Economic and Political Aspects of the Transition to Renewable Energy Systems

- Policies and Measures for Renewable Energy and Energy Efficiency in South Africa
- Research and Development Needs for Renewable Energy Technology in Industrialized Countries
- The Challenge of Renewable Energies Integration in Energy Distribution Systems
- Integrating Renewable Energy into Society
- Promotion of Renewable Energies for Heating and Cooling
- Transitioning to a Renewable Energy Future
- Full Solar Supply of Industrialized Countries – The Example Japan

Policies and Measures for Renewable Energy and Energy Efficiency in South Africa

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Background

The South Africa democratic elections held of 1994 initiated a change in government policy across all sectors. With the new government in place, there was an in-depth review of all government policies in order to align them with basic principles of democracy and human rights. The new policy paradigm addressed issues of economic efficiency, access to affordable energy for all and environmental sustainability. This, however, was not an easy task for the newly elected government, especially in view of the economic and infrastructural constraints and challenges.

One of the key challenges that South Africa still faces is for development aspirations to bring on board racial equity, job creation, poverty reduction and economic prosperity while minimising the adverse environmental impacts. For a long period of time the South African energy scenario has been dominated by coal, one of the most carbon intensive fuels and associated with a high emission rate of carbon, responsible for the global environmental threat. While it is recognized that Africa does not contribute much to total global emissions, South Africa remains a notable exception, with carbon emissions per capita closer to industrialised countries that are the major contributor to this threat. This reason and others necessitate a change in policy framework in order to tailor it to fit the requirements of sustainable development, putting in the development domain issues of economic, environment as well as social development.

Renewable Energy Policy

In 1998 South Africa formulated a new energy policy, significantly different from the pre-1994 one, which provided energy services according to race. Major objectives of the new government policy for the energy sector were spelled out in the 1998 Energy White Paper as:

1) Increasing access to affordable energy services.
2) Improving energy governance – clarification of the relative roles and functions of various energy institutions within the context of

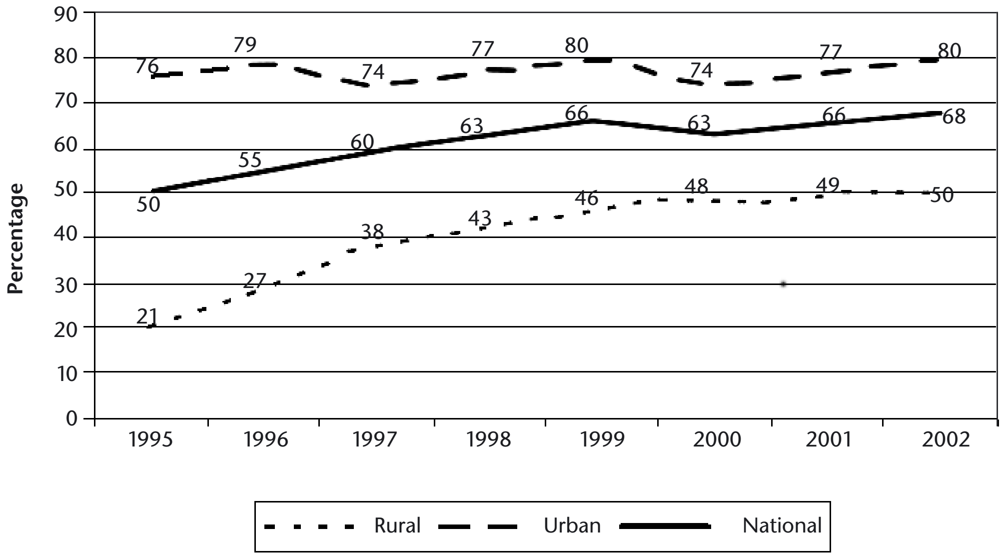


Figure 1
Trends in electrification of households in South Africa: 1995 – 2002

accountability, transparency and inclusive membership, particularly participation by the previously disadvantaged.

3) Stimulating economic development – encouragement of competition within energy markets.
4) Managing energy-related environmental and health effects – promotion of access to basic energy services for poor households while reducing negative health impacts arising from energy activities.
5) Securing supply through diversity – increased opportunities for energy trade, particularly within the Southern African region, and diversity of both supply sources and primary energy carriers.

