copyrights/patents is not strong enough to protect the technology from being duplicated/copied by the locals.

- Unwilling to adapt to the local culture: Asians have developed their own unique way of developing projects/business and is not necessarily the same approach as compared to Europe. For example, in Thailand and Malaysia, there are many European companies who are very successful in introducing their technology and one clear factor for their success is many of their key decision makers have been living in the "market" country for many years. A meeting with these people will surely reveal to us that they have "localised" their business ways and approaches.

- Lack of financing in Asia: Private sector renewable projects, especially in non-urban areas, often face the problem of loans to finance the project. In Asia, commercial banks are not very keen to provide loans as their perception of such projects are high risk and low returns. Most of the Asian countries rely on international donors to finance their projects but often such financing, though needed, does little to promote user-pay principle so as to attract commercial loans. In addition, when the financing ends, most of these systems will not have the funds to maintain and may become unusable eventually. Little productive use of energy in rural areas may also contribute to the poor financing situation.

- Lack of transparency in Asian markets: There have been frequent complaints from project developers regarding the integrity of tender projects. Foreign companies often find it impossible to "win" the projects unless they work with the right local partner and such partnership usually involves some kind of unofficial payment not related to the project. Local partners sometimes are politically driven and may have access to useful information not available to the public before the tender is closed. Although many have accepted such practices as inevitable and necessary to develop the projects, it certainly hinders a more competitive system to develop more cost-effective renewable systems for the benefit of the consumers.

- Poor demand: Approximately 80% of demand for environmental-related technology (including modern renewable systems) is driven by legislation that is effectively backed-up by appropriate enforcement. In addition, enabling policies to promote and develop cost-effective renewables should also be in place. For example, because of lack of enforcement, many people in rural areas are still using the traditional method of burning wood for heating purposes. A proper enforcement eliminating the use of wood (e.g. illegal cutting of trees) and at the same time, introducing wind/solar/hydropower as alternatives for heating and electricity will yield very successful technology transfer/exchange. Note that many a time, technology is not a problem but rather the enabling dimension that is sadly lacking.

- Local competition: Although the development of local competition in Asia for renewable technology should be seen as a positive note for the promotion of renewable projects, nevertheless, it is worth mentioning here that many European technology providers should be encouraged to conduct their own market study so as to evaluate the relevance of their technology, especially in terms of cost and financing. This is especially more so in Thailand and Malaysia, where the development of home-grown industries have advanced very much over the years. The issue becomes more complex when some governments impose tariffs to protect their own local industries.

What Went Well

Possible Key Factor for Greater Success: Embracing Economic Development (ED)

With the exception of Singapore, South Korea, Taiwan, Hong Kong and Japan, Asia is still essentially a developing region and therefore, the impact of technology transfer on economic development is critical to any partnership success. Most Asian governments placed economic development high on their priority list of national development agenda. In addition, economic development is also a strong political driver and all foreign technology providers, especially the private sector, should include as much as possible the benefits of economic development when planning for business in these countries.

Technology Transfer should be Investment-Driven

When a renewable energy project is developed from an economic investment perspective, there is a greater chance of successful implementation because the federal government as well as local authorities and community will increase their support. This is due to the fact that besides providing a sustainable energy source for these people, the project also offers other development-related areas like:

- Provide local contract work e.g. parts and basic equipment;
- develop manufacturing facilities (if demand justifies);
- provide employment;
- train locals to manage the system; and,
- poverty reduction by productive use of energy.

Benefits/Characteristics of Economic Development

A typical definition of economic development can be understood as "The process of developing and maintaining suitable economic, social and political environments, in which balanced growth may be realised, increasing the wealth of the community" (Source: Economic Developers Associations Alberta, http://edaalberta.com/)

To further understand the main characteristics of economic development in line with technology transfer for renewables, one good approach is to look into the strategies of the Economic Development Board (EDB) of Singapore and extract out the key areas of benefits that it is looking for.

Key Points on What Went Well

The following self-explanatory points are the main reasons why some European renewable technologies are successful in Asia:

1. Invest in market study:
   - Participate in industry partnership events.
   - Source for existing market reports.
   - Engage consultants to develop market reports.
2. Market (country) orientation and adaptation:
   - Regular visits to understand business culture.
   - Meet with relevant stakeholders.
3. Appoint local representative/agent:
   - "As if you are there" beyond simple distribution arrangement.

- Provide performance-driven incentives.

4. Promote win-win partnership/build local enterprise along with market success:
   - Setup local partnership company and employ local staff.
   - Possibly provide company/business shares to local management.

5. Setup manufacturing or production base:
   - Develop product locally.
   - Use local parts for entire product.
   - Employ locals for production staff.

6. Provide training:
   - Develop local human resources.

7. Setup research and development centre:
   - Provide opportunity for local innovation.
   - Contribute to local research growth and development.

8. Participate in the country's growth and development:
   - Visible participation in the country's economic growth.
   - Establish a strong local presence.

The Way Forward

In summary, other than international donor projects, technology transfer, in particular involving the private sector, should preferably follow a business approach. Understanding the country's policy on foreign participation as well as identifying the benefits will also help the technology transfer. Companies who are serious about technology transfer as well as doing business should be prepared to invest not just financially but also time in making friends, and making their presence felt in the region.

References

IEA, 2002. Renewable in Global Energy Supply-An IEA Fact sheet. International Energy Agency, Paris. November 2002.

IEA, 2004. Key World Energy Statistics. International Energy Agency, Paris. 2004

DOE/EIA, 2004. International Energy Outlook 2004. US Department of Energy/Energy Information Administration. April 2004

ASTAE, 1999. Options for Renewable Energy in Vietnam. Prepared by Asia Alternative Energy Program (ASTAE) with support from ESMAP for Two-day Participatory Workshop in Hanoi

INVESTING IN RESEARCH AND DEVELOPMENT TO ADVANCE RENEWABLES TECHNOLOGY: LESSONS AND OPPORTUNITIES

Dr. Morgan Bazilian[1]
Head of Renewable Energy
SUSTAINABLE ENERGY AUTHORITY OF IRELAND (SEI)

Prof. Frank Convery[2]
UNIVERSITY COLLEGE DUBLIN

and

Lisa Ryan[3]
UNIVERSITY COLLEGE DUBLIN, IRELAND

Abstract

This paper is animated by a specific challenge we face in Ireland. How much public funding should be allocated to renewable energy (RE) research and development (R&D), and on what mix of activities should it be focused? Subsidiary challenges include how to manage such funds and how to evaluate progress and performance. Since this is a challenge faced by every national authority, the issues should be of general interest. This paper found a relative paucity of evidence-based analysis of the issue, thus the paper raises

[1] *t + 353 1 8082075; f + 353 1 8082330; morgan.bazilian@sei.ie; www.sei.ie*
[2] *Sustainable Energy Authority of Ireland (SEI), Glasnevin, Dublin 9, Ireland.*
[3] *Department of Planning and Environmental Policy, University College Dublin (UCD), Richview, Dublin 4, Ireland.*

more questions for discussion than conclusions to be acted upon. The principal rationale for supporting RE (from an economic perspective) is to address various market failures (primarily, environmental and security of supply). There is a variety of policy instruments applied in the sector (grants and subsidies, price and tax incentives, regulations, etc.). Mobilising these instruments has involved the use of considerable fiscal support targeted at various RE technologies and associated infrastructure and services over the last three decades.

Justification for Policies supporting Renewables R&D

The primary rationale for supporting RE (from an economic perspective) is to address various market failures (primarily environmental and security of supply). Specifically, the main drivers[4] for supporting RE have been (Komor, 2004):

- Climate change mitigation;
- air (and water) pollutant mitigation (SO_2 , NO_x, Hg particulates, etc.);
- fuel diversity (a subset of security of supply[5]);
- hedging against fossil fuel price volatility;
- encouraging indigenous industry (and associated job creation[6]);
- meeting consumer demand;
- animating rural development; and,
- achieving dispersed (distributed) energy generation.

Notwithstanding the substantial public benefits yielded by renewable energies, it is notable how growth has slowed over the past decades in OECD countries (Table 1).

It is notable that there has been a secular decline over time in the overall growth rate of renewables, with only wind and solar showing a substantial rise.

[4] *The benefits may well also extend to issues of better distribution of autonomy and wealth between the developed and developing world. Indeed, theoretical arguments about natural and human capital substitutability may lie at the heart of the debate.*

[5] *It should be noted that security of supply is not always a well-defined or quantifiable goal. That being said, at least two subsets (fuel diversity, and hedging against volatile fossil fuel costs on international markets) can be justified under this heading.*

[6] *Komor (2003) quotes a figure of 40% more jobs per dollar than new coal plants.*

Table 1: Average Annual Growth Rates for RE (IEA, 2004)

	1970-1980	1980-1990	1990-2001
Renewables	3.2%	2.4%	1.2%
Biomass	3.5%	3.0%	1.6%
Hydro	2.6%	0.7%	0.4%
Geothermal	8.3%	9.4%	0.4%
Wind/Solar	6.4%	23.5%	23.1%

The paper includes discussion of: the context shaping the competitiveness of renewables, supporting RE R&D, the wider context of RE policy and energy R&D, the use of research and development as a policy instrument, and the difficulties in measuring success and in focusing programmes. It concludes by highlighting the issues and questions to be addressed if public policy and associated expenditure for research and development are to be effective in bringing forward economically competitive renewable energy technologies.

Policy Instruments and Research and Development

There are a number of policy instruments that have been or are being mobilised to compensate for market failure, and help bring renewables forward as socially competitive energy supply options. It has been shown repeatedly that a suite of tools, rather than any single one will provide the most fertile landscape for RE implementation. The effectiveness of a policy instrument combination is typically judged on the basis of four criteria: static efficiency or cost-effectiveness, dynamic efficiency, equity and administrative and political feasibility. In this paper, the focus is on research and development as a policy instrument.

Rationale for Research and Development as a Policy Instrument

It is well understood (in the literature) that the private return of conducting R&D generally falls short of societal returns (and thus benefits). This provides both a need for support from a public goods perspective and a challenge in correctly focusing that support. Blanes (2004) reinforces this sentiment, "...the public agency must be able to identify those R&D projects where the gap between private and social returns is high, and would not be carried out without some type of subsidy."

The Global Climate Change Group at the Pacific Northwest National Laboratory, (Dooley, 2000) define energy research and development as, "the linked process by which an energy supply, energy end use, or carbon management technology moves from its conception in theory (including necessary enabling basic research) to its feasibility testing and small scale deployment." There does not seem to be any consensus on a definition, however, this one seems useful for this paper. This group undertook a comprehensive cross-cutting analysis of energy R&D in large industrial countries in the late 1990s and early 2000s. The principle results (Dooley, 1998) include:

- The fraction of national energy R&D activities sponsored by national governments has declined steadily.
- Unlike overall national R&D, national energy R&D efforts have not experienced significant growth over the past decade.
- The performance of energy R&D is highly concentrated... The top 9 nations account for 95% of the industrialised world's publicly supported energy R&D. Renewable energy R&D programs have had relatively stagnant budgets throughout the past decade even though the nations that fund this research have adopted energy policies advocating increased use of renewable energy as a means of reducing carbon dioxide emissions, local air pollution and dependence on foreign energy sources.

The European Union (EU) Context

Support of RE has a legislative basis in the European Union (EU) under the RES-E Directive (2001/77/EC). However, the indicative targets therein and the associated dispatch, connection and reporting requirements, do not in themselves provide the goal clarity necessary to produce a robust policy framework. The Directive asserts the EC's need to promote renewables due to their contribution to:

... environmental protection and sustainable development. In addition this can also create local employment, have a positive impact on social cohesion, contribute to security of supply and make it possible to meet Kyoto targets more quickly (Preamble 1).

The EU White Paper on RE (COM (97) 599) notes the important role of RE in responding to security of supply and this theme is again reiterated in the EU

Green Paper on Security of Energy Supply (COM (2000) 769).

Supply policy needs to consider the immediate and longer-term availability of energy products at a price which is affordable to all consumers (domestic and industrial), while respecting environmental requirements and the needs for sustainability (COM (2000) 769).

The key significance of this strand of policy is not that it drives an EU renewables agenda per se; rather, it allows member states to introduce their own incentives without running foul of EU single market or competitive rules. However, there is one EU-wide policy emissions trading that does directly encourage and facilitate renewables.

The European Union has long had a substantial research programme, funded not just via the rolling series of R&D Framework programmes, but from a variety of other sectoral sources, notably agriculture, and structural funds directed at relatively low income regions. At the 2000 meeting of heads of state in Lisbon, it was agreed, "...to become the most competitive, knowledge-based economy in the world by 2010... the creation of the European Research Area (ERA) is integral to the achievement of this objective." A "Barcelona objective" was subsequently set to achieve an annual R&D expenditure of 3% of GDP. At every heads of state meeting, progress on Lisbon is an agenda item. The Commission responded to these challenges with More Research for Europe, so R&D is now firmly on the EU agenda at the highest level. During the Irish Presidency of the Union (2004), at a symposium in Dublin Castle, the Commission delivered a paper entitled "Europe and Basic Research". The conclusions of this meeting will prove crucial in driving the Community's research agenda in the Seventh Framework programme (post 2006), in which there will be a budget line for basic research. The Sixth Framework Programme (2002-2006) of the EU in the Sustainable Energy Systems (non-nuclear) thematic sub-priority defines EU priorities and is at the core of the research funding currently.

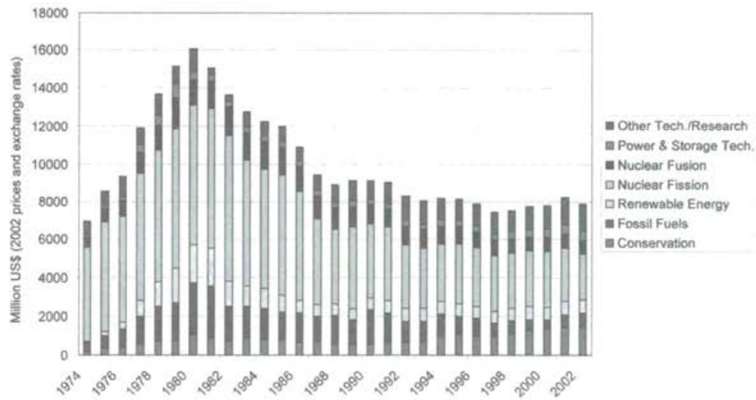
Research and Development as a Policy Instrument for Renewable Energy

Trends and Prospects

The cycles in the last 30 years for energy R&D have been similar in many member countries of the Organisation for Economic Co-operation and Development (OECD). They have responded closely to geopolitical energy trends (oil prices and supply shortages primarily) in a cyclical manner. To put this into context, we note that in 2001, renewable energy sources provided 5.7% of the total primary energy supply for OECD countries. Of the 5.7% of energy provided by renewable sources, 54% was supplied by biomass and municipal solid waste, 35% by hydropower, and 12% by geothermal, solar, wind and tidal energy (IEA, 2002). For electricity generation, renewables represented 15% of production worldwide, but only 2.1% if one excludes hydro (RFF, 2004).

Member governments of the International Energy Agency (IEA) allocated about US$291 billion (2002 prices and exchange rates) for energy R&D from 1974 to 2002. Figure 1 shows government budget outlays for energy R&D in this period. In response to the oil price crisis, total IEA government investment for energy R&D was about US$7 billion in 1974. Budget outlays peaked in 1981 at US$16 billion, but then declined to about US$9 billion in 1987 (IEA, 2004).

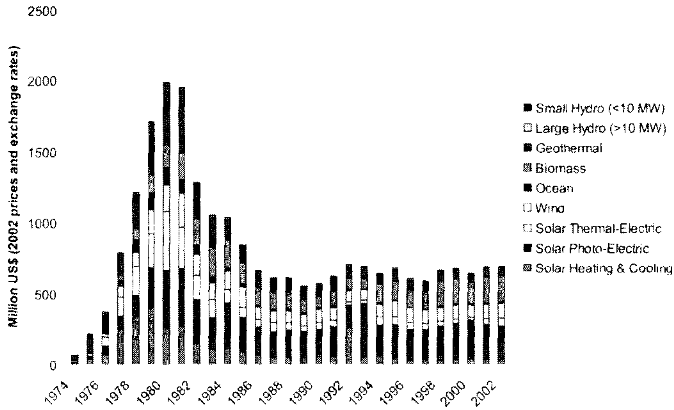
Figure 1: Energy R&D in OECD countries 1974-2002 (IEA, 2004)



IEA countries'[7] renewable energy R&D budgets totalled about US$ 23.55 billion, some 8% of total energy R&D funding from 1974 to 2002. Expenditures for renewables R&D grew rapidly in the late 1970s and peaked in 1980 at just under US$2 billion. Annual expenditures declined by about two-thirds in the early 1980s but have been relatively stable since the late 1980s, in the range of US$550 to US$700 million (IEA, 2004).

[7] *Comprising the main energy-importing countries.*

Figure 2: Government (OECD) Renewable Energy R&D Budgets (IEA, 2004)



The Optimal Level of R&D Expenditure

Davis and Owens (2003) have applied the method of real options to evaluate the optimal level of renewable electric R&D expenditures. This investigation was based on financial modelling using real-options theory instead of traditional discounted cash flow (DCF) concepts. Real options analysis employs a model that takes into account the alternatives to postpone renewable energy deployment and to continue with cost-reducing R&D. Thus, this method allows for the evaluation of the benefits of insurance[ii], should the price of fossil electricity increase significantly. It is therefore more useful for evaluating RE R&D than traditional DCF analysis. Owens (2003) notes that the limitations of using DCF analysis include its inability to appropriately account for technical and financial risk temporally.

R&D as a Factor of Production

As stated, government leadership is required to set policy and R&D direction. Industry/government partnerships in R&D are useful in order to add market relevance to the work and tap specialist expertise, however government must not lose sight of its special role in supporting long-term objectives. Government often supports high-risk, pre-competitive research in R&D collaborations.

This has been generally referred to as security of supply in other parts of the paper.

"R&D... can give some boost to renewables production early on if learning by doing and R&D are complements, but it can lower current production [compared to other support mechanisms] if they are substitutes (RFF, 2004)." How the policies are formulated and administrated has a large impact on; the success of programmes, stability over time (political time), technologies focused (banded or open market policies), and influence on actors at each stage in the R&D continuum (research, proof of concept, market).

In considering R&D support for energy technologies, there is always a choice of portfolio mix from high risk (revolutionary) to lower risk (evolutionary) projects. By appropriately balancing and hedging these risks, a programme can increase its likelihood for success based on the risk profile of the investor (the public, the government, an agency, a private company, etc.).

Renewable energy R&D funding priorities usually reflect the natural resource endowments of the country or region involved (IEA, 2004). Photovoltaics, biomass, and wind are the predominant technologies supported in OECD countries.

Implementation of RE R&D can include various projects, services and programmes. They need to be undertaken at a pace appropriate to the exogenous and endogenous influences, various actors (academic through to investors), and with appropriate tools (direct R&D, venture capital, incubator programmes, technology acceleration targeting, etc.). Sorensen (2003) emphasises the specific cultural considerations (in addition to technical and regulatory) when forming RE R&D policy (price and income elasticities, comfort requirements, demand responsiveness, oil and gas revenues, mobility considerations, etc.). He also points out the difficulty in merging technology and policy thinking, citing specifically, "...the tendency to leave technology out of policy, tendency to limit policy innovation, tendency to limit policy experts, and inefficient policy instruments." The traditional dichotomy between those engaged in technology research and development and those in politics and policy is appears to be rather common in RE R&D.

Evaluating Renewable Energy R&D Performance

Both the focus of R&D programmes and the methods of measuring and evaluation are critical in assessing their costs and benefits. Renault (2004) defines evaluation as, "...the collection, analysis, interpretation and communication about the effectiveness of programmes undertaken for the public good." She also notes that that evaluation process needs to have questions formed that are derived from the programme itself (and not some exogenous source).

The UK Department of Trade and Industry (DTI) undertook an independent review of their R&D Programmes for RE (New and Renewable Energy Programme 1994-1998). Three conclusions are salient here:

- That in the future, the objectives of any supporting programme of R&D and technology transfer should be more clearly delineated from the objectives of other parts of the government's overall N&RE programme such as the non-fossil-fuel obligation (NFFO) and administrative action.

- That the programme has added value to the NFFO in terms of success of deployment though whether at lower cost has been difficult to discover.

- The risks of not developing renewables in plausible climate change policy scenarios are quite uncertain and potentially quite large.

Dooley (2000) outlines the various international and national sources of data on energy R&D and their associated strengths and weaknesses. He identifies that there are ancillary benefits in other sectors that are not normally captured in evaluation of R&D spending, "...the exclusion of ancillary R&D efforts is driven by practicality and a desire to keep some temporal integrity to the data set being examined."

Estimating Benefits of Renewable Energy R&D

Coutts (2004) notes that the results and benefits of R&D are difficult to measure because:

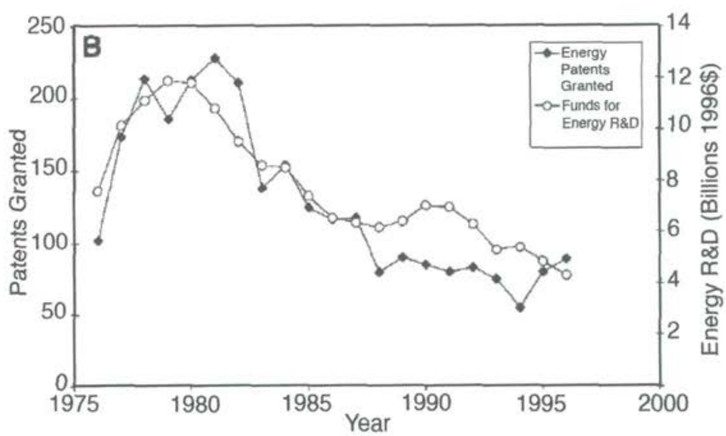
- Outcomes may materialise only after considerable periods.
- Relationships between research and eventual outcomes are complex and indirect.
- Outcomes and impacts are difficult to identify in advance.
- Knowledge gained is not always of immediate value or application.
- Results are sometimes more serendipitous than predictable.
- Negative determinations or findings are common.

- R&D perform different functions and produce different outputs.

Due to these difficulties and differences, any measurement system has to be designed accordingly. CETS (1996) also determined that "conventional metrics used by governments to quantify the results usually ignore output, distort the success and failure of co-operative technology programs, and serve as a flawed incentive, driving quantity (the total number of agreements) over quality" (Dougherty and Irish, 1995). The National Institute of Standards and Technology (NIST) came to similar conclusions in an assessment of the economic impact of four major NIST programmes, including laboratory R&D and the Advanced Technology Programme (NIST, 1994). NIST's conclusion was that setting priorities, evaluating performance and measuring economic impact "cannot be reduced to simple formulas that yield unambiguous, quantitative answers."

Margolis and Kammen (1999) attempted to construct a methodology for assessing R&D spending in the energy sector. "Investments in particular technologies are inherently risky, and past efforts "to pick winners" among energy options have produced a number of high-profile failures. We consider two measures: patents and the pattern of private- sector investment." The correlation between patents granted and R&D in the energy sector is very strong over time. Results are shown in Figure 3.

Figure 3: Correlation between Patents Granted and R&D Expenditure in the USA (Margolis and Kammen, 1999)



The US DOE Office of Energy Efficiency and Renewable Energy, after reviewing potential technology performance and market penetration rates, uses the Energy Information Administration's National Energy Modelling System to compare the market potential for future energy efficiency and renewable energy technologies (Garman, 2002). The DOE in investigating the impacts and benefits of energy R&D utilised three primary metrics (retrospective benefits) in a matrix approach:

- Realised (actual benefits such as the value of energy savings).
- Option (benefits that might be realised if there were market changes, for example the value of unconventional liquids R&D in the event of a long-term oil disruption or large and sustained price escalation).
- Knowledge benefits that were assigned where projects were unsuccessful.

It seems clear that RE R&D support measures have to have well defined expectations in order to measure success in a holistic manner. However as Weyant (2000) notes, "There does not exist good information on a number of key parameters such as those that determine the magnitude of spillover knowledge from investments in R&D".

Research and Development in Renewables in a Small Open Economy – Ireland

Economic and Innovation Context

For the past decade, Ireland has been the fastest growing economy in the European Union; it is also one of the most "open".[9] This has been associated with rising energy consumption, (notably for transport and electricity) and greenhouse gas emissions and increasing dependence on petroleum imports. Ireland has come very late to research and development, but in recent years, the Irish government has substantially increased investment in technology, innovation and scientific research, achieving a five-fold increase in investment for RTDI in the National Development Plan 2000-2006 to £2.48 billion, compared with £0.5 billion over the period 1994-1999. This has been driven in the first instance by the realisation in the international

[9] *See Clinch, Peter, Convery, Frank and Walsh, Brendan, 2002. After the Celtic Tiger – challenges ahead. O'Brien Press, Dublin for discussion of the causes of the Irish economic renaissance, and the economic and environmental challenges engendered thereby.*

market place that Foreign Direct Investment (FDI), much of it concentrated in the pharmaceuticals and information technology (ICT) sectors will dry up unless companies find Ireland an attractive place in which to invest in the knowledge-intensive, high value added elements of their enterprises. These sectors have both been crucial drivers of the Irish economic renaissance.

Innovation and Renewable Energy

The context for RE R&D in Ireland includes:

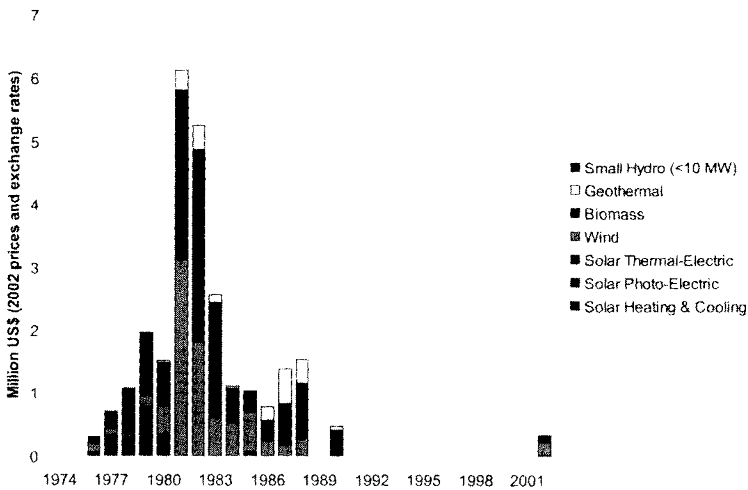
- Ireland currently lacks regulatory or policy certainty in the RE sector.
- There is likely to be a new fiscal support policy for RE put in place by the Department of Communications, Marine and Natural Resources (DCMNR).
- There is ongoing development of a new electricity market structure in Ireland at both the wholesale and retail levels.
- There are numerous technical considerations (nearly) unique to Ireland's electrical system (little interconnection, import dependent, low capacity margins).
- There is growing interest in the use and production of biofuels in Ireland.
- Deployment of biomass based heat and power systems is minimal compared to elsewhere in Europe.
- Ocean energy is at an early stage of technical development, but the potential resource in Irish waters is significant.
- There are large obstacles to wind farm development (primarily integration into the electrical grid) despite the large resource and mature technology.
- There are challenging emissions (GHG and transboundary) targets (NECD, LCPD, RES-E, Kyoto, etc.).

- European directives are becoming increasingly important in this area (e.g. RES-E, and biofuels).

Ireland spent a total of US$94.5 million (in 2002 prices and exchange rates) on government energy R&D between 1974 and 2002. About 31.6% of the total R&D budget in this period was allocated to renewable energy R&D. The overall trend of government R&D expenditures for renewables peaked in the early 1980s and declined notably after 1983. There was no significant funding between 1990 and 2001 (IEA, 2004) (Fig.4).

Among the various renewable technologies, biomass received the highest level of funding at US$13.6 million, or 45.6%, in the 1974 to 2002 period. Wind was funded at US$8.4 million, representing 28% of renewable energy RD&D (IEA, 2004).

Figure 4: RE R&D Expenditure in Ireland 1974-2001.



In 2003 the IEA completed its Energy Policies of Ireland Review. That report included a section (Chapter 10) on Energy R&D. It reviewed the energy R&D policies in Ireland from the Green Paper (1999) and through the National Development Plan (NDP 2000-2006). It clearly notes the importance of the Sustainable Energy Authority of Ireland (SEI) in delivering an important part of this sector of R&D. The SEI operates and strategically manages the national RE R&D Programme in line with government policy outlined in the

National Development Plan (2000-2006) and the Irish Green Paper and Sustainable Energy (1999). It notes that the Programme aims to:

- Ensure that Ireland develops a world class research capacity.
- Recognise the importance of encouraging a dynamic research culture.
- Build the capability of firms to carry out and manage R&D in Ireland.

To date these goals have been met only to a limited extent in the energy sector.

The programme is expanding and adapting to both policy and market needs in line with budget constraints and administrative processes. Formal and effective procedures are in place for evaluation, administration, legal issues, dissemination, marketing and the like. There are recent refinements being conducted to refocus the programmes in line with perceived demand and national policy. The exercise of future expansion will benefit from a number of incremental refinements as well as some paradigm changes in structure, approach or goals.

The RE R&D Programme Strategy was published in the summer of 2002. Over the 2002-06 period, the programme was originally allocated an indicative budget of £16.25m (NDP) and provided support for product R&D and technology demonstration. To April 2004, a total of £7.5m has been committed from the programme. The goal of the programme is to make a positive impact on the implementation of RE technology in Ireland.

The profile of expenditures to date (April, 2004) is shown in a Table 2:

Table 2: Breakdown of RE RRD Programme Commintments as of April 2004. (Million Euro)

Category	Total	R&D	Demo	Commision
Biomass	3,293,928	602,912	2,368,625	322,391
Wind	3,030,169	1,229,170	177,000	1,623,999
Ocean	357,939	236,325	0	121,614
Hydro	408,425	0	408,425	0
Solar+GSHP	245,437	245,437	0	0
Geothermal	173,500	173,500	0	0
Totals	7,509,398	2,487,344	2,954,050	2,068,004

The Irish RE R&D programme has been operating for approximately 18 months. Its impact on the sector is thus very difficult to quantify. Twenty centres, universities, utilities, county councils, government agencies, and companies received approximately 2 M£ from EU-funded programmes in 2003 (primarily from FP6).

Issues and Questions to Be Addressed

The analysis in this paper raises a number of questions for discussion, both general and specific to R&D.

General

1. How level is the playing field for renewables versus fossil and nuclear sources?

In parts of Europe, coal is heavily subsidised, but this is confined to locally produced coal which is higher cost than the imported product. Lower cost imported coal would probably not require subsidy to compete. What is the situation in Asia? At the margin, what are the relative subsidies of nuclear vs. renewables?

2. Can the declining share of renewables in the energy mix be reversed?

With rising total energy supply, and very little growth in hydro and geothermal, this puts the burden of growth on biomass, wind, solar and other renewables.

3. Does de-regulation of energy markets help or hinder innovation, and associated expenditure on R&D?

R&D Specific

4. What are the relative contributions of learning by doing, and research and development, in advancing the use of renewables?

The literature emphasises the fact that volume of activity induces innovation, and that R&D is complementary. Some countries, e.g. Germany, have highly incentivised the use of renewables to achieve the volume and learning by doing effects. Has it worked? That is, what is the evidence from such examples in Asia and Europe as regards to stimulation of innovation? Does R&D play a crucial complementary role?

5. How significant are price signals in general, and (in Europe) the CO_2 allowance market, in stimulating innovation in renewables?

The CO_2 market will give renewables a competitive advantage in the European Union. But will it stimulate innovation? How important is R&D as a complementary strategy?

6. How can we improve the evaluation of R&D in renewables?

It is clear from the evidence presented that success is difficult to measure, and that empirical data are difficult to acquire and analyse. What are the best examples from Asia and Europe in this regard?

7. What are the best examples of public-private partnerships in advancing renewables technologies?

Market failure means that the private sector on its own will not do "enough" in terms of R&D and innovation to advance renewables. Thus a public-private partnership is required. It seems that a three-way partnership is typically required, with universities, industry and government involved. Where are the best examples to be found in Asia and Europe?

8. Should the R&D priority be fundamental research or application and commercialisation?

Both the payoffs and the risks are greater at the fundamental level, and decline as commercialisation becomes the priority. Is there a scale issue, i.e. will large economies emphasise fundamental research and small open economies focus on commercialisation? What is the Asia-Europe experience in this regard?

9. How can R&D funding be made to operate counter-cyclically, i.e. intensify when economies are in recession and energy prices are low, and not the converse?

We have seen that public support rises sharply in times of energy "crisis" (high prices) and falls back to a relatively stable level once the crisis has passed. This surging is likely to be relatively inefficient.

10. How important are removing policy barriers and uncertainties, relative to other considerations?

11. Should "technology targeting" characterise R&D support, or should the focus be wider?

References

Beck, Fred, and Eric Martinot. (2004). "Renewable energy policies and barriers." In Encyclopedia of Energy (forthcoming). Academic Press/Elsevier Science, San Diego.

Blanes J., Busom I. (2004) 'Who participates in subsidy R&D Programmes'?, Universidad Pablo de Olavidea and Universitat Autonoma de Barcelona, Spain.

Clean Energy Group (2004), Global Clean Energy markets, May, Brooks, Milford, Schumacher, Vermont, USA.

Coutts, S. (accessed 2004), Building in Results: Challenges and Opportunities for Measuring PERD R&D. www.nrcan.gc.ca

Davis, G. A. and B. Owens, 2003, 'Optimising the level of renewable electric R & D expenditures using real options analysis', Energy Policy, Vol 31.

Dooley JJ, PJ Runci, (1998) Adopting a Long View to Energy R&D and Global Climate Change, PNNL-12115. Washington, DC. December.

Dooley JJ (2000). A Short Primer on Collecting and Analyzing Energy R&D Statistics, PNNL-13158. Washington, DC. February.

European Environment Agency (2004) Energy Subsidies in the EU, Technical Report 1/2004.

Engineering Research and Technology Development on the Space Station (1996), Commission on Engineering and Technical Systems

EWEA (2004) Strategic Plan for Research and Development, EWEA 1/2004, Brussels.

Garman (2002) Testimony to Subcommittee on Interior and Related Agencies House Committee on Appropriations U.S. House of Representatives Oversight Hearing on Energy Research-Measuring Success.

IEA (2004) 'Chapter 2', Renewable Energy Market & Policy Trends in IEA Countries, Paris.

Jordan G. (2003) Assessing and improving R&D Programmes, Sandia National Laboratory, NM, USA.

Karshena, M., and P. Stoneman, 1995: 'Technological Diffusion', Handbook of the Economics and Innovation of Technological Change, Blackwell Publishers Ltd.

Komor, P., Bazilian, M. (2004), Policy Goals for RE, Energy Policy,

Lev, Baruch, 2004. 'Sharpening the Intangibles Edge,' Harvard Business Review, June 2004, pp. 109-118.

Margolis, Robert M. and Daniel M. Kammen (1999) Underinvestment: The Energy Technology and R&D Policy Challenge, Science, Vol. 285.

Miketa, A., 2001: 'Analysis of energy intensity developments in manufacturing sectors in industrialised and developing countries', Energy Policy, 29, pp. 769- 775.

Nakicenovic, N., and K. Riahi, 2002: 'An Assessment of Technological Change Across Selected Energy Scenarios', IIASA report, RR-02-005. (reprinted from a publication by the World Energy Council on behalf of the Study Group on energy Technologies for the 21st century, Sept 2001).

NET Ltd. Switzerland based IEA / OECD 2000

Renault, C. (2004), Defining and Measuring Success in Technology-based Economic Development, RTI International. Centre for Technology Applications.

Report to the Inter Departmental Committee on Science, Technology and Innovation, 2004. Building Ireland's Knowledge Economy – the Irish Action Plan for Promoting Investment in R&D to 2010, Forfás, Dublin.

RFF (2001), 'RFF Council Explores Balancing US Energy Needs and Environmental Protection,' Resources Issue 145, p.22. Resources for the Future, Washington DC SPRU (1999) Evaluation of the DTI New and Renewable Energy, URN -02/555.

RFF (2004) Carolyn Fischer and Richard Newell 'Environmental and Technology Policies for Climate Change and Renewable Energy' Discussion Paper 04-05, Washington DC.

Sorensen, K. (2003), Technology policy for renewable energy, NTNU, Trondheim, Norway.

Swift, Byron, 2004. 'Emission Trading and Hot Spots: a Review of the Major Programs,' Environment Reporter, Volume 35, No. 19, July.

Swift, Byron, 2001. 'How Environmental Laws Work: an Analysis of the Utility Sector's Response to Regulations of Nitrogen Oxides and Sulfur Dioxide Under the Clean Air Act,' Tulane Environmental Law Journal, Number 309, Summer (available at http://www.epa.gov/airmarkets/articles/index.html)

Taylor J., Van Doren P. (2002) Evaluating the Case for RE; Is government support justified? CATO Institute, D.C., USA

UK NERC, (web documents), 2004

Weyant, J.P., 1997. 'Technical change and climate policy modelling.' In: proceedings of the Paper presented at the IIASA Workshop on Induced Technological Change and the Environment,
Laxenburg, 26-27 June.

Wiser, R., Bolinger, M., Milford, L., Porter, K., Clark, R. (2002). Innovation, Renewable Energy, and State Investment: Case Studies of Leading Clean Energy Funds. Lawrence Berkeley National Laboratory, Berkeley, CA.

....

CLIMATE TECHNOLOGY FOR SUSTAINABLE ENERGY: A LOOK AT INSTITUTIONS

Morihiro Kurushima
Professor
TOYO UNIVERSITY

and

Programme Manager
NEDO, JAPAN

Abstract

The Kyoto Protocol, which obliges developed countries to reduce emissions of greenhouse gases (GHG), was adopted at the third session of the conference of the parties to the United Nations Framework Convention on Climate Change (UNFCCC) in Kyoto, Japan, on December 11, 1997. Japan subsequently ratified the Kyoto Protocol in 2002 and is required thereunder to reduce GHG emissions by 6% below 1990 levels by 2008-2012. It is the only Asian country with legally-binding targets to reduce GHG emissions.

International co-operation is a vital strategy in addressing climate change, particularly with respect to technology transfer and exchange. The Climate Technology Initiative (CTI) is an important conduit for technologies, practices and processes addressing climate change in both developed and developing countries. Japan chairs the nine-member group, which consists of European and North American countries committed to the same mission.

Moreover, having already tackled development and promotion of energy conservation technologies after the second oil crisis, Japan emits the lowest levels of CO_2 in developed countries-approximately 9.4 tonnes per capita in the year 2000. Consequently, Japan is able to contribute to CO_2 emissions reduction in developing economies as well as in economies in transition by application of Japan's energy conservation technologies.

The Ministry of Economy, Trade and Industry (METI) of Japan is one of the key ministries that administers governmental policymaking on climate change and is undertaking establishment of a system to facilitate the Kyoto Mechanisms. Because the Clean Development Mechanism (CDM) and Joint Implementation (JI) of the Kyoto Mechanisms are efficient tools, the Japanese government's policy towards emission reduction makes active use of CDM/JI, thereby supporting domestic efforts in realising Japan's reduction commitment. The New Energy and Industrial Technology Development Organisation (NEDO), under the jurisdiction of METI, supports CDM and JI project activities implemented by Japanese private sector enterprises.

In this report, the author briefly introduces climate change policy measures in Japan and NEDO's activities to promote CDM/JI with special reference to the CTI. The paper concludes with a status report of the CTI's performance since its inception. The CTI is arguably a positive model for international efforts at building a technology response to climate change's perils.

International collaboration on technology transfer plays an essential role in the mitigation of greenhouse gas emissions. For this reason, a group of the Organisation for Economic Co-operation and Development (OECD) countries established the Climate Technology Initiative (CTI) in 1995, during the First Conference of the Parties to the United Nations Framework Convention on Climate Change (UNFCCC). The CTI has since functioned as a voluntary initiative to foster international co-operation and to strengthen the development and enhancement of technologies, practices and processes addressing climate change in both developed and developing countries.

Since July 2003, the CTI has been successfully functioning under an Implementing Agreement of the International Energy Agency (IEA). During this past year, several capacity building activities were held including workshops and seminars in various parts of the world in collaboration with international organisations including UNFCCC, IEA, UNDP (UN Development

Programme) and UNIDO (UN Industrial Development Organisation). The CTI believes that interaction among various stakeholders is a prerequisite for the effective transfer of technologies and therefore actively involves industry, academia and the financial sector to develop a common understanding of the issues and the actions to be taken. Such efforts need to be made continuously in order to follow new technology developments and to address rapidly changing international circumstances.[1]

Under the chairmanship of Japan[2], CTI membership includes Canada, Denmark, Germany, Norway, United Kingdom (Vice-Chair) and USA (Vice-Chair), expanding in 2004 with the addition of Austria and Finland.

The next sections provide an outline of climate change policy measures in Japan and the NEDO, the primary institution for Japan's activities to promote CDM/JI through international co-operation.

Overview of NEDO

The New Energy and Industrial Technology Development Organisation (NEDO) was established in October 1980, immediately after the second oil crisis, as a semi-governmental organisation under the Ministry of Economy, Trade and Industry (METI)[3]. NEDO is a unique organisation in that it works to co-ordinate the funds, personnel and technological strengths of both the public and private sectors in Japan. In October 2003, NEDO was re-organised as an "Incorporated Administrative Agency." The position held by NEDO in the government is shown in Figure 1.

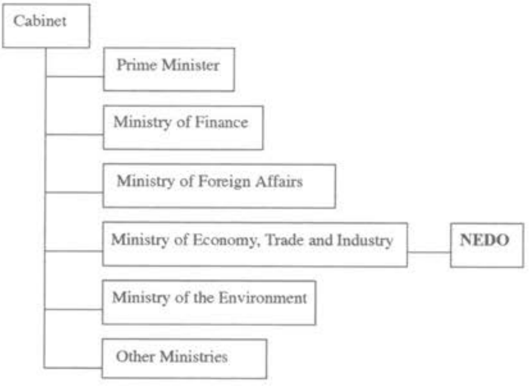
NEDO's principal activities are categorised under three topics:

- Research and Development (R&D) of industrial technology as well as new energy, energy conservation and environmental technologies.
- Introduction of new energy and energy conservation technologies.
- International co-operation.

NEDO's CDM/JI activities are included under international co-operation.

[1] *The past and future activities of the CTI can be found on the CTI website (www.climatetech.net).*
[2] *Japan furthermore serves as the CTI Secretariat.*
[3] *Formerly known as the Ministry of International Trade and Industry of Japan*

Figure 1: Position of NEDO in Government



Current Situation of GHG Emissions in Japan

Table 1 illustrates quantitative targets by sector for GHG emissions reduction in order to achieve Japan's overall target of 6% below 1990 levels, as stipulated in the Kyoto Protocol. However, domestic GHG emissions have been increasing since 1990 and were 8% above 1990 levels in 2000 (Figure 2).

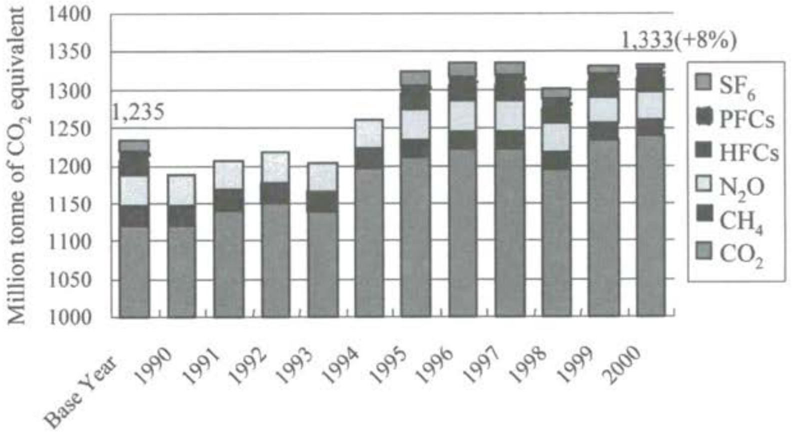
The major source of GHG emissions in Japan is energy combustion, contributing approximately to 90% of total emissions. Over the decade 1990-2000, substantial increases in CO_2 emissions (Figure 3) have been particularly evident in the transportation sector (20.6% increase over 1990) and business/home sector (21.3%). On the other hand, CO_2 emission levels from the industry sector have shown little increase since 1990 due to Japan's lengthy experience relating to development and promotion of energy conservation technologies. Therefore, energy conservation technologies in Japan have great potential to contribute to CO_2 emission reduction in developing economies and economies in transition. Because CDM/JI project activities offer the dual effects of reducing GHG emissions in such economies and transferring CO_2 reduction credits to Japan, CDM/JI utilisation has become more significant.