The new energy policy helped to consolidate programs that were already in place in trying to improve provision of modern energy services to people. This included the National Electrification Program for 1994 – 1999, targeting to increase electrification level from 36 per cent in 1994 to about 66 per cent nationally by 2001. The target was exceeded, with 2.75 million connections achieved by end of Phase 1 of the Programme. By end of 2001 the National Electricity Regulator (NER) recorded 3.4 million connections.

Renewable energy policy

Recognizing the contribution potential of renewable energy sources to modern energy services in South Africa, the Government in 2003 released the White Paper on Renewable Energy. This had a number of objectives, including ensuring that an equitable level of national resources was invested in renewable technologies; directing public resources for implementation of renewable energy technologies; introducing suitable fiscal incentives for renewable energy and; creating an investment climate for the development of renewable energy sector. The key objectives of the White Paper were considered in the five major facilitative areas given below.

Financial instruments

- To ensure that an equitable level of national resources is invested in renewable technologies, given their potential and compared to investments in other energy supply.
- To set targets for directing of public resources for implementation of renewable energy technologies.
- To extend existing state financial support systems and institutions and introduce sustainable financing mechanisms for delivering renewable energy systems.
- To introduce suitable fiscal incentives for renewable energy.
- To make easy the creation of an investment climate for the development of renewable energy sector, which can attract foreign and local investors.

Legal instruments

- To develop an appropriate legal and regulatory framework for pricing and tariff structures to support the integration of renewable energy into the energy economy and to attract investors.
- To develop an enabling legislative and regulatory framework to integrate independent power producers into existing electricity system.
- To develop an enabling legislative framework to integrate local producers of liquid fuels and gas from renewable resources into their respective systems.

Technology development

- To promote the development and implementation of appropriate standards and guidelines and codes of practice for the appropriate use of renewable energy technologies.
- To support appropriate research and development and local manufacturing to strengthen renewable energy technology and optimise its implementation.

Awareness raising, capacity building and education

- To promote knowledge of renewable energy and increase their use.
- To promote and stimulate renewable energy market through dissemination of information on economic, environmental, social and trade benefits of renewable energy technologies and their applications.

- To persuade institutions to implement training and education programs on renewable energy.
- To actively involve women in decision making and planning on renewable energy activities.
- To improve communication and interaction between government and other institutions on renewable energy policies.

Policies and measures for renewable energy implementation

There is considerable potential for renewable energy sources in South Africa, from solar, wind, biomass, waves and hydro, but the key challenge is to translate this into technical, economic and market realities. Doing this would need careful thinking of policies and measures that could result in optimal tapping of the renewable energy sources, taking into account the prevailing national circumstances.

A number of policies and measures have been proposed by different players, and some of the extensively researched were those put forward in a study that was commissioned to Energy Research Centre (ERC, University of Cape Town) by the Sustainable Energy and Climate Change Partnership (SECCP), a partnership between Earthlife Africa Johannesburg and the World Wildlife Fund of Denmark[1]. The policies and measures proposed by ERC centred around attaining three main objectives:

- a portfolio of policies and measures for realising the potential for renewable energy and energy efficiency in South Africa.
- investigating how such policies and measures could form part of an effective climate change response by estimating the potential greenhouse gas (GHG) reductions.
- identifying and making projections of sustainable development impacts related to realising the renewable energy and energy efficiency potential.

With this background, and considering the unique South Africa energy circumstances, a number of policies and measures were proposed, including recommendations on how they could be implemented. The policies and measures were grouped into four main categories, as being market-based instruments, regulatory measures, institutional and legal measures, and voluntary measures, as shown below:

Market based instruments

- Financing energy efficient housing and appliances (bonds and loans),
- Incremental housing subsidy for energy efficiency upgrade in low cost housing,
- Concessionary loans for incremental costs efficient equipment and combined heat and power,
- Production subsidies for renewable electricity generation,
- Pollution taxes,
- Wires charge and additional sources of financing.

Regulatory instruments – targets, codes and standards

- Targets for renewable electricity generation,
- Strengthen commercial building codes,
- Residential building codes,
- Household appliance-labelling and mandatory energy performance standards,
- Commercial and industrial equipment labelling and mandatory energy performance standards,
- Government procurement standards for equipment and upgrading energy efficiency standards in government buildings,
- Compulsory fuel efficiency standards for corporate and institutional fleets,
- Particulate emission control and transport policy,
- Regulatory interventions to promote energy efficiency,
- Green tariffs, trading and renewable electricity.