Table 1: GHG Emission Reduction Strategies in Japan

CO_2 emissions from energy use	±0%
CO_2 emissions from non-energy use, methane emissions, and nitrous oxide emissions	-0.5%
Emissions of HFCs, PFCs and SF_6	+2.0%
Reductions by innovative technologies and change of lifestyle	-2.0%
Sinks	-3.9%
Kyoto Mechanisms	-1.6%

(Source: Ministry of Economy, Trade and Industry, Japan)

Figure 2: GHG Emissions in Japan (FY1990-2000)

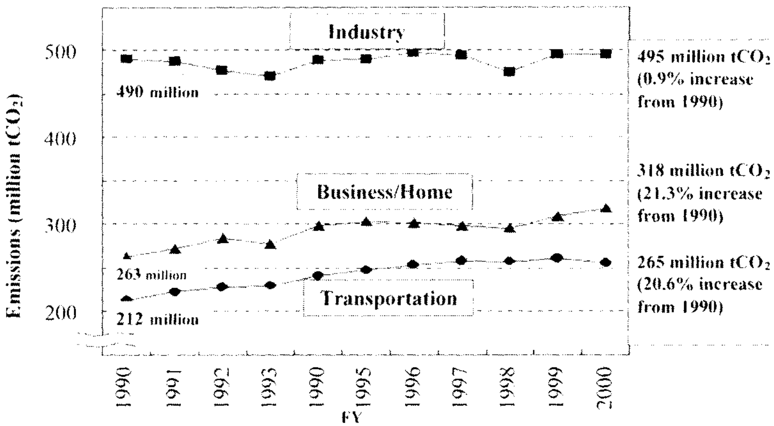


(Source: Ministry of the Enviroment, Japan)

Climate Change Policy Measures by METI and the Role of NEDO[2]

In 2001, METI established a "help desk" for the Kyoto Mechanisms to facilitate CDM and JI projects. The help desk serves as a focal point for CDM/JI government approval and inquiries from private sector enterprises. METI has further designed a financial support scheme for CDM/JI project developers and CDM capacity building programmes in Asia that utilises non-ODA (Official Development Assistance) funds. NEDO is actively conducting CDM/JI support programmes as well as CDM capacity building programmes.

Figure 3: GHG Emission Levels Change by Sector in Japan (FY1990-2000)



(Source: Ministry of Economy, Trade and Industry, Japan)

Table 2: Approved CDM/JI Projects in Japan

CDM/JI	Country	Applicants	Project Name	Amount of CER/ERU expected
CDM	Brazil	Toyota Tsusho Corporation	V&M do Brazil Fuel Switch	1,130,000ton-CO2
CDM	Thailand	Electric Power Development Co., Ltd.	Rubber Wood Residue Power Plant Project in Yala	60,000ton-CO2
CDM	South Korea	INEOS Fluor Japan Limited	HFC Decomposition Project in Ulsan	1,400,000ton-CO2
CDM	Bhutan	Kansai Electric Power Co., Inc.	e7 Bhutan Micro Hydro Power CDM Project	500ton-CO2
CDM	Vietnam	Japan Vietnam Petroleum Company	Rang Dong Oil Field Associated Gas Recovery and Utilization Project	680,000ton-CO2
CDM	India	Sumitomo Corporation	Thermal Oxidation of HFC 23 in Gujarat	3,380,000ton-CO2
CDM	Thailand	Chubu Electric Power Co., Inc	A.T.Biopower Rice Husk Power Project in Pichit, Thailand	84,000ton-CO2
CDM	Chile	Electric Power Development Co., Ltd	Graneros Plant Fuel Switching Project	14,000ton-CO2
JI	Kazakhstan	NEDO	The Model Project for Increasing the Efficient Use of Energy Using a Gas Turbine Cogeneration System	62,000ton-CO2

(Source: Ministry of Economy, Trade and Industry, Japan)

NEDO's Activities to Promote CDM/JI

NEDO's Financial Support Programmes for CDM/JI Project Developers

The Kyoto Protocol will enter into force after being ratified by Russia, which accounted for approximately 17.4% of global GHG emissions in 1990. Therefore, CDM/JI projects presently carry great political risk (also other risks) for private sector enterprises in Japan. NEDO's financial support programmes for CDM/JI projects are capable of reducing these risks and potentially encouraging CDM/JI project implementation.

CDM/JI Feasibility Study Programme

The aim of NEDO's CDM/JI feasibility study (F/S) programme is to assess and realise private sector projects that are expected to lead to future CDM or JI project activities. In order to receive support from this programme, proposed CDM/JI projects must satisfy the following requirements:

1) To reduce GHG emissions through advanced technologies for increasing the efficient use of energy.

2) To contribute to sustainable economic development in the host country.

3) To be proposed by Japanese private sector firms.

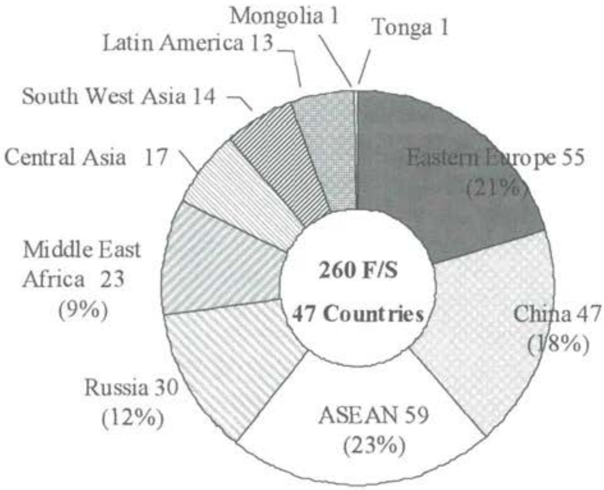
NEDO initiated this F/S programme in 1998 and has conducted 260 CDM/JI project feasibility studies in a total of 47 countries through July, 2004 (Figure 4). It is evident from the chart that Japanese private sector enterprises consider that Eastern Europe, China and ASEAN hold high potential for future CDM/JI projects.

Subsidy System for CDM/JI Project Activities

NEDO's subsidy system for CDM/JI project activities, shown in Figure 5 below, was initiated in 2003. In this system, a maximum of 25% of necessary costs for a project will be granted to Japanese private sector enterprises for their implementation of CDM or JI project activities in host countries through introduction of efficient GHG emission reduction technologies.

Necessary costs include equipment introduction, validation of the project design document, certification and verification.

Figure 4: NEDO's CDM/JI Feasibility Studies (FY1998-2004)



Contribution to CDM Capacity Building

CDM projects will contribute, not only to global environment conservation, but also to sustained development of host countries. One of METI's roles is to plan and sequentially implement, the "Asia CDM Capacity Building Programme" agreed at the World Summit on Sustainable Development (WSSD) held in the Republic of South Africa in 2002.

The aim of CDM capacity building is developing incentives to accept CDM projects and assisting development of approval systems in host countries. Experiences of CDM capacity building by METI and/or NEDO are shown in Table 3. In addition, CDM capacity building by NEDO is being planned in the Philippines, Malaysia and Indonesia in the near future.

Figure 5: NEDO's Subsidy System for CDM/JI Project

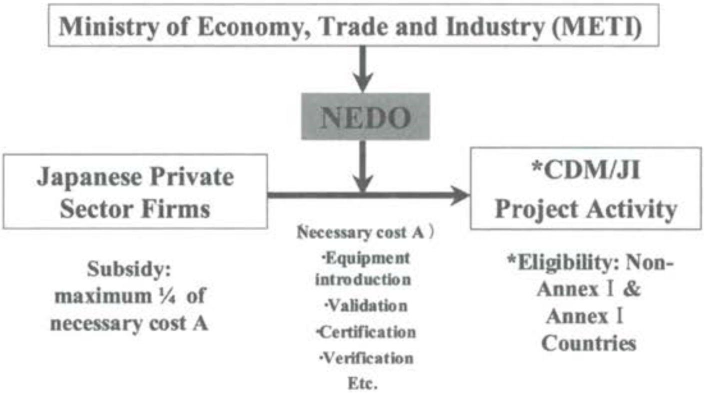


Table 3: Experiences of CDM Capacity Building

- **CDM Workshop (China), Sep. 2004**
- **CDM Training course (Japan), June - Aug. 2004**
- **CDM Manuals (Vietnam and Thailand), 2003 - 04**
- **CDM Technology Needs Assessment (The Philippines), Dec. 2003-Mar. 2004**
- **CDM Training course (Japan), June - Aug. 2003**
- **CDM Seminar (Thailand), Mar. 2003**
- **Japan-ASEAN CDM Workshop (Indonesia), Jan. 2003**

(Source: Ministry of Economy, Trade and Industry, Japan)

International Actions to Achieving Breakthroughs in Renewable Energy Technology Development

These efforts have yielded positive results. For example, the production cost of photovoltaics (PVs) is only one eighth (12%) of what it was 20 years ago. Moreover, as an example, in Japan total PV capacity reached 860 MW, which is by far the highest in the world. Japan also has a 45% production share of the world market.

Notwithstanding such successes, however, we still find that generation costs of renewable energies are high when compared to those of conventional energies. It is necessary to further reduce costs through technical development and other efforts. Renewable energies also have certain characteristics which cause problems related to the stability of their quality and output of electricity (Figure 8). Further technical development is needed to improve the reliability of renewable energies for long-term use and to increase energy efficiency.

Figure 6: Cost and Capacity of PV Systems in Japan

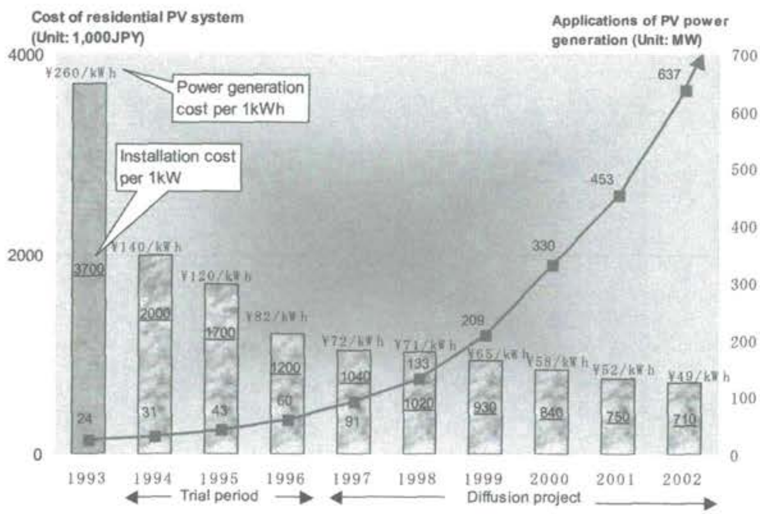


Figure 7: Conceptual Framework to Overcome Market Barriers

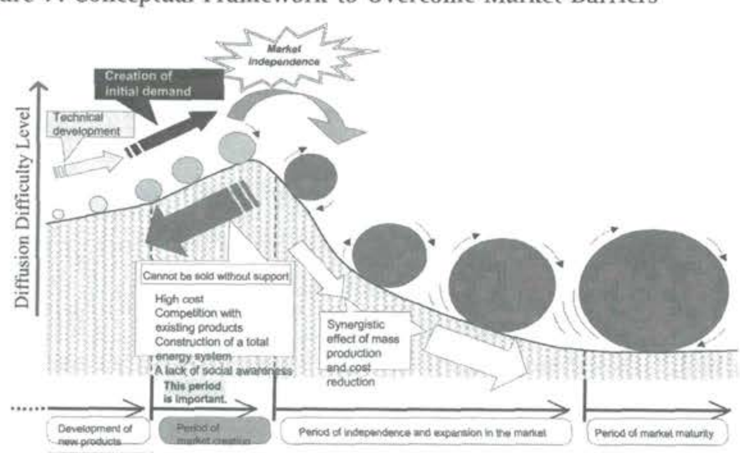


Figure 8: Electric Power Generation Costs

Power generation cost of new energy (Unit: JPY/kWh)

Type	Photovoltaic power		Wind power		Waste power		Biomass power	Small- and medium-scale hydropower
	Residential	Non-residential	Large-scale	Small- and medium-scale	Large-scale	Small- and medium-scale		
Power generation cost	46~66	73	9~14	18~24	9~11	11~12	7~21	14

Source :Report by the New Energy Subcommittee of the Advisory Committee on Energy and Natural Resources (July 2001), and others

Power generation cost by power source (Unit: JPY/kWh)

Type	Nuclear power	LNG-fired	Coal-fired	Oil-fired
Power generation cost	5.9	6.4	6.5	10.2

Source :Data of the 70th Nuclear Power Subcommittee of the Advisory Committee for Energy (December 1999)

Thus, in order to promote the adoption of renewable energies, it is important for us to foster broad-based co-operation among industrial, administrative, financial and academic sectors, and to share information when wrestling with the issues which need to be overcome.

As a part of these efforts, Japan actively undertakes technology transfer activities in developing countries, as seen in the example of its provision of technical and financial assistance to a power supply project in Mongolia. This is a positive experience involving NEDO and the private sector that could be replicated in other contexts (Figure 9).

There are no borders in the air and market expansion is important in order to achieve breakthroughs in renewable energy technology development.

Figure 9: Power Supply Project in Mongolia with NEDO-Japan and Sharp Co.

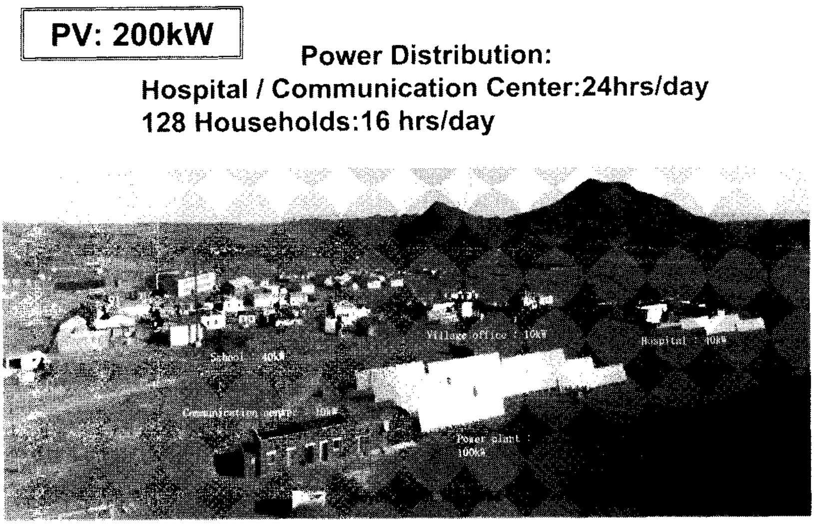
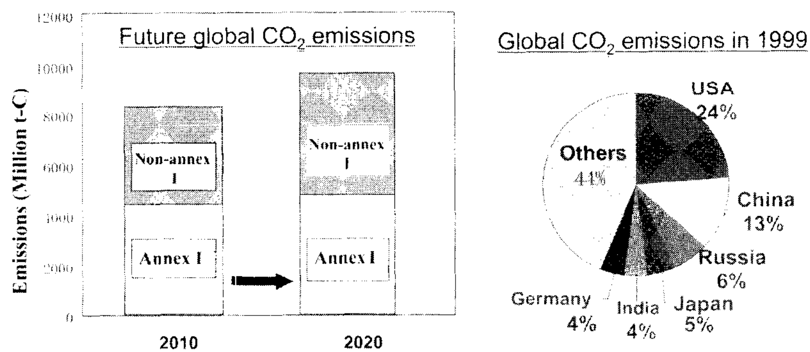


Figure 10: Global CO_2 Emissions



The CTI for our Common Future

The Climate Technology Initiative (CTI) was established at the first Conference of Parties to the UNFCCC in 1995 by 23 IEA/OECD member countries and the European Commission. Since July 2003, the CTI has been successfully functioning under an Implementing Agreement of IEA. Its mission is to bring countries together to foster international co-operation in the accelerated development and diffusion of climate-friendly and environmentally sound technologies and practices

Figure 11: Overview of CTI

Austria, Canada, Denmark, Germany, Norway, UK, USA, Japan and Finland

Chair : Mr.Sakamoto/METI,JAPAN
Vice Chair : Mr.Holts/US.DOE,
Mr.Carrington/UK.DTI
Project Manager : Prof.Kurushima
Seminars and Symposia
Technology Needs Assessments
Training Courses
Information Dissemination
Working with UNFCCC/EGTT, UNIDO, UNDP etc.

The CTI participating countries undertake a broad range of co-operative activities in partnership with developing and transition countries and other international bodies. The CTI works closely with the UNFCCC process, including its secretariat and the Expert Group on Technology Transfer (EGTT), relevant IEA Implementing Agreements and other international organisations or initiatives.

The CTI's activities are designed to be consistent with the UNFCCC objectives, in particular the framework for technology transfer incorporated in the Marrakech Accords and adopted at the Seventh Conference of the Parties of the UNFCCC. As an IEA Implementing Agreement, the CTI intends to continue its original programme and to extend it into new areas consistent with its overall objectives.

The UNFCCC has acknowledged the CTI for its contribution to technology transfer, particularly in respect of its collaboration with the EGTT and has been asked to continue its financial and in-kind support for the implementation of the EGTT work in 2005.[4]

[4] *See SBSTA 21 Decision on Development and transfer of technologies (FCCC/SBSTA/2004/L.28)*

Activities

Technology Needs Assessments

The CTI provides technical assistance to selected countries carrying out technology needs assessments. It also collaborates with the UNDP and the UNEP on technology needs assessment methods training, including workshops. The CTI also develops and disseminates relevant materials and information on lessons learned. The CTI's objectives include advancing the development and use of coherent and integrated approaches to conducting technology needs assessments among developing and transition countries. Activities in this area support the development of a flexible methodology for conducting technology needs assessments that can respond effectively to circumstances and priorities of the particular country. Such activities are carried out in partnership with multilateral organisations, country partners and the private sector.

Unique conditions in every country rule out any generic approach to technology transfer. Country circumstances differ widely and steps, sectors and options that apply in some countries may be inappropriate in others; in other words: "one size does not fit all". However, there are many steps and considerations that are common to all and an approach can be designed as far as is practicable, to be modified and adapted to suit circumstances.

Specific activities include:

- Capacity building for technology needs assessments;
- technical assistance to countries carrying out needs assessments;
- development of methodological approaches to technology needs;
- exchange of experiences about successful approaches to conducting technology needs assessments; and,
- facilitating interaction between governments, agencies and relevant international organisations on technology needs assessments.

For instance, CTI collaborated with the UNDP and the UNFCCC in the development and dissemination of technology needs assessment methodologies and was carried out through 2004. Specific activities included provision of technical input and comment to revisions of technology needs assessment (TNA) methodology handbook section on adaptation in co-ordination with the UNDP. This input was based on a significant degree on the outcomes and recommendations of the Regional Technology Needs Assessment Workshops that had been organised by the CTI in the two proceeding years.

To maximise the utility of TNA findings, the CTI works with the UNFCCC secretariat, UNDP, UNEP and the US government (USG) representatives of the CTC-Gateway to explore and examine more effective ways to integrate TNA outcomes and materials with other information resources and tools for broader international dissemination. The CTC-Gateway and the UNFCCC's TT:CLEAR (Technology Information Clearinghouse) tool benefited from this engagement and elements of these recommendations have been incorporated in the upgrading of these web-based resources.

The CTI moreover, provides direct technical assistance based on lessons learned from its previous country support to additional countries carrying out technology needs assessments. Efforts focus on responding to information requests by email, providing contacts for further information and cataloging key recommendations on the CTI website for use by other countries in a format that is user-friendly and applicable to the range of country needs.

Seminars and Symposia

The CTI has an ongoing programme of seminars and workshops, which are organised in support of the UNFCCC process, in order to facilitate the diffusion of climate-friendly and environmentally sound technologies and practices. Active participation of the private sector, international organisations and financial institutions is being sought.

Key events have been organised in Asia and Europe recently. For example, the CTI "Industry Joint Seminar on Technology Diffusion in ASEAN and Small Island States of the Pacific Region" was held in Jakarta, Indonesia on 4-5 February 2004. Organised by the CTI in co-operation with the UNFCCC and the government of Indonesia, this event was attended by approximately 150 participants, including a minister and executive officials from five national governments in the target area, senior executives from the industrial sector and upper management of financial institutions and relevant intergovernmental organisations.

The main objective of the seminar was to raise the participants' awareness on issues concerning climate change, with a focus on clean energy technology and energy efficiency. The seminar also aimed to foster shared understanding of current situations and what the challenges are, with regard to transfer of climate-friendly technologies.

One of the key recommendations was that for rural and small island areas, introduction of renewable energy for electrification is highly desirable in terms of socio-economic development. It was also noted that stable energy supplies can be best secured through making use of indigenous resources. In countries where agriculture is a major sector, power co-generation by biomass such as bagasse, rice husk, oil palm and wood residues have high potential for development.

It was noted that technology transfer between developing countries (south-south co-operation), not just from developed countries to developing countries, would be effective since they have similar circumstances with regard to the development of climate-friendly technologies, in particular renewable energy technologies. Networking within the region should be enhanced through information sharing so as to draw lessons from experiences of other countries' technology transfer projects.

It was also pointed out that regardless of the government's energy strategy, lack of institutional and legal capacities would remain the main barriers to the promotion of climate-friendly technology transfer. Reliable national policies and enabling environments in both developed and developing countries are essential.

Financial aspects of technology transfer were frequently mentioned. In the worldwide trend toward reduction of Official Development Assistance (ODA), Foreign Direct Investment (FDI) and private financing are the key elements for accelerating diffusion of climate-friendly technologies. Although not every climate-friendly project could be conducted under the Clean Development Mechanism (CDM), there are great hopes that the CDM acts as a catalyst for technology transfer as well as economic growth.

In Europe, the CTI organised a Joint Seminar on "Technology Diffusion in Central and Eastern Europe (CEE) and the Commonwealth of Independent States (CIS)" on October 28-29, 2004 in Vienna, Austria. Organised by the CTI with co-operation of the UN Industrial Development Organisation (UNIDO) and the International Center for Environmental Technology Transfer

(ICETT), the Seminar was attended by over 90 representatives from governments, inter-governmental organisations, non-governmental organisations, business and industry groups, and academic institutions.

The objectives of the seminar were to provide insight into:

- Best practices for the deployment of energy efficient technology (e.g. in power/heat generation and supply, base materials industry, building/households, transport);
- how other policies such as energy security and market reform may create positive or negative incentives for energy efficiency improvement;
- major barriers to the diffusion of energy efficient technologies in CEE/CIS and suggestions on how to overcome these barriers; and,
- linkages between climate change and energy efficiency.

The participants realised that the energy efficiency business is alive and that the CEE and CIS countries offer a huge market potential.

It was noted that developing appropriate policies and building capacity for Kyoto-related activities are both long-term processes. It was also noted that resources have to be made available to facilitate these processes.

An important observation made was that there still are barriers to implementing energy efficiency projects despite increased profitability induced by carbon credits. But some voiced a positive outlook that a combination of an enhanced carbon market, desires for increased energy security, considerations of sustainable development and resultant policy changes would alter energy use patterns. The participants concluded that small-scale energy efficiency projects may well be made more attractive for the carbon market through utilisation of instruments such as ESCOs.

Implementation Activities

The CTI facilitates technology implementation activities identified during the technology needs assessment process through a variety of actions, including:

- Identifying priority clean energy technology sectors in partnership with developing countries based on outcomes from the TNA process;

- implementing targeted activities in selected priority sectors to foster market development and clean energy technology transfer;

- evaluating activities and disseminating lessons learned, to inform market development and country activities in other regions and sectors; and,

- developing a strategy for eliminating any institutional, informational or other barriers to establishing the necessary enabling environment for effective and lasting technology transfer.

For example, the CTI collaborated with the Experts Group on Technology Transfer (EGTT), the UNFCCC Secretariat and UNEP to co-sponsor a workshop in late September 2004 in Montreal focused on innovative options for financing the development and transfer of technologies. This event brought together a broad range of developing and developed country representatives along with experienced financing and risk management experts from the private sector. The workshop sought to complement other initiatives in this area to improve the understanding of clean energy technology practitioners and climate officials on barriers to effective and innovative financing to support the transfer of environmentally sound technologies and practices internationally. The success of this event was due in large part to the practical focus which allowed hands-on financing professionals to provide candid assessment of those in-country conditions that were necessary before any meaningful level of external financing could be expected. There were many constructive outcomes that are already helping to better inform the technology transfer process. The current programme of work of the EGTT calls for a follow-on activity to build on the momentum that was started by this important workshop.

Technology Needs Assessments

Training courses are organised in collaboration with relevant international organisations, with a focus on the special requirements and circumstances of the target countries. Specific activities include:

- Capacity building for technology needs assessment, project planning and assessment, and establishment of institutional settings;

- information dissemination about environmentally sound technologies and best practices appropriate to the region and circumstances of the target country;
- identification of financing needs and alternative means of project financing;
- exchange of experiences in the use of successful environment energy policy instruments (e.g. law, taxes, subsidies, etc.);
- professional education and training;
- initiation and strengthening of networking between agencies/centres for energy saving, energy efficiency and renewable energy; and,
- facilitating interaction between governments, agencies and relevant international and other organisations.

For instance, CTI organises a series of capability-building seminars. One of the most recent was the 5th CTI Capacity-building Seminar, "Climate Technology and Energy Efficiency - Using the Kyoto Mechanisms" held on October 16-20, 2004 in Leipzig, Germany. Experts from governmental and non-governmental organisations came together to discuss the issues of Emissions Trading (ET), Joint Implementation (JI) and the Clean Development Mechanism (CDM). The participants came from 21 countries of Central and Eastern Europe and the former Soviet Union.

The seminar discussed JI and CDM experiences and concluded with a panel discussion on the future of international climate policies in general and the effectiveness of the Kyoto mechanisms after the ratification of the Kyoto Protocol in particular. As a result of the seminar, a number of priorities were identified for future CTI activities: post-Kyoto strategies, the linking directive of the European Union, the brokerage of emission certificates and about the interdependences of climate protection and employment.

A workshop on energy efficiency for Asian countries was organised on October 18-27, 2004 in Yokkaichi, Japan by the CTI and the International Center for Environmental Technology Transfer (ICETT). The workshop aimed to enhance participants' understanding and appreciation of international efforts for greenhouse gas abatement and sustainable development, as well as to strengthen their commitment to more efficient use of energy in the relevant sectors of their countries. Twelve representatives from national governments, industrial sector and other relevant organisations from China, India, Malaysia, the Philippines, Thailand and Vietnam participated in the workshop.

The workshop put special emphasis on the interactive process of information sharing among the participants as a way to promote, at the national level, energy efficiency in the industry sector. It also provided the participants with an opportunity to obtain information from Japanese experiences through site visits at the local enterprises as well as from the presentation delivered by the resource persons from various specialised agencies.

The workshop highlighted policy options for energy efficiency in each country and the participants shared their experiences with various measures taken by their governments and the industry sector. It especially underlined the importance of the energy management at the factory level. The participants also found considerable potential for regional co-operation in Asia for energy efficiency improvement.

The workshop also covered updates on cleaner production practices in the Asian region and paid attention to the major barriers that hindered small and medium enterprises from applying cleaner production practices. The participants discussed the roles of the government and the industry for cleaner production promotion and identified the following actions that should be prioritised: incentives; law enforcement and monitoring by government; capacity building and awareness-raising; promotion of energy management system at factories; and, regional co-operation.

Information Dissemination

One objective of the CTI is to facilitate information dissemination among governments, industry, academia and relevant international and other organisations, and to support the diffusion of climate-friendly and environmentally sound technologies and practices.

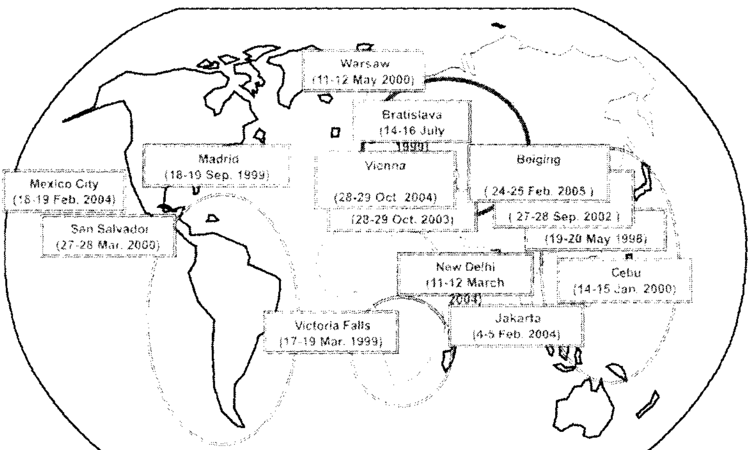
The CTI also provides support for UNFCCC-organised seminars and workshops, designed to better inform participants on key technology transfer issues, including enabling environments, technology needs assessment, technology information resources and capacity building.

The CTI organises side events at UNFCCC events to share experiences and lessons learned from CTI-supported technology transfer activities in collaboration with developing and transition country partners.

Summary and Concluding Notes

In conclusion, informative seminars are held in developing and transition countries. The location of the CTI/Industry Joint Seminars on Technology Diffusion rotates among four regions-Asia, Europe, Latin America and Africa-with the objective of visiting each region once annually. In Asia, the concentration of activities has been in Southeast Asia and China, while in Europe, CTI has targeted Central and Eastern Europe. Each seminar caters to the needs of the region and to those of the UNFCCC process. For an illustration of this aspect of the joint industry seminar series, see the Figure 12.

Figure 12: Map."CTI/Industry Joint Seminar on Technology Diffusion" Series

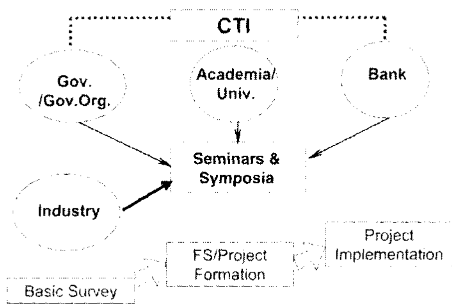


As such, the CTI provides: (i) opportunity for the private sector to voice their policy recommendations to key decision-makers, helping to create a climate that attracts environmentally sound technologies; (ii) a platform to pave the way for project development; and, (iii) insight into financing opportunities for climate projects, including the CDM/JI and risk management opportunities.

It means CTI may play a role such as a "toolbox" for energy and environment (Figure 13).

In addition, the CTI holds training courses in each developing region and in the countries with economies in transition. The training courses have been held in Asia, in Latin America and the Caribbean, Central and Eastern Europe and Southern Africa. The training courses are designed to "train the trainers". Thus, countries are asked to select participants who will be in a position to return to their organisations and share information and techniques that are disseminated at the events.

Figure 13: CTI as "Toolbox for Energy and Enviroment."



Synergy among the four stakeholders-governments, academia, financial circles and industries-is essential. The government should establish the foundation by setting policy and organise the necessary co-ordination work; academia could provide expert and scientific analysis; while financial circles may invest and industries would be the main players in the technology and energy market. As discussed in this paper, the Japanese experience exemplifies this multi-stakeholder approach as seen in both the country's climate change responses as well as in its international co-operation activities. For example, in the case of a Mongolian power supply project as mentioned earlier, the Japanese government provided not only financial assistance but also technical assistance through NEDO's participation in feasibility study (FS) preparation. Furthermore, Japanese universities like Tokyo University of Agriculture and Technology and Toyo University provided expert advice, Sharp Co. Ltd supplied the facility and technology "know-how". It is foreseeable that Japanese banks may provide loan facilities for activities in the next stage.

Figure 14: Goverment May Support Industry at the First Step

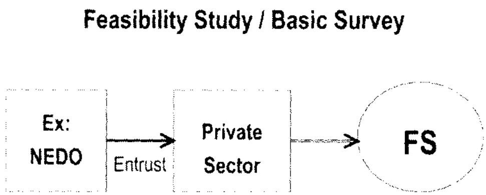


Figure 15: Industry and Finance

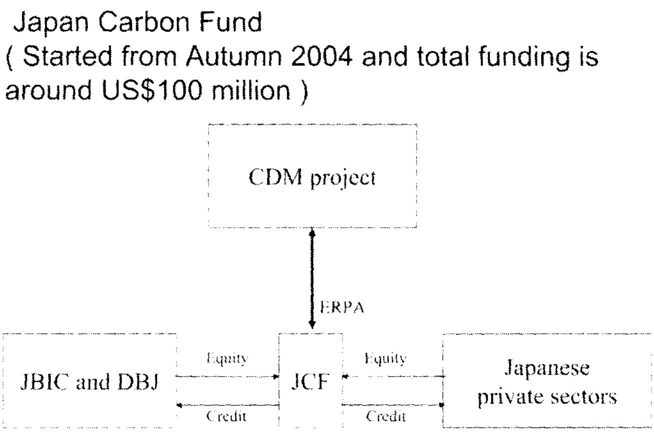
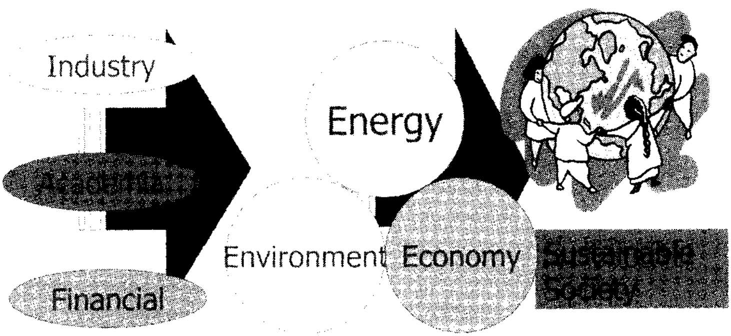


Figure 16: Goverment Initiative with "3 Players for 3E."



Therefore, in support of international co-operation on greenhouse gas emission reduction and mitigation as spear-headed by Japan in developing countries, the CTI could be considered as an institutionalised common resource-a "tool box for energy and environment". Enhancing and enlarging such efforts bring the international community closer to the goal of addressing climate change for our common future.

References

Carbon Dioxide Information Analysis Center (http://cdiar.esd.ornl.gov)

CTI 10th Anniversary Brochure

Ministry of Economy, Trade and Industry, Japan (http://www.meti.go.jp)

Ministry of the Environment, Japan (http://www.env.go.jp)

Chapter 5

Conclusions

5

PRACTICAL ELEMENTS FOR SETTING UP AN ASIA-EUROPE TECHNOLOGY EXCHANGE FOR RENEWABLES

Philippe Bergeron
Project Director
ASEAN Study for CDM Investment Promotion
ASEAN Centre for Energy (ACE-Jakarta)

Abstract

This paper summarises issues to be considered when assessing the desirability and feasibility of establishing a network for the facilitation of Renewable Energy (RE) investment especially by small and medium-sized enterprises (SME) entrepreneurs between Asia and Europe possibly under the Asia-Europe Meeting (ASEM) umbrella.

It provides a framework for discussion to address a series of fundamental questions that need to be asked if/when the establishment of such a network is considered by interested parties. The paper asks and provides among others discussion and commented responses to the following questions: How could this network avoid duplicating existing networking initiatives? What could the preferable focus of action be? What kind of RE technology application could the network address? Why would a network be setup at the ASEM level? What could the network do practically? What could the added value of this network be? Who would be the preferable network partners? Which financial resources could the network mobilise? What would the general governance structure of the network be? What would help make the net-

work successful? What value adding product could the network deliver and to whom? And what could be overall performance indicators for the network?

This paper introduces desirability and feasibility considerations as well as practical recommendations for setting up an Asia-Europe Technology Exchange for Renewables (conveniently defined as AETER in the following paragraphs) presented as a series of questions and answers commenting and justifying its purpose.

What could the "AETER" Network Objectives Be?

AETER would be a networking tool under the ASEM umbrella to foster on a voluntary basis the commercial uptake of value-adding RE investments between Asia and Europe. AETER objectives would be three pronged. It would firstly build awareness about the numerous advantages of wide RE dissemination in Asia. Secondly, it would then demonstrate the viability and the mutual benefits of a commercial approach. Finally, it would finally help foster Asia-Europe business co-operation initiatives and reduce the transaction cost for deployment in the two regions.

In sum, there are seven prominent functions that AETER could take on:

- As a **forum** with stakeholders for experience-sharing and good practice dissemination on policy, management technique, financial resources, financial service, business support, technology, etc. In addition, it could play a role in human resources exchange and perhaps in the mediation of project opportunities involving more than one country and between ASEM countries.

- As a **think tank** to stimulate market-making policy (where there is no market) and non-market distorting regulatory regimes (when market is established) for wide RE uptake across the ASEM region. It could actually facilitate national needs assessment and the periodic development of national RE strategy reports that can guide investors toward promising domestic RE investment opportunities.

- As a **mobiliser** of public and private financial resources, at both international and local levels in the ASEM countries taking into account the differential economic capabilities and financial interests of each individual country.

- As a **facilitator** of donor-assisted RE investment capacity building projects and programmes in ASEM countries interested in participating to establish RE market-enabling regulatory measures, SME business opportunity promotion, market-making RE investment and financial service facilitation and intermediation.

- As a **monitor** for the ASEM region on RE investment uptake and documentation of the triple bottom line benefits (jobs, capital, know-how, technology, etc.) catalysed by these investments across the region.

- As a **trainer** of decision makers and as a disseminator of know-how and good practice on a) effective (non-market distorting) RE investment processes and alliances; b) financial service facilitation methodologies, processes and procedures; and c) related enabling regulatory measures.

- As a **publisher** of regional RE investment strategy reports, directories of RE solution providers, guidebooks on RE investment promotion, best practices and self-help manuals stimulating RE uptake by SMEs in the ASEM region. AETER could also promote the development of RE investment awards by periodically rewarding individuals, governmental organisations, banks and non-profit intermediaries that best contribute to the uptake of RE investment in the ASEM region and in individual ASEM countries.

What is the Significance of Setting Up AETER at the ASEM Level?

The embedding of an internationally supported RE investment facilitation network in an ASEM context would help provide a series of mutually reinforcing economic and environmental opportunities.

In the economic development field, this includes:

- **The promotion of economically vibrant and efficient SMEs** that can significantly contribute to sustainable development in their respective national economies and across the ASEM region; and,

- **the stimulation of innovative financial services for direct investment** by SMEs in efficient, adapted and advanced RE technologies that can contribute to an enhancement of the triple bottom line (economic prosperity, environmental sustainability and social equity) in the ASEM countries.

In the sustainable development field at least three dimensions could justify the positioning of AETER at the ASEM level:

- **Facilitating the fulfillment of commitment under Multilateral Environmental Agreements (MEA).** This can help raise the capacity of the ASEM process and to optimise the regional delivery of improvement in global environmental concerns especially in connnection with the United Nations Framework Convention on Climate Change (UNFCCC) and the Kyoto protocol.

- **The lowering of non-tariff environmental barriers to international trade** through economic stimulating measures that can help strengthen the capacity of the ASEM region in bridging the gap between the trade and environmental decision making processes in a mutually reinforcing and economically beneficial approach for the ASEM countries.

- **The stimulation of an approximation process of the environmental regulatory framework in the countries of the ASEM region;** national environmental regulation and their enforcement have clear economic impact in each ASEM country. Different environmental regulations in various countries distort the economic playing field. By promoting market making RE investment based on enabling national environmental regulations, ASEM through AETER could help start a dialogue among its member countries and work towards an approximation of the Asia-Europe environmental regulatory framework, contributing to the establishment of a more level economic playing field.

What Could the "AETER" Network Do?

An efficient AETER network would be established in ASEM countries' national programmes and project activities that promote Renewable Energy (RE) business solutions and sustainable energy needs across the ASEM region. It would complement and synergise such activities through experience-sharing and facilitating activities at the regional and ASEM level. To avoid duplicating existing institutional capacity building activities across the ASEM region, the AETER network should focus essentially on market-making and fertilising activities in the following three main areas:

- The stimulation of the growth of small and medium-scale enterprises (SMEs) that use, supply, trade or facilitate RE solutions on a commercial basis for the economic benefit of the ASEM region and the global environment.

- The facilitation of innovative financial services and associated business support services by and/or for SMEs investing in RE across ASEM countries.

- The fostering of enabling environmental regulatory measures and non-market distorting incentives schemes to support broad RE investment uptake throughout ASEM countries.

Value adding products delivered by AETER would include:

- **RE investment awareness and promotion training modules** aimed at providing a standard material to help RE promoters to disseminate practical and convincing case studies on the win-win character of RE investment, as well as the economic benefits of triple bottom line investing. These modules could also document the positive role of enabling regulation and enforcement and would reflect, through case studies, the likely positive economic impact of enabling regulatory framework on RE investment in the participating countries. These modules would be expected to augment the outreach of existing RE promotion projects and raise the consciousness of the benefits of RE investment amongst managers in the supply chain. The modules can also establish how to best approach and structure such investment to maximise economic benefit and to reduce costs. The ultimate objectives of these products would be to raise the interest of a community of SMEs and to consider exploring the use of the two following AETER products in helping them move into value added and revenue-generating RE investments.

- **RE investment option identification guidelines** would be generic and mostly self-help supporting guidelines aimed at assisting managers, facilitators as well as RE suppliers and providers to i) identify practical opportunities for RE investment in various sectors; ii) create a hierarchy of options for RE investment alternatives; and, iii) develop a system-based approach to select the most economically rewarding investment opportunities while taking into account triple bottom line considerations.

- **RE investment financial service mechanisms models** could be generic types of processes and alliances needed to bridge the gaps between SMEs who are considering RE investment and financial service providers in search of commercially viable RE investment lending opportunities. Based on past success stories in the region, these mechanisms will document the benefit of innovative strategic alliances (for example, between EST suppliers, banks and consultants) and financial service tools and procedures worth exploring between various actors along the RE investment supply chain in order to stimulate RE investment lending. This documentation will also offer step-by-step practical guidelines on how such alliances and mechanisms can be put into practice in various socio-economic settings prevailing in the ASEM countries.

- **Network marketing documentation** would provide a streamlined overall documentation about the network, its products and services, its main actors, its sponsors and sources of funds for RE investments as well as its achievements to date. The documentation would also include the value of joining the network (no membership foreseen, just project contribution and willingness to share knowledge for mutual benefits) and the criteria for eligibility in the respective ASEM countries.

The AETER marketing documentation and other AETER products would essentially be constructed as a web based documentation for easy downloading and printing for dissemination by any interested intermediaries in the RE investment supply chain. All documents should reflect a strong AETER corporate identity characterised by a logo, a simple and catchy mission statement and standard forms and formats that help enhance the quality of the professionalism of the AETER network and its services.

Activities fostered by the AETER network would exploit existing country-based RE promotion projects and programmes as well as existing regional, national or local resource centres, associations, network or agencies active in the RE field. AETER's focus would be to promote all these efforts to deliver greater growth of practical RE investment in interested and committed ASEM countries.

Why the Focus on Investment?

Facilitating investment flows including Foreign Direct Investment (FDI) is a major theme of the economic co-operation dimension in the ASEM process.

The AETER network would therefore focus on the facilitation of practical RE investments, especially by SMEs that have limited capability to project their investments between Asia and Europe. The network could help mobilise financial resources for investment loans as well as grants required to stimulate the demand and build capacity for RE investment uptake. It could capitalise on the technical assistance interest of a number of bi- and multi-lateral donors toward less developed Asian ASEM countries. It could also assist the investment interests of private SRI funds.

Ideally, the AETER network would offer both donors and private equity funds the possibility of effectively channelling resources for the facilitation of RE investment business transactions that are compatible with the Organisation for Economic Co-operation and Development (OECD) technical assistance guidelines. On a practical level, the network could contribute to the build up of efficient financial service capacity for commercial RE uptake within a non-trade-distorting operational framework.

The capacity building efforts that donors or private funds could contribute, under an AETER network placed under an ASEM umbrella, to develop market mobilisation effort. They could also stimulate the creation of new Public-Private-Partnership (PPP) models in the RE sector (such as, among financial service providers, business support service consultancy and suppliers) and facilitate the dissemination of innovative financial services mechanisms and processes that support (but do not interfere with) commercial RE investment processes.

Due to the impact of RE investment on job creation, technology transfer and capacity building, AETER would be expected to attract intellectual leadership of key institutions in charge of economic development (innovation, productivity, entrepreneurship, risk, finance, governance, competition, social responsibility, etc.) in the ASEM region.

The diversity of financial resources mobilised (from donor grants to concessional loans up to equity finance), depending on the economic development status of participating ASEM countries, would provide a vision of the continuum of financial instruments and regulatory incentives that can progressively be tapped for RE investment along the economic development path.

What Kind of Investment?

RE investment promoted under the AETER network would have to be value added RE solutions that are transacted by "profit-making" SMEs in the ASEM countries in a number of categories. Three initial main categories requiring very different (and partially mutually exclusive) technical solutions stand out. Other categories or market segments may be added as the market develops.

- **Decentralised off-grid rural RE electricity (lighting, motive power, communication, etc.).** These RE investments would focus on providing individual or small scale RE solutions for rural areas not yet covered by national electricity grids, a concern in a number of emerging Asian ASEM countries. By providing rural areas access to local electricity, AETER would significantly contribute to an acceleration of economic development in vulnerable and so far unprivileged areas.

- **Other decentralised rural RE applications (heating, pumping, etc.).** These investments would represent poverty alleviating investment measures addressing the need of the poorest areas at the village level in the ASEM region.

- **On-grid industrial/urban grade RE electric power.** Investments would address the huge and rapidly growing electricity energy demand of urban and industrial areas to be served by investors in RE electricity production facilities. Due to the large and spatially highly concentrated energy demand involved, special, large and industrial scale grid feeding solutions around the areas with high electricity demand are a necessity.

In addition, two additional supporting categories of investment may benefit from the AETER network:

- **RE equipment producer investments.** These are investments in equipment, machinery or services to develop, produce, assemble, trade or market RE solutions produced, distributed and sold in the ASEM region.

- **RE business support investments.** These are investments in equipment, know-how or services to build up business support services including financial services that can help structure, prepare, and facilitate the delivery of revenue generating RE investments to businesses concerned.

The main beneficiary of the AETER network should be a great variety of SMEs investing in numerous applications along the RE value chain under the categories above.

What Kind of RE Technology?

Common denominators of RE solutions promoted by the AETER network would prove the efficiency of RE based on recognised international good practices. In addition, RE investments facilitated under AETER can demonstrate revenue generating capacity so that the cost of the investment can, under commercially acceptable risk for the financial service provider, be effectively repaid out of the added cash-flow generated by the investment.

In technological terms, RE should include solar energy (PV/thermal), hydropower, (mini/micro water turbine), wind energy (turbine/pump), geothermal (electricity/thermal), biomass (electricity/thermal) and ocean (tidal/wave).

The AETER network could also contribute to the application of RE technology solutions (such as demand side management, industrial green productivity, performance contracting) that are often considered a necessary value adding complement.

As part of its activities, the AETER network would ensure that adequate information about these technologies are conveyed to the various economic agents interested to advance RE investments.

Important information worth disseminating in this perspective would include:

- **Renewable resources availability** such as water flow rate and head, wind speed and distribution, sunshine hours and distribution in promising areas. Intriguingly, these important pieces of information are currently often widely unavailable, especially rural areas potentially have the highest demand for RE solutions.

- **Alternative energy supply opportunity** such as grid extension, hydro, geothermal, wind, solar, biomass and hybrid systems.

- **Technical information** including full engineering details, system configuration, equipment specs, O&M requirement or performance benchmarks;
- **Cost analysis and financing** such as financial data demonstrating the economic viability of upfront investment, short/long term O&M, financing resource, interests and loan term, ROI, etc.
- **Needs and market information** such as potential market, real market, user affordability, competition, market distribution, etc.
- **Policy support** such as taxes, concession, incentives, commercialisation, etc.

Information like this would help alleviate a number of additional risks (political, social and cultural) that can also impact RE projects.

What Would the Added Value of AETER Be?

The benefits of widely encouraging RE investment in the ASEM region could be far reaching.

AETER assistance in facilitating value added RE uptake in ASEM countries could assist some countries to **leapfrog economically** through more efficient domestic and foreign direct investments. It can provide insights on innovative economically-driven means to tackle poverty and social sustainability issues and help provide specific ways and means to redress triple bottom line imbalances.

By also focusing on FDI, which all ASEM countries aggressively compete for, the AETER network could mobilise government, business, academia and civil society at the highest level of the economic development policy and bridge the gap between environmental and economic decision-making processes in some ASEM countries.

Being an international forum, AETER could nurture intra-regional and international networking as well as create strategic links and alliances toward sustainable international trade and investment opportunities especially between Asia and Europe.

Furthermore, because of its capacity to address broader levels of behavioural and system-level changes (climate change, poverty alleviation, capacity-building and governance) the AETER network could **enlist broad international institutional support** for capacity-building from donors in advanced countries and advanced SRI equity funds from the most developed countries.

By promoting an internalisation of the transaction costs of RE investment into standard business processes, AETER would **attract the interest of businesses and entrepreneurs**, accelerate the uptake of RE solutions between the two regions and contribute to a levelling of the playing field for investment in the region.

For investors, banks and financial firms, AETER could **deliver new credible mechanisms and processes in which banks and suppliers can rely on in order to finance** RE in a sustainable way. This can lower uncertainty for businesses, diminish risks for investors and reduce the transaction costs for project proponents on the supply or demand side of value added RE solutions.

For governments and academics AETER would enable informal networking of professionals and stakeholders and provide a **source of inspiration for intellectual leadership** on many topics on the sidelines of facilitating sustainable investment in the ASEM region.

Who Could Be the AETER Network Partners?

AETER network partners would essentially be stakeholders of RE investment in the ASEM region. Five main categories could be:

- **Public authorities:** development agencies, investment and productivity boards, climate change agencies, energy boards, local government that are promoting RE investment domestically, regionally or internationally.

- **Finance and investors:** banks, funds and fund managers, export credit agencies, microfinance NGOs which can provide funding for RE investment.

- **Industry:** business associations, companies and contractors in manufacturing, production or services along the RE value chain.

- **Civil society:** NGOs, users associations and elected civil representatives that benefit from RE solutions at the local level.

- **Research:** academia in RE/EE S&T, innovation centers in RE/EE technology, policy and finance that can help design and disseminate best practices for RE investment.

Which Financial Resources Could AETER Mobilise?

Financial resources mobilised by AETER could be of two kinds and from four different sources.

AETER would be expected to essentially stimulate loan funded RE investments. These resources would come from domestic environmental/energy funds in the respective ASEM countries complemented by loans from interested multilateral or bi-lateral donors such as World Bank (WB), European Investment Bank (EIB), International Finance Corporation (IFC), Asian Development Bank (ADB), Kreditanstalt für Wiederaufbau (KfW), Japan Bank for International Co-operation (JBIC), etc. With growing disbursement and commercial success of governmental environmental funds, commercial banks and private finance service providers would win greater trust in the dependability of applied RE financial mechanisms and services and be invited to play a growing role in loan provision and the delivery of financial service for project intermediation. The ultimate goal would be the complete mainstreaming of RE uptake and the take over of loan activities by commercial banking operations.

AETER as a facilitator would also need some **grant resources** to support the capacity-building activities needed especially in the less developed countries. Equally important is the need to establish the financial mechanisms and business support services required to stimulate the levels of RE investments up to a level where commercial operators can take over. Grants would also be needed for information dissemination and "best practice exchange, nationally and regionally".

These project-based grants could come from several sources mobilised with the initial institutional support of ASEM:

- **The national budget of individual ASEM countries** could be tapped to support country based capacity-building efforts in order to enable

RE investment and provide supportive regulation and incentives in line with established national RE strategy. Many ASEM countries have dedicated RE and EE funds for investment promotion already.

- **Donor resources.** Funds from this source could be mobilised on a project basis to complement domestic national resources. Poverty alleviating RE investments and their facilitation would be a key field of action for such resources. Another area for action would be capacity-building tasks that address particular RE investment facilitation needs in selective countries in line with donor support agenda and political priorities. In as much as the network would build synergy to complement numerous RE promotion and awareness-building activities already provided by various donors, such add-on international costs would be expected to be relatively low and would focus essentially on the establishment of proven financial services mechanisms based on transparent processes and procedures already successfully applied in comparable contexts. Multi-country knowledge sharing and exchange would be another type of action requiring donor support.

- **Kyoto mechanisms and carbon trading.** RE is significantly contributing to a reduction of greenhouse gas (GHG) emissions. AETER would also be expected to benefit from the flexible mechanisms established under the Kyoto protocol of the UNFCCC, especially the JI mechanism (between countries committed to GHG reduction) and the CDM mechanism (between committed and non-committed countries). Among Asian ASEM countries, only Japan is currently committed to GHG emission reduction under the Kyoto protocol. However, all other Asian countries are parties to the protocol and are in the process to ratify the protocol.

- **The private equity market and investment funds** targeting sustainable development and the triple bottom line. These increasingly large funds are seeking good RE investment opportunities that are commercially viable and profitable. The operators of such funds have marketing budgets and can pay performance-based project finding fees to efficient facilitators of investment who make use of these funds.

What Could the AETER Network Governance Structure Be Like?

To be operational and credible, the AETER network would need to establish some kind of governance structure. Possible governance instruments could include a two-tiered board for efficient supervision and good linkages with government **(supervisory and advisory boards)**, as well as a very lean **secretariat** with a dedicated director to drive and manage AETER operations. For operation at the country level, the network would preferably rely on **national focal points** in each participating ASEM country. In addition, AETER would seek active programme and project co-operation with a network of partner organisations at the international and country levels.

Rather than create a new legal structure for the operation of AETER upfront, it should start initially as a project and over time see which existing non-profit legal form (charity, association, membership, partnership, etc.) may be best suited to sustain the advancement of its evolving objectives and activities. If successful, with time a legal entity already existing in various ASEM countries could be entrusted to take over the functions of the network that require a legal structure for operation (acceptance of funds from public donors, project responsibility and liability, accountability toward stakeholders and sponsors, etc.).

If hosted by a legal structure, the following qualities would be desirable:

- Be already a regionally registered non-profit legal entity with legal members from the region to allow a fast track start-up phase that can withstand sensitive national legal registration issues and concerns.

- Have a reputation of being thoroughly regional in terms of current outreach, contacts and projects; so as to have a good receptiveness to ideas adapted to the socio-economic interest of participating countries and to enable a broad promotion of initiatives and the dissemination of best practices across the whole region. This is important to facilitate a wide distribution of the benefits of the network to all participating countries, regardless of their interest and socio-economic level of development.

- Have experience to manage international projects and programmes efficiently from the multilateral and bi-lateral funding community. This is important in order to facilitate access to international institutional funding and to allow the network to easily win the trust of international donors and sponsors. In addition, it is also important to have an outstanding and established track record in the financial management, monitoring, controlling and auditing of internationally assisted projects. This will allow the network to generate short term significant impacts swiftly on which further progress can be built.

- Be perceived as regionally neutral and open in terms of technical project interest and to be able to address a wide range of initiatives across the whole spectrum of RE/EE solutions taking into account the differentiated socio-economic situation of the ASEM countries.

- Have a track record as an enabling facilitator that not only implements projects on its own but develops networks and alliances to build synergy and assist other institutions to build regionally relevant competence. This is to enable a distribution of the network technical capabilities to a number of separate "centres of competence" spread widely across different countries to address regional RE concerns and interest in narrower technical fields.

In operational terms, the ASEM level activities would be through a lean AETER secretariat that could help participating countries to mobilise and orchestrate public, private, international and domestic resources to lower the transaction costs of RE investments. In addition, an AETER secretariat could co-ordinate ASEM level information-sharing activities on best practice dissemination, expert exchange, publication, event development as well as on periodic reviews and performance-monitoring of national RE investment objectives and targets. Finally, the secretariat could help balance the benefits of the AETER activities across all participating ASEM countries in order to maximise mutual benefits.

What Would Make the AETER Network Successful?

The following elements would be expected to be vital ingredients contributing toward the success of an AETER network:

- **Effective products** in the form of generic innovative financial service mechanisms and alliances, practical RE investment-seeking techniques as well as professional AETER services marketing material and documentation (easily understandable and attractive to both the business world and entrepreneurs) as well as to project sponsors' agencies. These products and services would have to be specific and value adding for users to allow AETER to differentiate itself against other networks addressing RE issues.

- **Champions** at the ASEM, regional, national and local levels. These senior figures with outstanding political and moral authority will help raise the visibility and credibility of the initiative, support the marketing of the products and services, disseminate its value adding character and achievement and provide political support for attracting the interest of project sponsors and SME managers interested in RE investment.

- **Professional secretariat** to structure, develop and manage professional facilitation services to the AETER stakeholders, to cultivate effectively the support of projects donors and sponsors for country-based facilitation projects, as well as regional information sharing and exchange. The secretariat shall also be able to provide swift and professional contact assistance to businesses interested in guidance along the supply chain of RE investment across the ASEM region.

- **Government commitment to enabling RE regulation** to ensure that RE investment friendly regulations and incentives are enacted and deployed throughout the ASEM countries supporting the initiative.

- **Pro-active RE investment country managers** with good links to the relevant business communities as well as governmental finance service providers and national RE/EE funds managers. These managers should preferably be business professionals accustomed to business transactions and performance based results, well acquainted in the provision of investment financial services and willing to capitalise on performance based financial incentives.

- **Synergy with existing initiatives** and intermediaries to facilitate the swift and broad dissemination of AETER products and services to a large audience of local RE investors, suppliers or users in the participating ASEM countries.

What Could Be Performance Indicators of the AETER Network?

To bring tangible results, the network would need to be driven by practical RE investment facilitation objectives and targets as seen in the four following dimensions:

- **Outreach.** Such as, number and quality of professionals exposed to the network products and services and interested to invest in solid RE projects; number and quality of professionals associated with the AETER network to stimulate RE uptake especially by SMEs; number and quality of stakeholders mobilised to monitor the triple bottom line criteria of RE investment in the region over time, etc.

- **Mobilised resources.** Such as, volume of financial resources (loans and grants) mobilised from various national and international sources to facilitate RE investment and volume of lending disbursed for RE investment; number and quality of financial service models to advance RE uptake by SMEs, etc.

- **Enacted regulations.** Such as, number, quality and outcome of enacted RE investment-enabling regulation, incentives and implementing guidelines established and enforced in the ASEM countries; number and quality of regulatory incentives offered and exploited by SMEs, etc.

- **Direct investment.** Such as, number, volume and quality of RE investment made by SMEs using the facility network and its products and services, etc.

Behind the AETER concept is the recognition that "investment" has a powerful enabling economic transformation function. Without investment, there can be no technology application and no sustainable development. Although trade and investment are two sides of the same coin, it is investment, especially direct investment, which is at the heart of economic development. Investment facilitates sustained employment, capacity building, productivity growth, technology development and implementation as well as access to know-how and markets.

Faced with resource allocation pressures and environmental constraints unmatched in the world, many future global environmental battles will be fought in Asia. The region will undoubtedly become the global magnet and brainstorming playground for innovative eco-efficiency options and environmentally sustainable technology platforms, including RE technology. Europe is the global leader in terms of developing and implementing renewable energy systems. For the future well being of Asia, Europe and the world, Asia and Europe need to enhance their co-operation in sustainable energy investment, which will also have positive impacts for Asian and European business interests. AETER could help lower the transaction costs for co-operation and act as an important catalyst for RE technology exchange.

....

TOWARDS A NEW FRAMEWORK FOR ASIA-EUROPE PARTNERSHIPS IN ADVANCING THE IMPLEMENTATION OF RENEWABLE ENERGY TECHNOLOGIES

Francis X. Johnson
Research Fellow, Energy and Climate
STOCKHOLM ENVIRONMENT INSTITUTE

and

Yong Chen
Research Associate
STOCKHOLM ENVIRONMENT INSTITUTE, SWEDEN

Abstract

Co-operation between Asia and Europe on renewables is arguably the world's most significant axis of international co-operation in light of concerns over energy security, future economic competitiveness, and climate change. Energy consumption growth and especially electricity consumption growth will be concentrated in developing countries in the future, with China and other Asian countries representing the major regions of growth. The EU is moving aggressively towards ambitious targets for increasing renewables in the energy mix. Renewable energy industries have seen tremendous technological innovation in recent decades, especially in wind and biomass. In the short term, there are excellent business opportunities, as Europe can offer excellent renewable energy "packages" for countries in Asia that are increasingly

recognising the value of more diverse energy sources. In the longer-term, co-operation between Asia and Europe will facilitate Asian industries' development of domestic renewable energy industries. There already exists tremendous technical capability and human resources for renewable energy in Asia. What Europe can assist with, is the financial packaging and the experiential knowledge concerning the many different applications and the need to scale-up renewables in a way that is economically feasible, socially acceptable and environmentally sustainable.

Historical Background and Overview

Over thirty years have passed since the first oil crisis ushered in a new era in which medium and small-scale renewable energy technologies moved out of laboratories and away from smaller prototypes into broad commercialisation and a variety of new applications and markets. Many other issues have since provided further economic and environmental rationale for the expansion of renewables: the capital cost burden of large-scale power plants; concern over the safety of nuclear power; the threat of climate change; and, a broader view of energy security that recognises the need to address regional sustainability as well as geopolitics.

Nevertheless, an analysis of the energy mix in various regions around the world reveals that among renewables only large-hydro and traditional biomass have a significant share. The social and environmental impacts of large-hydro have led to it being "de-classified" as renewable in many certification schemes. Traditional biomass in the form of wood and charcoal is still used in much of the developing world, accounting for as much as 95% of household energy use in some African countries. The transport sector has barely been touched by renewables, with the exception of a few countries like Brazil, with its ethanol programme.

Perhaps more significantly, the new era also marked an end to the long period of continuous growth in energy consumption in OECD (Organisation for Economic Co-operation and Development) countries and the start of a period of rapid growth in energy consumption in many developing countries. The experience in OECD countries showed that energy efficiency, energy conservation, and the increasing importance of information technology allow for a decoupling of energy from economic growth, and it is now widely understood that there are many possible "energy paths" to choose from.

In spite of the many options available, many developing countries have nevertheless opted for more traditional power sources in pursuit of increased economic growth and there are certainly many private companies in OECD countries that are happy to sell equipment and expertise for large-scale and/or non-renewable-fuelled power plants. Most of the energy consumption growth in the coming century will be in developing countries and consequently the key for expansion of renewables is essentially rooted in co-operation between OECD and developing countries.

One might say that the challenge is now to "scale up" renewables and energy efficiency - not simply by increasing the size or number of installations and/or the amount of energy produced (or saved), but through the gradual learning processes through which appropriate applications and markets can be found. Implementation of renewables needs to better incorporate social and environmental goals and constraints and demographic trends.

Given the pre-eminence of climate mitigation among climate goals, a great deal of climate policy analysis is focused on quantifying the adjustments on a macro-level in terms of the amount of carbon that needs to be saved and how it shall be accomplished. Pacala and Socolow (2004) have suggested thinking about the energy-climate problem in terms of rapid expansion of seven "wedges" of alternate technologies, each amounting to 1 GtC. They also suggest that the issue is mainly one of scale since the necessary technologies are already available.

At the same time, the smaller scale, diversity and intermittent nature of renewables poses both challenges and opportunities compared to traditional power sources. Policy analysts, researchers, project developers and development specialists will need to look for "creative intersections" between the growing energy service needs of the developing world, the need for regional integration towards sustainable development and global environmental problems - with climate change foremost among them. There is also a need for "higher-level" policy signals from major international players such as the UN, World Bank and the IEA (International Energy Agency).

The Renewables Challenge at Johannesburg and Bonn

The Bonn International Conference on Renewable Energy in May 2004 provided such higher-level policy signals and the Conference was a significant turning point for the global transition towards energy systems that are environmentally sustainable, economically achievable, and politically acceptable. The Bonn Conference grew out of commitments made at the World Summit on Sustainable Development (WSSD) in Johannesburg in 2002, and the momentum both events provided has contributed to a variety of international co-operation efforts. The EU and other international bodies have subsequently set a number of targets for renewable energy expansion and dedicated more resources to deployment and implementation as opposed to supporting mainly research and development, emphasising the fact that major technological breakthroughs are not necessarily needed - there is a tremendous amount that can be done with existing technologies.

The axis of international co-operation between Asia and Europe is arguably the most important among all the major region-to-region co-operation efforts currently in place or expected in the foreseeable future, for a number of reasons. First, demand is nearly saturated in the EU (European Union) whereas it has only recently started to take off in much of Asia - and it is where energy consumption growth will be concentrated in the coming century. Consequently there exist many valuable complementarities in the form of new business partnerships, technology transfer, expanded trading opportunities, and the specialised knowledge that is required to match end-user needs to the capabilities of suppliers.

Second, the EU has been in many respects the environmental leader for the world during the past decade, especially in light of the US rejection of Kyoto, and much can be learned from the considerable effort expended within the EU on developing broad policy platforms and institutions to support climate mitigation, with a special focus on renewables. EU-Asian partnerships on renewables have been an almost inevitable result of the leadership role taken by the EU and the fact that Asia will most likely be the key battleground for climate mitigation efforts in the coming century.

Third, most of the main "coming-of-age" stories for renewable energy have occurred within the EU and have been clearly attributed to prolonged support from national governments and the establishment of appropriate co-operation with private industry. The case of wind energy in Denmark and biomass in Sweden offer perhaps the most classic examples of how modest support that is sustained over many years can help to overcome the lock-in and vested interests that characterise the bulky power sector.

Finally, there is a continuously improving rapport between Asian and European societies as well as between their respective governments, whereas the unilateralist approach of the current US administration has damaged the credibility of American institutions. More importantly, in contrast with the tendency in the US to draw a clear distinction between the roles of government and industry, the less legalistic division between government and industry in both Asia and Europe offer more latitude for energy sector co-operation, especially in light of liberalisation in the power and gas sectors.

Asian-European partnerships will be increasingly facilitated by the greater social exchange they have been experiencing as well as the global political forums (mainly the United Nations) in which international energy-environmental initiatives are formulated. However, a number of key areas will need to be addressed in order for European-Asian co-operation on renewables to achieve its potential; a sketch of these key areas and methods of co-operation is provided in the remainder of this paper.

Current and Future Energy Sources in Asia and Europe

In Europe, renewable energy sources currently play a marginal role, accounting for only about 6% of the EU-15's primary energy consumption in 2002. The share of renewables in the EU-25 is slightly less. Globally, we can note that only biomass and hydropower have any real market share. Furthermore, with the exception of some areas in the US and a few countries in Europe, biomass consumption is mainly for traditional use in developing countries for cooking – a low efficiency use, which is more costly in real terms, since these low efficiencies are not sustainable for increasing populations and demands on land use. Moreover, the smaller-scale and more intermittent renewables (e.g. wind, photovoltaic (PV)) will require considerable scaling-up in order to have a major impact, although wind in particular clearly has significant potential in the long-term. In the case of wind that is supplying power to the grid and/or located near urban areas, installation becomes an important issue since a given wind farm will generally require hundreds of windmills to be on par with major geographical demand centres. Table 1 lists the fuel shares for the EU and other major regions (EC DG-TREN 2004).

In Asia, renewables represent a much larger share, but this is due primarily to traditional biomass use for cooking, lighting, and heating, as is still common in the developing world. Indeed, given that more than one billion persons in Asia lack access to modern energy services, a major challenge in Asian countries will be to find substitutes as populations increase and resource pressures limit the availability of biomass. There has been a significant increase in the use of small-scale biogas for household and small commercial applications, especially in China and India, and these applications represent useful improvements in the efficiency of utilisation for the overall biomass resource base. However, rapid urbanisation in Asia has led to much greater growth in energy consumption in the transport sector and in newer industry sectors, and this consumption is much higher in aggregate by comparison to the smaller-scale uses of biomass.

Table 1: Fuel Shares for Primary Energy Consumption in Various Regions

	Solids	Oil	Gas	Nuclear	Hydro	Biomass	Other
USA	23,7%	39,3%	23,5%	9,2%	0,9%	3,0%	0,4%
EU-15	14,6%	40,1%	23,5%	15,6%	1,6%	3,8%	0,8%
Japan	19,3%	49,4%	12,8%	14,9%	1,4%	1,4%	0,8%
Russia	17,3%	20,8%	52,7%	6,0%	2,3%	1,1%	-0,2%
China	57,2%	20,1%	2,7%	0,5%	2,0%	17,5%	0,0%
India	33,1%	22,0%	4,2%	0,9%	1,0%	38,7%	0,1%
Others	15,4%	37,3%	23,7%	3,6%	3,6%	15,6%	0,8%
World	23,5%	34,9%	21,2%	6,8%	2,2%	10,9%	0,5%

The table is a reminder of the tremendous challenge in bringing renewables to the market. Even the one renewable option that is economic and fully commercialised at large-scale – hydropower – represents only a very small share of energy consumption. The other major renewable energy source - biomass - is consumed predominantly in the developing world for traditional uses in cooking, lighting, and heating, with extremely low conversion efficiencies.

In the long-term, it is quite likely that the electricity generation mix – rather than the primary energy mix - will determine whether climate stabilisation can be achieved, due to the fact that most of the carbon resources in the world are in coal rather than oil or gas (Grubb 2005). Consequently, the areas of future growth in electricity consumption will need to be the focus of efforts to de-carbonise energy supply by increasing renewables.

Table 2 shows the electricity consumption in various regions of the world in 2002 and the IEA projected electricity consumption in 2030 (IEA 2004). Growth in world electricity consumption will be concentrated in developing countries (non-OECD in the table) in the future. China's electricity consumption, which is currently about half of that of the EU-25, is projected to exceed that of the EU-25 by 2030. Overall, non-OECD countries will grow from accounting for one-third of electricity consumption to over half of world electricity consumption. Growth in electricity consumption in many developing regions will be about three times the growth in OECD countries, and this shift in consumption patterns has significant implications for climate policy and the role of renewable energy.

Table 2: Electricity Consumption in Various Regions of the World (Current and IEA Projection).

YEAR(s)	2002		2030		2002-2030
	Consumption (GWh)	Share of World Total	Consumption (GWh)	Share of World Total	Share of Growth Rate
Africa	480000	3%	1602711	5%	4,40%
Middle-East	512000	3%	1203684	4%	3,10%
ASEAN	420397	3%	1295031	4%	4,10%
India	596543	4%	1991846	6%	4,40%
China	1640478	10%	5477525	17%	4,40%
Japan + Australia + NZ	1359645	8%	2006727	6%	1,40%
Other Asia + Pacific	669872	4%	2236690	7%	4,40%
Brazil	344645	2%	810242	3%	3,10%
Other SA, CA, Mexico	656010	4%	1814327	6%	3,70%
U.S. + Canada	4834162	30%	6940419	22%	1,30%
EU-25	3149738	20%	4522087	14%	1,30%
Russia + Other	1409079	9%	2322058	7%	1,80%
World	16072569		32088804		2,50%
OECD (+Russia+Other)	10752624	67%	15791290	49%	1,38%
non-OECD	5319945	33%	16297513	51%	4,08%

(Source for consumptions and projections: IEA 2004)

Renewable Energy and Climate Policy

This radical shift in electricity consumption patterns implies that in order for climate strategies to be effective in the long term, they will have to be aimed primarily at non-OECD countries. In fact, the carbon intensity of world electricity supply will be largely determined by choices made in China and a few other key growth regions. The challenge for OECD countries will be primarily to decrease the energy intensity of their economies, i.e. to improve energy efficiency on a very large scale. The current ambitious long-term climate strategy in the UK, which aims to decrease carbon emissions by 60% by 2050, is based squarely on these two pillars - decreasing carbon intensity by increasing renewables and decreasing energy intensity by improving energy efficiency (Grubb 2005). The UK climate strategy may very well be seen as a prototype for the global strategy, and the innovative public-private partnerships developed through the Carbon Trust may be seen as prototypes for the international partnerships that will be required for an effective global climate strategy (Carbon Trust 2003).

It is not only climate policy that is driving efforts to promote renewables in the EU. Concerns over energy security and future economic competitiveness have also helped to spur efforts to increase the share of renewables within the EU. The indigenous availability, climate-neutral nature and improving technological maturity of renewables are increasingly seen by industry as attractive investment options that can create new market opportunities and enhance the competitive advantage of European companies. The EU has set targets for 2010 of 21% for electricity production from renewables and 6% for the market share of biofuels for transport.

Security of energy supply is an even greater concern in Asia, where the share of imported energy has been rapidly increasing amidst economic growth. In recent years, the volatility of oil prices has exposed any nation that heavily depends on oil imports to a vulnerable position. This is particularly true when it comes to developing countries in Asia. Promoting modern use of renewable energy sources may provide part of the solution to strengthening a country's national energy security situation. Furthermore, energy security concerns have transcended the Middle East oil debate and now include the recognition that diversity in energy supply, both in transport and in the power sector, leads to a more robust economy.

The problem often comes in translating such broad policy goals into investments in renewables, and this is often affected by the issue of economic scale. The small-scale of most renewables translates into many economic "transactions" compared with the commissioning of a large baseload power plant fired by coal, nuclear or hydropower. Each transaction requires an investment decision and thus the challenge for policy-makers will be how to re-direct investments and at the same time find ways to bundle or package renewable energy options so that the transaction costs are minimised.

Ideally, advanced European renewable energy technologies should be made available to ensure Asian energy supplies, particularly to support rural development. This would in turn help to increase production volumes and thereby reduce costs. However, the reality provides a more complex picture, due, primarily, to apparent differences of conditions and institutions, background motives and incentives. As a consequence, there is a performance gap in applying renewable energies between the continents and how to bring the experience developed in Europe to the potential renewable energy users in Asia becomes an issue. One of the main conclusions of the 3rd Roundtable Conference of the Asia-Europe Environment Forum was that the key lies in non-technical factors, rather than in the technologies themselves. Of these non-technical factors, the most important would be to create an enabling environment in Asian countries to promote the use of renewable energy options. For example, human and institutional capacity building, financing frameworks and a sound governance system serve as vital prerequisites for effective technology investments.

The most significant barrier to renewable energy, besides the technical limitations such as intermittency, is the generally high production cost of energy from most renewable sources. Although Europe is taking a leading role in developing technologies for renewable energy sources, if no economic incentive or subsidy schemes are adopted the use of these technologies is curbed by the high prices (with a few exceptions such as wind power in some locations in Denmark and large-scale hydropower). However, as a critical mass of renewable energy use is being attained, the production costs are expected to decline.

Key Drivers behind Asia-Europe Co-operation on Renewables

Given that countries in Asia and Europe are posed with different developmental challenges, renewable energies play distinctly different roles on the two continents. For European countries, renewable energy sources primarily serve as a means to diversify the national energy supply. Promoting renewables is also a way to implement commitments to sustainable development and reduction of greenhouse gases (GHGs) emissions, while creating jobs and enhancing competitiveness. For most countries in Asia, renewables are associated primarily with poverty reduction and basic economic development; however, in the longer-term the same issues of energy security and diversity are applicable in most Asian countries as well.

In this context, two key driving forces from the European side behind a co-operation with Asia would be: (1) exports of renewable energy technologies and know-how, such as wind power (Denmark, Germany), thin-film PVs (Sweden) and biomass-based boilers/co-generation technology (Sweden and Finland); and (2) carbon credit to support energy-intensive industries, such as the Swedish iron and steel industry, concerned by the restriction of carbon dioxide emissions, jeopardising the development and international competitiveness of European industries.

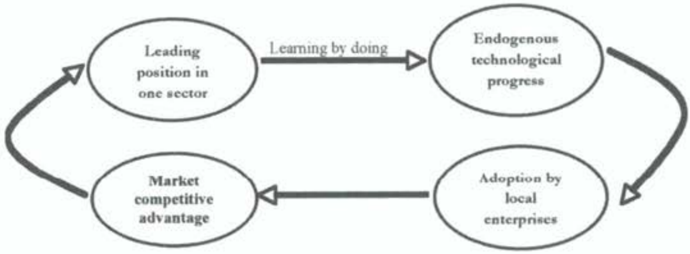
Adequate renewable energy sources and mature technologies are available to provide a considerable part of the future energy supply in both Asia and Europe. However, without implementing significant measures to create an institutional, financial and legislative enabling environment for applying renewable energy in modern ways, political promises made will not be translated into real progress on the ground.

It is important to note, however, that in developing countries this political resolve would not be rooted in commitment to environmental improvements, but rather to satisfy economic interests and development needs. These driving forces vary between countries with the poorer ones, such as Cambodia, Laos and Nepal, focusing on energy services and poverty reduction, while others at a relatively more advanced development stage, such as China, India, the Philippines and Thailand, would focus on economic growth and business development.

Opportunities of Technological Leapfrogging

Over the course of history, new technology has advanced incrementally by gradual improvements, as depicted in Figure 1. This has occurred through learning-by-doing and most rapidly so, in developed countries. However, developing countries as latecomers have the advantage of avoiding mistakes made by today's developed countries in their developmental trajectory and catching up with state-of-the-art technology through shortcuts. This opportunity for shortcutting the technology development was in the 1980s termed "leapfrogging".

Figure 1: The Circle of Conventional Technology Progress



Leapfrogging some historical steps in the technological development of today's industrialised countries makes it possible for developing countries to become the first to adopt modern technologies. By adopting leapfrogging technologies with high efficiency, developing countries benefit not only from higher productivity but also from conservation of scarce natural resources and mitigation of environmental stresses. The economic loss of phase-out of the old technology in developing countries, if any, is usually much lower than in developed countries, which facilitates the decision to adopt the new technologies.

Although a majority of new technologies are invented and developed in more mature economies, market saturation there provides disincentives for technological upgrading. At some economical and technological stage, the very success of a leader in technological development could become a potential barrier to further progress (Brezis, Krugman and Tsiddon, 1991). With appropriate policy schemes and strong implementing institution and instruments, individual investors, whether domestic or international, driven by the competitive advantage to be gained from the combination of frontier technology, low wage costs and expanding local and regional markets, pursue the application of appropriate frontier technologies in developing countries (Jefferson, 2000).

The case of the Brazilian ethanol fuel for transportation is an illustrating example. Nearly three decades ago, Brazil adopted an advanced technology to produce ethanol fuel from sugarcane with the intention to reduce oil dependency and support Brazilian sugar farmers. An enabling environment was created by introducing a package of supportive policies: 1) low interest loans; 2) guaranteed purchases at a reasonable price; 3) subsidies for pure ethanol enhancing its market competitiveness; and, 4) sales tax incentives for ethanol vehicles during the 1980s. Furthermore, local R&D and technology dissemination facilitated the production of ethanol fuels by providing improved technologies (Carvalho 1998). In 1998, ethanol fuelled one third of vehicles in Brazil and Brazil has become a world leader in ethanol-conversion technology (Geller and Howard, 2003). This initial step of leapfrogging, triggered a chain reaction producing multiple benefits beyond the targeted technological upgrading. In addition to ethanol production for transportation fuel, a number of new uses of sugarcane and ethanol residues such as electricity generation and chemical production could further expand modern bio-energy use in Brazil. Social benefits are also significant with improved living conditions, for instance, better air quality, more employment opportunities and improved public health. (Moreira 2000).

In most Asian countries, it has been agreed that using off-grid facilities is an increasingly attractive option for rural electrification. Photovoltaic (PV) technology is one such option. Along with the widespread application, PV technologies have been transferred to domestic manufacturers, as observed in China and India where PV lamps, solar modules assembly and charge regulators are produced locally (Campen, Guidi and Best, 2000). In addition, China has become the world's largest manufacturer, user and exporter of solar water heaters, with an industry-wide profit over $1.3 billion in 2002 (Wang et al, 2003).

Clearly, opportunities do exist, but the question is, as pointed out by a number of participants in the 3rd Roundtable Conference of the Asia-Europe Environment Forum: What would be the appropriate point on the learning curve for renewable energy technologies for developing countries to engage and by what mechanisms can the high initial investment costs be off-set by long-term gain?

Renewables, Fossil Fuel Imports and Energy Security

As a result of the strong demand for energy to fuel the surging economies, particularly in China with 12% of global primary energy demand, but also in other countries, such as India, Indonesia, Malaysia and Vietnam, Asia will become the largest energy-consumer in the world. However, one of the challenges facing these growing economies is limited energy sources, particularly oil. Almost all of the countries in the region will face declining endogenous oil production in a timeframe of up to 30 years, with consequently rising oil dependency and weaker energy security. (IEA, 2004)

In the past decades, the world oil price has been varying a great deal, ranging from $2.17 in 1971 to $10 in 1998 and even up to over $55/barrel in late 2004 (Hwang et al, 2004; The Economist, 2004). In addition, in the longer term perspective the "oil age" will come to an end at some point on account of eventual depletion of exploitable oil resources and serious environmental constraints on the use of fossil-based fuels. The oil industry is already seriously concerned about rapidly declining reserves, surging costs and a lack of access to cheap new reserves (The Economist, 2004). The short-term price volatility and potential longer term shortage of oil present a threat to developing Asian countries not only in terms of short-term disruption of energy supply, but also to continued economic development and even national security, as oil economy plays an increasingly important role in the region with most Asian countries, except for Japan and South Korea, having insufficient strategic stockpiles in case of an oil crisis.

One may argue that coal still is and will continue to be the dominant energy source in Asia, accounting for around 80% of its primary energy supply (IEA, 2004). Nevertheless, the concerns about its negative impacts on the environment and human health are growing faster than ever, globally, regionally and locally. This suggests that using coal in conventional ways in the future may not be as easy and cheap as it was.

In this context, greater concern should be given to the security of long-term energy supply, particularly for economies that are increasingly active fossil fuel importers. On this point, European countries, in general also highly dependent on imported fossils fuels, and Asian countries, share a commom ground for diversifying energy sources and supplies.

To justify adopting RES as one way to enhance energy security, a portfolio-based approach for energy planning can be applied. This approach provides a new perspective on the role of renewable energy sources, in the current situation where the fundamental barrier for widespread utilization of renewables, i.e. internalising externalities of fossil-based energy supplies, remains unsolved. The core concept behind the theory in the context of energy security is that a certain percentage of renewable energy sources with relatively fixed production cost is able to offset the fluctuation of portfolio cost caused by uncertainty of fossil fuel prices and thereby reduce the resulting risk (Awerbuch, S., 2004).

Key Barriers for Asia-Europe Partnerships in Advancing the Implementation of Renewable Energy Technologies

It is a daunting task to analyse the complex barriers for the development of an Asian-European partnership for promoting renewable energy technologies, due to the multi-dimensional differences between and even within regions and countries. To gain an in-depth insight on the issues, a broad and deep study on a country basis is required, which is beyond the scope for this chapter. Generalisation of various barriers is made here based on the extensive discussions during (and the insightful articles prepared for) the Stockholm 3rd Roundtable Conference.

Policy, Institutional and Legal Barriers

Without appropriate policy support, development of renewable energy technologies is not very likely to take place in a competitive energy market, as almost all renewable energies with the exception of large-scale hydropower are unable to compete with conventional energies (P.E.Morthorst, 2003). This is particularly true in Asian developing countries where the use of renewable energy systems is closely linked with and therefore affected by policy and regulations related to, for example, rural development, rural electrification, planning and environmental protection. This is primarily because a majority of the population in these countries lives in the countryside and remote areas where off-grid renewables become the optimal solution for providing energy service. There will be 1.7 billion people by 2030 relying on biomass for cooking and heating; most of them living in the countryside.

In most Asian countries, although there are political commitments to implement modernised renewable energy technologies, clear targets and pathways to achieve them as well as effective policy schemes are still lacking. This implementation gap may influence European investors' confidence simply because investors are concerned about the policy environment.

In addition, weak institutional and legal systems cause various complex concerns related to investment on modern renewable energy systems. A general lack of planning capacity, coupled with lack of appropriate legislation, little respect for the judicial system and weak legal enforcement, gives a considerable element of insecurity to renewable energy investors, who will have to make decisions on investments without knowing for example how the grid electrification of new areas will proceed or what will be the future legalisation when it comes to, for example, taxation or electricity tariff setting.

Lack of Financial Mechanisms in Favour of Renewables

Lack of access to financial capital poses a paramount constraint to adoption of renewable energy technologies, due to the following causes: (Chen, 2004)

- In most cases, renewable energy projects are capital intensive as investment per unit of energy is usually higher than conventional energy sources.
- For almost all types of new renewable energy investment (excluding large hydro power), the scale of production and investment is so small, compared to conventional energies, that it is difficult to attract traditional lenders' interest.
- There are high risks, difficult to be accurately assessed, associated with technological immaturity and unpredictable government energy policies.

In most Asian countries, the financial markets are immature and the financial tools in favour of renewable energy technologies are missing. This is coupled with the fact that most financial institutions lack understanding of renewable energy projects and their potential benefits. For European investors, the Clean Development Mechanism (CDM) provides a possible solution. However, without establishing mature financial markets and functioning financial tools, CDM as a means to finance renewable energy projects would be less efficient.

In Europe, there are a number of effective policy schemes and financial incentives in favour of use of renewable energy sources, such as feed-in-tariff mechanism, tradable green certificates and environmental bonus/subsidies. These schemes and instruments help renewable energy projects improve financial and economic viability. There may be ways to introduce these European experiences in the Asian context to tackle the financial barriers to modernisation of renewable energy technologies. More on this topic can be found in the article entitled "Market mechanism and the use of renewables in the power sectors of Asia and Europe" authored by Guido Alfredo A. Delgado in this proceeding.

For the end users, especially the poor in most Asian developing countries, it can be excessively difficult to find financing sources for a renewable energy system. This is not only because of the high installation costs, but also lack of innovative micro-financing schemes, such as revolving funds. In this case, even though the rural end-users are keen to and willing to pay for modern energy that can be provided by PV, wind mills, or hybrid systems, with small and irregular income, it is unrealistic.

Mismatched Technological Solutions

One of the fundamental barriers in transferring technologies between developed and developing countries is that the technologies being transferred are neither appropriate to the local context and demands, nor to the local environment. Not all modern technologies are suitable for developing countries. Instead, technologies need to be assessed and selected against the local and regional needs, as well as available natural resources. However, in most cases, in particular in rural areas of Asian countries where renewable energy solutions present greater added value, required local information, such as actual demand of energy services, prospect of productive energy use, water flow rate, wind speed and distribution, sunshine hours and distribution in proposed areas, may be lacking, insufficient or incorrectly provided, as pointed out by Dr. Philippe Bergeron in his article herein. In addition, the lack of sufficient research capacity in most Asian countries limits the support available in the selection of technological development routes.

Innovative or tailor-made technical solutions should be encouraged. For example, renewable energy technologies from developed countries may not be well adapted to different types of biomass or other more harsh wind conditions perhaps including sandstorms. A number of technical adjustments should be made prior to demonstrating its functionality and adaptability to local contexts. It is difficult to convince local people to adopt a new technology on a broad basis without a successful pilot project, even though successful cases can be found worldwide. A failed demonstration of technical solutions may, however, risk reducing public acceptance of the new technology.

According to Dr. Philippe Bergeron, many European entrepreneurs and investors are not ready to commit themselves to a longer term business/project strategy, primarily because of various non-technical factors, such as financial and economic viability, institutional and legal capacity as well as protection of intellectual property right. Thus, few European entrepreneurs/investors even consider technological adaptation and localisation in their business strategies.

Conclusions

Renewable energy technologies in the power sector have come down in cost significantly in Europe over the past three decades, especially in the case of wind and biomass. The cost reductions and expanded market opportunities have generally NOT been the result of major technological breakthroughs, but rather the result of a more gradual learning process to encourage technological innovation not only in R&D, but in the continuous chain of events and feedback processes through which end-users communicate their requirements to suppliers, who in turn, move products into new and expanding markets. Co-operation between Asia and Europe in the implementation of energy efficiency measures and renewable energy technologies has special significance and importance with respect to both regional and global environment and development goals.

References

Awerbuch, S., 2004. Portfolio-based Electricity Generation Planning: Implication for Renewables and Energy Security. Prepared for REEP Environment Policy Department of Foreign and Commonwealth Office, London, and Division of Technology, Industry and Economics of United Nations Environment Program, Paris. May 2004.

Brezis, E., Krugman, P., Tsiddon, D., (1991). Leapfrogging: A Theory of Cycles in National Technological Leadership. In: NBER Working Paper Series, National Bureau of Economic Research. October 1991. On-line Available: http://papers.nber.org/papers/w3886

Carbon Trust (2003), 'Building options for UK renewable energy', Oct 2003, www.thecarbontrust.co.uk

Carvalho 1998. The role of Copersucar in Improving Technology for Ethanol Production from Sugar Cane in Sao Paulo. Paper presented at the STAP Workshop on Technology Transfer in the Energy Sector, Amsterdam, Jan. 19-20.

Chen, Y., 2004. Promotion of Renewable Energy Globally-Based on Johannesburg Follow-up, Nordic Council of Ministers, Copenhagen, ISBN: 92-893-1019-7, 2004

Choucri, F., (1998). Knowledge Networking for Technology Leapfrogging. Cooperation South Journal, No. 2, 1998. United Nations Development Program (UNDP)

Economist, 2004. Not exactly what they seem to be. The Economist, Issue October 30th - November 5th, 2004. pp.65-66.

EC, 1997. Energy for the future: Renewable Sources of Energy - White Paper for a Community Strategy and Action Plan. COM(97) 599 final. European Commission, 1997. On-line available:
http://europa.eu.int/comm/energy/library/599fi_en.pdf

EC DG-TREN (2004) European Commission Directorate-General for Transport and Energy, Statistical Yearbook 2004.

Gelle. and Howard, 2003. Market Transformation. Energy Revolution: Policies for a sustainable future. Island Press, Suite 300. Washington DC. P. 117-122.

Grubb, Michael (2005) "Climate, energy and innovation: Moving from theory to practice," prepared in conjunction with the Asia-Europe Environment Forum (ASEF) Third Roundtable: "Technology Partnerships for Renewables: Key to Energy Security" Stockholm, Sweden, 26-28 August 2004.

He Ke Zai Sheng Neng Yuan Fa Zhan Fen Xi]. Study of China's Energy Issues in 2002 (chief edt. Zhou, D.D. and Han, W.K.) [Zhong Guo Neng Yuan Wen Ti Yan Jiu]. China's Environmental Science Press. Beijing, 2003.

Hwang, M.J., Yang, C.W., Huang, B.N., and Ohta, H., 2004. Oil price volatility. Encyclopedia of Energy, Volume 4.

IEA (2004) World Energy Outlook 2004. International Energy Agency, Paris.

Jefferson, M., 2000. Chapter 12: Energy Policies for Sustainable Development. World Energy Assessment. United Nations Development

Program (UNDP), United Nations Department of Economic and Social Affairs (UNDESA), and World Energy Council (WEC). New York, 2000.

Moreira, J.R., 2000. Sugarcane for Energy: Recent Results and Progress in Brazil. Energy for Sustainable Development 4 (3): 43-54.

Morthorst, P.E., 2003. A green certificate market combined with a liberalized power market. Energy Policy 31 (2003). pp. 1393-1402.

Pacala S. and R. Socolow (2004), "Stabilization wedges: Solving the climate problem for the next 50 years with current technologies," Science, 305 (5686), pp. 968-972, August 13, 2004, and its Supporting Online Material.

Wang, J.Y., Li, J.F, Liang, Zh.P., Song, Y.Q., Shi, J.L., Hu, R.Q., 2003. Analysis of Development of China's Novel and Renewable Energy Sources [Zhong Guo Xin Neng Yuan].

Appendices

....

CONFERENCE AGENDA

DAY 1 – 27th August

9:30-10:00 Introductory Session

Sustainable Development, Climate Change

Chairperson

Amb. Dr. Delfin Colomé

Executive Director, ASIA-EUROPE FOUNDATION (ASEF)

Welcome Remarks

Mr. Erland Ringborg

Director General, SWEDISH INSTITUTE & ASEF BOARD MEMBER FOR SWEDEN

Dr. Roger Kasperson

Executive Director, STOCKHOLM ENVIRONMENT INSTITUTE (SEI), SWEDEN

Mr. Hideyuki Mori

Director, ASIA-PACIFIC FORUM ON ENVIRONMENT AND DEVELOPMENT (APFED) SECRETARIAT, INSTITUTE FOR GLOBAL ENVIRONMENTAL STRATEGIES (IGES), JAPAN

Mr. Eric Usher
Energy Programme Deputy Co-ordinator, UNITED NATIONS ENVIRONMENT PROGRAMME (UNEP)

10:00-11:15 Keynote Addresses

Mr Krister Nilsson
State Secretary, MINISTRY OF SUSTAINABLE DEVELOPMENT, SWEDEN

Prof. Michael Grubb
Policy Director, THE CARBON TRUST, UNITED KINGDOM

Prof. Emil Salim
Eminent Person, EXTRACTIVE INDUSTRIES REVIEW, WORLD BANK GROUP & *Former Chair,* WSSD PREPARATORY COUNCIL, INDONESIA

Discussion

11:15-11:30 COFFEE BREAK

11:30-12:00 Toward a Common Voice for a Sustainable Future
(Overview of the Asia-Europe Environment Forum & 3rd Roundtable)

Mr. Bertrand Fort
Director for Intellectual Exchange, ASEF & *Co-ordinator,* ASIA-EUROPE ENVIRONMENT FORUM

Discussion

Session 1: Technology
What kind of Energy is Sustainable for Various Consumption Needs?

This session will review the technologies presented during the poster session. A vision of sustainable cities and how they are being achieved in Asia and Europe will be discussed. The use of nuclear energy is an important *debate in countries like China with 90% of its population in the dense, urbanised coastal areas where the demand is for large-scale, centralised energy. How can this paradox be resolved? The prevailing power industry structure is a very important component to look at as well. Is a decentralised model possible in densely populated urban areas? Economic aspects, particularly price volatility from fossil fuels, must be considered. How could an increased role for renewables to reduce such volatility? How can we advance sustainable energy as a technological solution for all?*

Moderator:

Mr. Hideyuki Mori
Director, APFED SECRETARIAT, IGES, JAPAN

12:00-13:00 Scoping Paper 1
What renewable resources are abundant in each region (Asia, Europe) and what technologies on renewables are or are likely to be demanded within the next 15 years?

Mr. Peter Danielsson
President, EUROPEAN RENEWABLE ENERGIES FEDERATION, SWEDEN

Discussion

13:00-14:30 LUNCH

14:30-15:30 Scoping Paper 2
How can renewable energy technologies be adapted to various consumption needs or demand (dense urban areas, island settings, rural areas)? Focusing on large-scale, urban demand, how can renewables fare against nuclear energy, for instance?

Prof. Pan Jiahua
Senior Research Fellow and Executive Director, CHINESE ACADEMY OF SOCIAL SCIENCES, CHINA

Discussion

15:30-15:45 COFFEE BREAK

Session 2: Financing and Policy
From an Idea to the Market: Sustaining the Technology Innovation Process

The technology innovation is a continuing chain or process that includes: research and development in the public, private and academic sector; project development; and, introducing new, environmentally-sustainable technology into the market through a mix of regulations and incentives; and, up-take or adoption. What are the critical factors that determine uptake of technology right through from conceptualisation to commercialisation, and those that were not? What incentives and institutions/policies (including standards, labelling schemes) are needed to stimulate and sustain the process of technology innovation to the point of profitability? A key issue of advancing technology development is through investment in innovative solutions that will only be adopted if a market can be nurtured and a demand emerges. What modalities of finance are and/or should be available to stimulate technology development?

Moreover, the quality of the market needs to be assessed. Technologies get developed, and these technologies get adopted because there is a demand. The quality of this demand must be assessed. Even in countries or areas where renewable energy is most appropriate, the level of purchasing power and structure of the market make investments in technology difficult. The question therefore is: how do we develop appropriate market mechanisms that will support renewable energy investments? How does the structure of the power industry create incentives or disincentives for the development, adoption, and marketing of renewable energy technology? How could the market for renewables be enabled through empowering policies?

Moderator:

Tan Sri Ahmad Zaharudin Idrus
Chairman, F3 STRATEGIES BERHAD, MALAYSIA

15:45-17:45 Scoping Paper 3
What is the general power industry structure in the two regions?

Guido Alfredo A. Delgado
Former President, National Power Corporation, THE PHILIPPINES

Scoping Paper 4
The technology innovation for renewables: how can we compare incentives (domestic subsidies, procurement programmes, CDM...) in policy and finance instruments throughout Asia and Europe, and the impact on the innovation process?

Dr. Dörte Fouquet
European & International law specialist (Energy & Environment) & Senior Partner, KUHBIER LAW FIRM, BELGIUM

Discussion

17:45-18:00 Wrap-Up by Moderators

DAY 2 – 28th August

Session 3: Asia-Europe Platform
From Technology Tranfer to Technology Exchange

Technology in Europe and advancing economies of Asia is developing very quickly–technology cooperation and exchange is a natural imperative to "leap frog" or accelerate the development of technological innovations. There is an imperative to create an Asia-Europe CDM

	Task Force or Observatory that could serve as a platform for multistakeholder dialogue, capacity-building, technology investment facilitation, monitoring of investment uptake, and dissemination of good practices and other important investment information, as well as other functions that facilitate technology cooperation and exchange. How could this platform gain support from existing processes such as the Renewables Coalition, through facilities of the EU, ADB, ASEAN programmes and East Asian regional instruments, the International Chamber of Commerce, and civil society networks? How could it be championed by the Asia-Europe Meeting (ASEM)?
	Moderator:
	Mr. Bertrand Fort *Director for Intellectual Exchange*, ASEF
09:15-11:15	Scoping Paper 5 What went well, what went wrong: A review of technology transfer successes and failures
	Mr. Robert Koh *General Manager*, Regional Institute for Environmental Technology (RIET), Singapore
	Scoping Paper 6 Practical elements for setting up an Asia-Europe technology exchange for Renewables
	Dr. Philippe Bergeron *Project Director*, ASEAN network for CDM investment Promotion (ACE-Jakarta)
	Discussion
11:15-11:30	COFFEE BREAK

Session 4: Wrap-Up

Moderator:

Dr. David Stanners
Head of International Co-operation, EUROPEAN ENVIRONMENT AGENCY (EEA)

What are the major findings of the roundtable on sustaining the technology innovation process for renewable energy and the concrete steps for an Asia-Europe technology cooperation platform for renewables & CDM. What could be presented to the larger public, on one hand, & to policy-makers, on the other?

11:30-12:30 Discussion/Brainstorming

12:30-14:15 LUNCH

Euroscience Open Forum (ESOF) 2004 Scientific session: "It's not easy being green?
Prospects and Perspectives for Green Technology in Asia-Europe"

While the roundtable focuses on the policy prescriptions, the scientific discussion on the technologies themselves will be communicated in a panel organised as one of the 45 scientific sessions to be held throughout the ESOF 2004.

Moderator:

Ms. Ella Antonio
Area Manager for Asia and the Pacific, EARTH COUNCIL THE PHILIPPINES

14:45-17:45 The International Landscape for Renewable Energy, Poverty Alleviation, and Sustainable Development

Dr. Emil Salim
Eminent Person, EXTRACTIVE INDUSTRIES REVIEW, WORLD BANK GROUP & *Former Chairperson,* WORLD SUMMIT ON SUSTAINABLE DEVELOPMENT (WSSD) PREPARATORY COUNCIL, INDONESIA

Innovation for Renewables: Economics and Institutional Support

Prof. Michael Grubb
Policy Director, THE CARBON TRUST, UNITED KINGDOM

Investing in Research and Development (R&D) to advance Renewables Technology - lessons and opportunities

Prof. Frank Convery
UNIVERSITY COLLEGE DUBLIN, IRELAND

Dr. Morgan Bazilian
Head of Renewable Energy, SUSTAINABLE ENERGY AUTHORITY OF IRELAND (SEI)

Discussion

Challenges for New Technologies for a Sustainable Energy System

Prof. Morihiro Kurushima
TOYO UNIVERSITY, JAPAN

Rice husk fuel-power

Mr. Jackrit Watanatada
Executive Committee Member, AT BIOPOWER, THAILAND

Green Energy in Europe

Mr. Arjin B. J. Van As
Technical Commercial Manager, GREENPRICES.COM, THE NETHERLANDS

Discussion

Technology Partnerships for Renewables: Key to Energy Security
(Report on the 3rd Asia-Europe Environment Roundtable)

European rapporteur:
Philippe Bergeron

Asian rapporteur:
Jackrit Watanatada

Discussion

Closing

Amb. Dr. Delfin Colomé
Executive Director, ASEF

....

LIST OF PARTICIPANTS

SPEAKERS

1. Dr. Philippe Bergeron, Project Director, ASEAN Network for CDM Investment Promotion (ACE-Jakarta)

2. Prof. Frank Convery, Heritage Trust Prof of Environmental Policy and Chair of Sustainable Energy Authority of Ireland, University College Dublin, Ireland

3. Mr. Peter Danielsson, President of EREF, Sveriges Energiforeningars RiksOrganisation (SERO), Sweden

4. Mr. Guido Delgado, Former President, National Power Corporation, The Philippines

5. Dr. Dörte Fouquet, Senior Partner and Director, Kuhbier law firm/EREF-European Renewable Energies Federation, Belgium

6. Prof. Michael Grubb, Associated Director of Policy, The Carbon Trust United Kingdom

7. Mr. Robert Koh, General Manager, Regional Institute of Environmental Technology (RIET), Singapore

8. Prof. Morihiro Kurushima, Professor, Toyo University, Japan

9. Mr. Krister Nilsson, State Secretary, Ministry of the Environment, Sweden

10. Prof. Jiahua Pan, Senior Research Fellow and Executive Director, Research Centre for Sustainable Development Chinese Academy of Social Sciences, China

11. Prof. Emil Salim, Eminent Person, Extractive Industries Review & Former Chair, World Bank Group&WSSD Preparatory Council, Indonesia

12. Mr. Arjin B. J. Van As, Technical Commercial Manager, GreenPrices Ecofys B. V., The Netherlands

13. Mr. Jackrit Watanatada, Member of the Executive Committee, Business Development and Project Finance, AT Biopower, Thailand

ROUNDTABLE DISCUSSANTS

14. Mr. Peter Ahm, Director, PA Energy A/S, Denmark

15. Mr. Mike Enskat, Advisor, Energy Policy Division for Environment and Infrastructure, Deutsche Gesellschaft für Technische Zusammenarbeit (GTZ) mbh, Germany

16. Mr. Alimin Ginting, Chairman, Indonesia Geothermal Association (INAGA), Indonesia

17. Mr. Takahiko Hiraishi, Senior Consultant, Institute for Global Environmental Strategies, Japan

18. Tan Sri Datuk Dr. Ahmad Zaharudin Idrus, Chairman, F3 Strategies Berhad, Malaysia

19. Mr. Johannes Lackmann, President, German Renewable Energy Federation, Germany

20. Dr. Philip Lewis, Group Director and Assistant Professor, VaasaEmg/Department of Marketing, Finland

21. Ms. Christine Lins, Secretary General, EREC - European Renewable Energy Council, Austria

22. Mr. Preben Maegaard, President, World Wind Energy Association, Denmark

23. Dr. Poul Erik Morthorst, Senior Research Specialist - System Analysis Department, Riso National Laboratory Denmark

24. Mr. Lorenzo Pagliano, Director of End-use Efficiency Research Group, Politecnico di Milano-Dipartimento di Energetica-end-use Efficiency Research Group, Italy

25. Mr. Claes Pihle, Senior Expert, Ministry of the Environment, Sweden

26. Mr. Peter Melchior Roedder, Renewable Energy Specialist, Consultant Dowes Aps., Denmark

ASEF/SI-SPONSORED ASIAN SCIENTISTS (Roundtable Discussants)

27. Dr. Xuhui Cai, Associate Professor, Peking University, China

28. Mr. Li Dan, Assistant Professor, Chinese Academy of Sciences, China

29. Dr. Zhaoguang Hu, Vice President and Chief Economist, State Power Economic Research Center, China

30. Mr. Sivapalan Kathiravale, Research Officer, MINT Incineration and Renewble Energy Centre (MIREC), Malaysia

31. Mr. Van Tien Nguyen, Senior Researcher, Institute of Materials Science, VAST, Viet Nam

32. Ms. Maria Retnanestri, Ph.D. Research Student, University of New South Wales, Australia

33. Mr. Ramon Faustino Jr. M. Sales, Assistant Director and Assistant Vice-president; a Philippine Rural Reconstruction Movement (PPRM) and Philippine Network on Climate Change, The Philippines

34. Dr. Heru Santoso, Research Staff, Research Centre for Geotechnology Indonesian Institute of Sciences, Indonesia

35. Mr. Armi Susandi, Ph.D. Student, University of Hamburg, Germany

36. Dr. Jason Hui Hong Yapp, Adviser (Renewable Energy Consultant), Foundation for Community Studies and Development, Malaysia, Malaysia

ASEF/SI-SPONSORED ASIAN SCIENTISTS

37. Mr. Raul Badilla Alamban, Assistant Director, PCARRD, The Philippines

38. Mr. Shingo Hamada, Affiliated Researcher, Science and Technolgy Foresight Centre, Japan

39. Dr. Tung Hoang, Rector's Assistant for Research and International, University of Fisheries, Viet Nam

40. Dr. Maihe Li, Research Scientist, Chengdu Institute of Mountain Hazards and Environment, China

41. Mr. Junguo Liu, Ph.D. Student, Swiss Federal Institute for Environmental Science and Technology, China

42. Dr. Kobkaew Manomaipiboon, Assistant Professor, Mahidol University, Thailand

43. Dr. Opart, Panya, Assistant Profesor, Mahidol University, Thailand

44. Mr.Katsumasa Tanaka, Ph.D. Student, IMPRS, Max Planck Institute for Meteorology, Germany

45. Dr. Chavalit Vidthayanon, Head of Marine and Freshwater Unit, WWF Thailand Programme, Thailand

46. Dr. Maria Lea Villauicencio, University Researcher I/Dvision Head, University of the Philippines, Los Baros College, The Philippines

OBSERVERS

47. Dr. Morgan Bazilian, Head of Renewable Energy, Sustainable Energy Authority of Ireland

48. Ms. Martina Krueger, Greenpeace, Sweden

49. Ms. Patrin Watanatada, Master's Candidate 2005, Fletcher School of Law and Diplomacy, Tufts University, United States

JOURNALISTS

50. Mr.David Fouquet, Director-Editor, Asia-Europe Project Information Service, United Kingdom

51. Ms. Yanning Luo, Journalist, Sanlian Week, China

ASIAI-EUROPE ENVIRONMENT FORUM STEERING COMMITTEE MEMBERS

52. Ms. Ella Antonio, Area Manager for Asia and the Pacific, Earth Council, The Philippines

53. Dr. David Stanners, Head of International Co-operation, European Environmental Agency, United Kingdom

ORGANISERS

54. Mr. Erland Ringborg, Governor, Asia-Europe Foundation, Sweden

55. Amb. Dr. Delfin Colomé, Executive Director, Asia-Europe Foundation

56. Mr. Bertrand Fort, Director Intellectual Exchange (IE), Asia-Europe Foundation

57. Ms. Sol Iglesias, Project Manager, IE, Asia-Europe Foundation

58. Ms. Ira Martina Drupady, Project Assistant, IE, Asia-Europe Foundation

59. Mr. Hideyuki Mori, Director, Asia-Pacific Forum on Environment and Development Secretariat & Project Leader, Institute of Global Environmental Strategies, Japan

60. Dr. Roger Kasperson, Executive Director, Stockholm Environment Institute, Sweden

61. Ms. Helena Forslund, Research Associate, Stockholm Environment Institute, Sweden

62. Mr. Eric Usher, Energy Programme Deputy Coordinator, United Nations Environment Programme

....

GLOSSARY OF TERMS USED

ACE	=	ASEAN Centre for Energy
ADB	=	Asian Development Bank
ADEME	=	French Environment and Energy Management Agency
AER	=	Alternative Energy Requirement
AETER	=	Asia-Europe Technology Exchange for Renewables
ANES	=	Asociación Nacional de Energía Solar
APCTT	=	Asian and Pacific Centre for Transfer of Technology
APDC	=	Asia-Pacific Development Centre
APENPLAN	=	Asian and Pacific Energy-Environment Planning Network
ASEF	=	Asia-Europe Foundation
ASEM	=	Asia-Europe Meeting
ASSOCHAM	=	Associated Chambers of Commerce & Industry of India
ASTAE	=	Asia Alternative Energy Programme
BIGCC	=	Biomass Integrated Gasification Combined Circle
BMU	=	German Federal Ministry for the Environment, Nature Conservation and Nuclear Safety
BOT	=	Build-Operate-Transfer
CEE	=	Central and Eastern European
CIS	=	Commonwealth of Independent States
CONAE	=	Mexican National Commission for Energy Saving
CO_2	=	Carbon Dioxide
COP10	=	Tenth Conference of Parties to the UN Framework Convention on Climate Change
CDM	=	Clean Development Mechanism
CEO	=	Chief Executive Officer
c/kWh	=	cent per kilo Watt hour
CRW	=	Combustible Renewables and Wastes
CSD	=	Commission for Sustainable Development

CTI	=	Climate Technology Initiative
DCF	=	Discounted Cash Flow
DCMNR	=	Department of Communications, Marine and Natural Resources
DOE	=	Department of Energy (US)
DSM	=	Demand Side Management
EC-ASEAN	=	European Commission-Association of Southeast Asian Nations
ED	=	Economic Development
EDB	=	Economic Development Board (of Singapore)
EE	=	Energy Efficiency
EGTT	=	Expert Group on Technology Transfer
EIB	=	European Investment Bank
EIR	=	Extractive Industry Review
EPR	=	European Pressurised Water Reactor
ERA	=	European Research Area
EREF	=	European Renewable Energies Federation
ESB	=	Electricity Supply Board
ESOF	=	EuroScience Open Forum
EST	=	Energy Saving Trust
EWEA	=	European Wind Energy Association
FIT	=	Feed-In Systems
EJ/yr	=	Exajoules per year
ET	=	Emissions Trading
EU	=	European Union
FDI	=	Foreign Direct Investment
GBP	=	Great British Pound
GDP	=	Gross Domestic Product
GEF	=	Global Environment Facility
GHG	=	Greenhouse Gas
GJ/ha/yr	=	Giga Joules per hectare per year
GNP	=	Gross National Product
GtC	=	Giga-tonnes of Carbon
GtC/yr	=	Giga-tonnes of Carbon per year
GW	=	Giga Watts
GWh/year	=	Giga Watts hour per year
IBRD	=	International Bank for Reconstruction and Development
ICETT	=	International Centre for Environmental Technology Transfer
IDA	=	International Development Agency

IEA	=	International Energy Agency
IEF	=	India Energy Forum
IFC	=	International Financial Corporation
IIASA	=	International Institute of Applied Systems Analysis
IMF	=	International Monetary Fund
IPCC	=	Intergovernmental Panel on Climate Change
IPR	=	Intellectual Property Rights
ISES	=	International Solar Energy Society
JBIC	=	Japan Bank for International Co-operation
JI	=	Joint Implementation
KITE	=	Kumasi Institute for Technology and Environment
KfW	=	Kreditanstalt für Wiederaufbau bank
kWh	=	kilo Watt hour
kW/m^2	=	kilo Watt per metre square
LIP	=	Local Investments Programme
LCPD	=	Large Combustion Plant Directive
MEA	=	Multilateral Environmental Agreements
METI	=	Ministry of Economy, Trade and Industry
MIGA	=	Multilateral Investment Guarantee Agency
MJ/l	=	Mega Joules per litre
mtoe	=	million tonnes of coal equivalent
MWh	=	Mega Watts hour
NECD	=	National Emissions Ceilings Directive
NEDO	=	New Energy and Industrial Technology Development Organisation
NFFO	=	Non-Fossil-Fuel Obligation
NGO	=	Non-Governmental Organisation
NIST	=	National Institute of Standards and Technology
NOx	=	Nitrogen Oxides
NYPA	=	New York Power Authority
ODA	=	Official Development Assistance
odt	=	oven-dry tonnes
O&M	=	Operation and Maintenance
OECD	=	Organisation for Economic Co-operation and Development
PCF	=	Prototype Carbon Fund
PPP	=	Public-Private-Partnership
PTC	=	Production Tax Credit
PV	=	Photovoltaic
R&D	=	Research and Development
REEEP	=	Renewable Energy and Energy Efficiency Partnership

RE	=	Renewable Energy
REED	=	Rural Energy Enterprise Development
RES	=	Renewable Energy Systems
RES-E	=	Renewables-based Electricity
RIET	=	Regional Institute of Environmental Technology
RMB/kWh	=	yuan per kilo Watt hour
ROI	=	Return On Investment
RPS	=	Renewables Portfolio Standard
RUE	=	Rational Use of Energy
SB20	=	Twentieth Sessions of Subsidiary Bodies
SEI	=	Sustainable Energy Authority of Ireland
SEI	=	Stockholm Environment Institute
SME	=	Small and Medium-sized Enterprise
S&T	=	Science & Technology
SO_2	=	Sulphur Dioxide
TNA	=	Technology Needs Assessment
TPES	=	Total Primary Energy Supply
TT:CLEAR	=	Technology Information Clearinghouse
TWh	=	Terra Watt hour
TWh/yr	=	Terra Watt hour per year
UNDP	=	United Nations Development Programme
UNEP	=	United Nations Environment Programme
UNIDO	=	UN Industrial Development Organisation
UK	=	United Kingdom
UNFCCC	=	United Nations Framework Convention on Climate Change
US	=	United States of America
USG	=	United States Goverment
WB	=	World Bank
WEC	=	World Environment Centre
WCED	=	World Commission on Environment and Development
WSSD	=	World Summit on Sustainable Development
WTO	=	World Trade Organisation

....

ABOUT THE AUTHORS AND EDITORS

Morgan Bazilian
Head of Renewable Energy
SUSTAINABLE ENERGY AUTHORITY OF IRELAND (SEI), IRELAND

Morgan Bazilian is currently serving as department head of energy policy development at Ireland's national energy agency, Sustainable Energy Authority of Ireland (SEI). Previously, he headed the renewable energy and CHP department at the Authority. He also maintains an adjunct position at the Electricity Research Centre at UCD. Morgan holds a PhD in the area of energy studies and has been a Fulbright fellow. Prior to joining SEI, Morgan worked as a research scientist at SINTEF (Norway). He has held a number of professional and academic positions all focused on the technical and economic aspects of renewable energy supply and delivery. He is currently the Chair of the Programme Board of REEEP.

Philippe Bergeron
Project Director
ASEAN NETWORK FOR CDM and INVESTMENT PROMOTION
(ACE JAKARTA)

Dr. Bergeron's experience in Environmental Management and Technology spans some twenty-five years as director and manager of environmental projects and programmes covering a wide range of "brown" environmental issues. With professional experience in 45 countries including 18 in Asia, Dr. Bergeron core competence is environmental policing, planning and financing, environmental management and good practice, environmental investment and environmental business facilitation and development, especially in Asia.

Between 1993 and 2002, Dr. Bergeron was the Director of the Regional Institute of Environmental Technology (RIET) in Singapore. RIET is a public not-for-profit organisation acting as an environmental business facilitator, think tank, strategic consultancy, training organisation, publisher and developer of conferences across Asia that Dr. Bergeron designed and launched with the initial support of the Singapore Government and the European Commission. In the period 1999–2002, Dr. Bergeron managed as regional partner for Asia, the GREENTIE information centre on suppliers of greenhouse gases (GHGs) mitigating technology and services. The GREENTIE network is an initiative of 11 OECD countries under the International Energy Agency (IEA) to provide support to emerging countries to meet their greenhouse gas emission targets, offer a platform to promote latest clean energy technology applications and disseminate supplier information to facilitate international transfer of energy technologies.

Currently Dr. Bergeron is Board member of RIET and an independent consultant. He is currently the Project Director of an Initiative sponsored by the ASEAN Centre for Energy (ACE) Jakarta to brainstorm and structure a regional facility to stimulate the financing and uptake of GHG emission saving investment under the CDM and other flexible mechanisms of the Kyoto protocol.

Dr. Bergeron is also assisting the ASEAN secretariat to design and develop a facility to promote environmental investment in Environmentally Sound Technology (EST) with market making and fertilizing activities to stimulate the growth of SMEs that use, supply or trade EST solution on a commercial basis, to facilitate innovative financial services and associated business support services by and/or for SMEs and to foster enabling environmental regulatory measures and non-market distorting incentives schemes to support a broad EST uptake in the ASEAN region.

Yong Chen
Research Associate
STOCKHOLM ENVIRONMENT INSTITUTE (SEI), SWEDEN

Yong Chen holds a MSc degree in Environmental Management and Policy from Lund University and specialises in energy and environmental policy making in developing countries. Prior to joining Stockholm Environment Institute in 2002, he worked for several years within the Chinese Environmental Protection Administration, where he was in charge of bilateral and multilateral assistance in the environmental sector and participated in negotiations of international environmental treaties. At SEI, Yong Chen is mainly engaged in research projects in the field of renewable energy, and in implementation of projects on environment and sustainable development in China and other Asian countries.

Frank Convery
Heritage Trust Professor of Environmental Policy
UNIVERSITY COLLEGE DUBLIN (UCD), IRELAND

and

Chair of Sustainable Energy Authority of Ireland (SEI)

Frank Convery is the Heritage Trust Professor of Environmental Policy at University College, Dublin, and chair of the Sustainable Energy Authority of Ireland. He has co-ordinated the European Union research networks on market based instruments for environmental policy and emissions trading respectively. He is a member of the Network of World Class Economists designated by the European Commission and the European Environment Agency to advise on policy. He has a passionate interest in mobilising markets to conserve natural resource and environmental endowments.

Peter Danielsson
President
EUROPEAN RENEWABLE ENERGIES FEDERATION (EREF), SWEDEN

Peter Danielsson has been the President of EREF (European Renewable Energies Federation) since 2004, board member of SERO (Swedish Renewable Energies Association) since 1998 and owner of a company in the renewable energy business since 1987.

From 1962-1988, he has held different positions in the pulp and paper and packaging industry as general manager, general sales manager, general production manager and production manager. He holds a degree in MS Technology from the Royal Institute of Technology, Stockholm.

Guido Delgado
Chairman
WORLDWATER PHILIPPINES INC., THE PHILIPPINES

Guido Alfredo A. Delgado is currently President and CEO of G. A. A. Delgado Inc.- a management and investments consultancy company; Chairman of Worldwater Philippines, Inc.,- a subsidiary of Worldwater Corporation USA, a solar water management company; Chairman of Philippine Power Distributors Investments Corporation - the first and only company in the country engaged primarily in management and investment services in the power distribution sector; Chairman of RISE Foundation - a venture capital company based in Mindanao, Philippines with focus on small and medium enterprises; Rehabilitation Receiver of First Dominion Prime Holdings Inc- the largest tuna canning and exporting company in the Philippines until the year 2000; Treasurer of Microenterprise Bank; Director of Fuego Hotels & Properties Management Corp.- a hotel and hospitality management company; Director of A Brown Company, Inc – a publicly-listed company engaged in property development and investment and trading of goods like petroleum products; and, Director of PAREF Northfiled School for Boys.

Mr. Delgado graduated Cum Laude from the University of the Philippines with the degree of Bachelor of Science in Agricultural Business and completed his Masters Degree in Management Science (Finance) from the University of Manchester Institute of Science & Technology, United Kingdom.

Past positions held include: President and CEO of the Philippine government's National Power Corporation (NPC, 1994–1998); Board of Director, NPC and National Electrification Administration (1994–1998); Managing Director of Mindanao Development Bank (1985–1994); Co-Chairman, Regional Development Council of Region X; and, President, Cagayan de Oro City Chamber of Commerce and Industry, Inc.

Bertrand Fort
Director for Intellectual Exchange
ASIA-EUROPE FOUNDATION

AND

Co-ordinator
ASIA-EUROPE ENVIROMENT FORUM

Bertrand Fort has been the Director for Intellectual Exchange at the Asia-Europe Foundation since 2002. He attained his bachelor degree in economics from Paris I Pantheon-Sorbonne University and in communications and information (Paris II Assas) in 1985. He also attained a diploma at the Institute of Political Sciences (IEP-Paris) and received a postgraduate diploma in sociology of organisations from the same institution in 1988. Starting his career as an Assistant of a member of the French Parliament, Bertrand Fort became Deputy-Counsellor for Press Relations for the French Defence Minister (1989-1990) and was Communications Chief in the French Parliament (1991-1996).

In 1996, he went on a year-long sabbatical as a journalist travelling through countries such as India, Nepal, Burma, Laos, Vietnam, Malaysia and Indonesia. He covered external relations as well as investigations and interviews for the monthly *L'Asie* magazine (1997-1998). Bertrand Fort joined the staff of the French Foreign Affairs Minister, Hubert Vedrine, as Counsellor for Political Affairs, in charge of relationships with parliamentarians (French and European), think-tanks, foundations and civil society organisations from 1998-2002, a post he held while concurrently a postgraduate lecturer on international affairs at the Institut d'Etudes Politiques in Paris and Lille for three years.

He has co-edited the book, "Paths to Regionalisation: Comparing Experiences in East Asia and Europe", published by Marshall-Cavendish in early 2005. Forthcoming, later this year are "Regional Integration in Europe and East Asia: Convergence or Divergence?" (co-edited) from Routledge as well as "Democracy in Asia, Europe and the World: Toward a Universal Definiton?" (co-edited) and "Overcoming Vulnerability: Managing New Security Challenges in Asia and Europe" from Marshall-Cavendish.

Dörte Fouquet
Senior Partner and Director
Kuhbier law firm, Belgium

Dr Dörte Fouquet is a German lawyer, based since 1991 in Brussels. She is Senior Partner of the international law firm, Kuhbier (www.kuhbier.com).

Mrs. Fouquet is specialised in European and International law, especially concerning energy and environment, state aid, competition law, WTO and related matters.

Mrs. Fouquet has a strong profile in the field of renewable energies, energy efficiency and sustainable energy development. Before becoming an independent lawyer, she worked for many years in high level positions in the administration for energy and environment of the German town and region of Hamburg.

She regularly advises the European Commission on legal issues with a specific focus on energy law. She worked in many Central and Eastern European countries on legal approximation. She works regularly as advisor to European governments, especially the German government. She regularly works as legal advisor for industries and other companies.

Since 1999, she represents the European Renewable Energies Federation (EREF) in Brussels, an umbrella organisation of national associations of producers of green electricity and fuel. She represented EREF on the steering committee and as stakeholder for the International Bonn conference for Renewables (June 2004). She is also member of the steering committee of the UN ECE for renewable energies in Geneva.
EREF web page: www.eref-europe.org

Prof. Michael Grubb
Policy Director
THE CARBON TRUST, UNITED KINGDOM

Michael Grubb is a leading researcher on economic, technology and policy aspects of climate change and related energy and international issues. He is the Associated Director of Policy at the UK Carbon Trust, a half-time post, complemented by contracted research work through his academic affiliations, namely, Imperial College, London; Royal Institute of International Affairs, London; and Cambridge University.

Until September 1998, he was Head of Energy and Environmental Programme at the Royal Institute of International Affairs at Catham House in London where he also remains Associate Fellow. He was subsequently Professor of Climate Change and Energy Policy at Imperial College before joining The Carbon Trust in January 2002.

Prof. Grubb has been a lead author for several reports of the Intergovernmental Panel on Climate Change (IPCC), addressing the economic, technological and social aspects of limiting greenhourse gas emissions. He is Editor-in-chief of the journal *Climate Policy* and is on the editorial board of *Energy Policy*. Advisory positions include the UK government (Green

Globe Network), the European Commission (including member of EC delegation to climate change negotiations) and consultant to BP and the Shell Foundation. He is also a member of Advisory Council, International Association for Energy Economics and Council Member, British Institute of Energy Economics (1995-1998).

Prof. Grubb is the author of seven books and about forty journal research articles. His book *The Kyoto Protocol: A Guide to Assessment* is the principle published analysis of the protocol and has been translated into Japanese and Russian. For more details and a publication list, please visit http://www.env.ic.ac.uk/research/epmg/michaelcv.html

Francis X. Johnson
Research Fellow, Energy and Climate
STOCKHOLM ENVIROMENT INSTITUTE (SEI), SWEDEN

Francis X. Johnson is Research Fellow in Energy and Climate at Stockholm Environment Institute in Stockholm, Sweden, and has previously been a Senior Research Associate in Energy Analysis at Lawrence Berkeley National Laboratory in Berkeley, CA and in Washington, DC. He has fifteen years of experience in energy-environmental policy analysis, with an emphasis on climate mitigation strategies, building sector energy efficiency measures, bio-energy options, and renewable energy portfolios for developing countries. His educational training includes a BSE (Systems Science and Engineering); an MS (Operations Research); an MA (Public Policy); and, completion of PhD examinations (Geography and Environmental Engineering). Recent projects are bio-energy studies in several developing countries, sustainable governance strategies for renewable energy, and development of international co-operation platforms for renewable energy and energy efficiency in Southeast Asia and southern Africa. He is currently scientific co-ordinator for a consortium of thirteen international partners for a four-year programme on multi-sector bio-energy resource strategies.

Robert Koh
General Manager
REGIONAL INSTITUTE OF ENVIRONMENTAL
TECHNOLOGY (RIET), SINGAPORE

Robert Koh has worked in RIET for almost eight years and is a specialist in facilitating technology transfer programmes for environmental technology and best practices in Asia. He has personally managed numerous such activities across Asia and Europe, especially SE Asia and China.

Holder of a mechanical engineering degree in Singapore, Robert Koh also conducted numerous market studies on Asian countries' demand and drive for environmental technology solutions as well as speaking in many environmental-related conferences and seminars.

As RIET used to be a European Commission initiated institute (1993-2002), Robert Koh has acquired much experience in understanding the role and success of European technology providers (environment) in Asia and is also instrument in assisting many European organisations to understand and penetrate the Asia market with much success. He has also worked with many institutional organisations across Europe as well as Asia.

Morihiro Kurushima
Professor
TOYO UNIVERSITY, JAPAN

Morihiro Kurushima received his Masters Degree from the Kyoto University, Graduate School of Engineering. He Joined the Ministry of International Trade and Industry (MITI) in 1976. He was the MITI Representative for Metal and Mining Affairs in London from 1988-1991; Director-General of the Natural Resources and Energy Department, Kanto Bureau of International Trade and Industry, MITI from 1995-1997; Director General of the Global Environment Technology Department, New Energy and Industrial Technology Development Organization (NEDO) from 1997- 1999; Professor in the Department of Computer, Information and Communication Sciences at Tokyo University of Agriculture & Technology from 1999-2001; Director General of the Policy Planning Department of New Energy and Industrial Technology Development Organization (NEDO) from 2001-2003; and, Professor in the Department of Regional Studies at Toyo University from 2003 to present.

Professor Kurushima's international activity includes attendance as Delegate from Japanese to the Conference of the Parties (COP) to the United National Framework Convention on Climate Change (UNFCCC) since November 1997. He also has been the chair to the steering committee of the CTI/Industry Joint Seminar Series (IEA/OECD) since February 1998.

He received the "1997 Stratospheric Ozone Protection Award" from the US Environmental Protection Agency.

He was appointed as the member of National Committee on Energy and Resources Engineering, Science Council of Japan since October 2003.

Krister Nilsson
State Secretary
MINISTRY OF SUSTAINABLE DEVELOPMENT, SWEDEN

Krister Nilsson graduated with an undergraduate degree in Asian-African studies from Uppsala University, Sweden. He then went on to do his graduate degree in international law at the same institution. Mr. Nilsson began his political career as the International Secretary for the youth group for the social democratic party in 1993. He then went on to be one of the party's political adviser's in the European parliament. Mr. Nilsson was appointed as a political adviser to the Ministry of Environment, Sweden in 2002. He is currently the State Secretary for the Ministry of Environment, Sweden.

Jiahua Pan
Executive Director
RESEARCH CENTRE FOR SUSTAINABLE DEVELOPMENT
CHINESE ACADEMY OF SOCIAL SCIENCES (CASS), CHINA

Jiahua Pan is the Executive Director of the Research Centre for Sustainable Development at the Chinese Academy of Social Sciences (CASS) and Professor of Economics at CASS Graduate School. He received his PhD at Cambridge University in 1992. His research interests cover economic and social dimensions of sustainable development, energy and development, climate policy, and economics of the environment and natural resources.

He worked for the UNDP Beijing Office as an advisor on environment and development and for the IPCC (Intergovernmental Panel on Climate Change) Working Group (WG) III as a senior economist in the Technical Support Unit and a co-editor of IPCC WG III Third Assessment Report. He serves as a lead author of the IPCC WG III 4th Assessment Report. His recent research projects include CDM Policy in China and Human Development with low emissions as a scenario for post-Kyoto. He has held senior positions in a number of professional associations including vice presidency of Chinese Society for

Ecological Economists. He has authored over 150 papers and articles in academic journals, magazines and newspapers.

Lisa Ryan
Research Fellow/PhD Candidate
Department of Planning and Environmental Policy
UNIVERSITY COLLEGE DUBLIN (UCD), IRELAND

Lisa Ryan has her primary degree in chemical engineering from University College, Dublin. She did a Masters of Science in Chemical Engineering at Colorado School of Mines, Colorado, USA, where her focus of research was the regulation and measurement of heavy-duty vehicle emissions. From 1998, she worked for Volkswagen AG in Wolfsburg, Germany in the engine development division where she was responsible for European technical policy developments. Lisa returned to UCD in 2002 as a research fellow/PhD candidate in the Department of Planning and Environmental Policy. She completed a Masters in Economic Science in 2004. Her research focuses mainly on the application of economic instruments to achieve optimal national and European targets in energy and transport greenhouse gas emissions. Another area of research focuses on the mobilisation and impact of technological change on greenhouse gas emissions and energy sustainability.

Emil Salim
Eminent Person
EXTRACTIVE INDUSTRIES REVIEW, WORLD BANK GROUP

and

Former Chair
WSSD PREPARATORY COUNCIL, INDONESIA

Prof. Salim obtained his PhD in Economics from the University of California, Berkeley, 1964. He teaches post graduate courses for environmental sciences at the University of Indonesia. He is also an economic advisor to the government of Indonesia (still active) and Chairman of the Association of Community Empowerment.

....

ABOUT THE CO-ORGANISERS

ASIA-EUROPE FOUNDATION

The Asia-Europe Foundation (ASEF) was established in 1997 as the sole institution of the Asia Europe Meeting (ASEM) and acts as its manifestation toward civil society. ASEF works for intellectual, cultural, and people-to-people exchange among our member-countries in Asia and Europe. In particular, Intellectual Exchange aims to contribute to policy debate and strategic thinking on themes of current and future inter-regional importance between Asia and Europe. For more information on ASEF, please visit http://www.asef.org

INSTITUTE FOR GLOBAL ENVIRONMENTAL STRATEGIES

Established in 1998, the Institute for Global Environmental Strategies (IGES) is an independent, not for profit think tank, based in Japan, that goes beyond research to provide practical ways to protect the earth's environment and to realize greater sustainability and equity in the global community. While the outlook of IGES is global, the principal geographical scope of its activities is Asia and the Pacific region, an area which is experiencing rapid economic development and which will affect the global environment through its population growth, urban environmental problems and other environmental issues. For more information on IGES, please visit http://www.iges.or.jp.

The participation of the IGES in this endeavor is made possible with the support of the government of Japan.

STOCKHOLM ENVIRONMENT INSTITUTE

The Stockholm Environment Institute (SEI) is an independent, international research institute specialising in sustainable development and environment issues. It works at local, national, regional and global policy levels. The SEI research programmes aim to clarify the requirements, strategies and policies for a transition to sustainability. These goals are linked to the principles advocated in Agenda 21 and the Conventions such as Climate Change, Ozone Layer Protection and Biological Diversity. For more information on SEI, please visit http://www.sei.se

UNITED NATIONS ENVIRONMENT PROGRAMME

The United Nations Environment Programme (UNEP) mission is to provide leadership and encourage partnership in caring for the environment by inspiring, informing, and enabling nations and peoples to improve their quality of life without compromising that of future generations. For more information on UNEP, please visit http://www.unep.org

What is the Asia-Europe Environment Forum?

The Asia-Europe Environment Forum is a platform for dialogue and debate on issues pertaining to sustainable development and the environment in Asia and Europe. The series is organised by the Asia-Europe Foundation (ASEF), the Hanns Seidel Foundation (HSF), the Institute for Global Environmental Strategies (IGES) of Japan (with support of the Japanese government), and the United Nations Environment Programme (UNEP). The forum is advised by a steering committee of representatives from the Association of Southeast Asian Nations (ASEAN) Secretariat, the Asian Development Bank (ADB), the Hamburg Institute of International Economics (HWWA) International Climate Policy Programme, the European Environment Agency (EEA), and the Earth Council. The Regional Institute of Environmental Technology (RIET), the Swedish Environment Secretariat in Asia (SENSA) and KEHATI-The Indonesian Biodiversity Foundation, joined the steering committee in 2004.

Visit us online at
http://env.asef.org

For more information, please contact:

Intellectual Exchange
Asia-Europe Foundation
31 Heng Mui Keng Terrace
Singapore 119595
Tel : +65 6874 9707
Fax : +65 6872 1207
E-mail : env@asef.org

SGD $20.00 / 9.40 €
ISBN 981-05-4099-X
9 789810 540999 >