Institutional and legal environment

- Strengthen the institutional framework for energy efficiency,

[1] This study was undertaken by the Energy Research Centre, Iniversity of Cape Town. The team of researchers involved included; Prof. Ogunlade Davidson (Project Leader), Prof. Kevin Bennet, Pierre Mukheibir, Stanford Mwakasonda, JC Nkomo, Randall Spalding-Fecher, Harald Winkler, Rodney Xali, Mark Howells, Alison Hughes and Frances Craigie.

- Renewable energy legislative framework,
- Research, development and demonstration,
- Awareness and education,

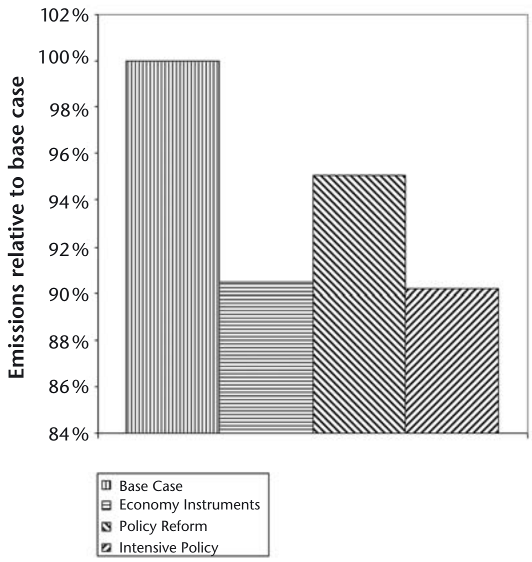
Voluntary agreements
The above policies and measures analysed with reference to three implementation scenarios in order to assess their impact of implementation. Modelling was used on certain aspects of the policies and measures. The three scenarios for implementation were as shown in *Tab. 1*.

Base case	Business as usual government policy, based on Department of Minerals and Energy (DME) official projections and public domain data
Economic instruments	Moderate; focus on economic instruments to correct market failures in relation to RE and EE
Policy reform	Moderate; focus on meeting targets for RE and EE cost-effectively
Intensive policy	Intensive; more focus on promoting RE and EE; stronger weighting of social and environmental concerns

Table 1
Scenarios for implementation of policies and measures for renewable energy and energy efficiency

It was observed that the three implementation scenarios each had benefits and costs across a range of different indicators. In the reduction of GHG emissions for example, setting a renewable energy target of 25 % for electricity generation over a 20 year period showed a significant level of lower local pollution (up to 10 %), as well as reductions in GHG emissions (6 – 10 %).

Figure 2
Relative emissions of carbon dioxide (cumulative over 20 Years)



After such analysis of different combinations of policies and measures, the following five policies and measures were recommended as priorities:

1) Mandatory codes and standards for energy efficient buildings in government, commercial and residential sectors
   - aiming to reduce commercial building energy consumption (excluding lighting)
2) Equipment standards for industry and commerce
   - development of mandatory performance standards for industrial equipment as well as a mandatory energy labelling system
3) Targets for renewable electricity generation
   - a target of renewable electricity generation providing 15 % of total electricity consumption by 2020
4) Production subsidies for renewable electricity
   - in order to make renewable electricity competitive
5) Pollution tax
   - A tax on air pollutants, levied per mass unit of emissions

Appropriate enabling conditions are an important prerequisite in order for any policies and measures to have the required impact. While recognising the role of market-based instruments, the right place for subsidies to contribute to their effectiveness is also crucial, especially in an immature market like the renewable energy. In any case, there can not be a "one-size-fits all" rule to the applicability of the above mentioned policies and measures. Each country need to make an in depth analysis of the prevailing circumstances before deciding on what to include in the shopping basket for policies and measures for either renewable energy or energy efficiency programs.

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Research and Development Needs for Renewable Energy Technology in Industrialized Countries

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Abstract

With a large number of users and high volumes of production, renewable energy technologies will be typical industrial mass products. Using photovoltaics as the example, we show that the most important research and development (R&D) function of industrialized countries in renewable energy is to focus on the reduction of cost per unit of power output. Reducing the cost/power ratio of renewables relies on the ability of developed countries to conduct advanced R&D.

Renewable energy – a large-volume industry

Renewable energy generation must be large to have impact on the global energy supply. Renewable energy will have many users, will produce large quantities of electrical or thermal energy or fuel, will use large quantities of material for their construction, and will require large investments of capital. These characteristics are typical of mass-produced industrial goods.

Therefore, renewable energy sources are following a path that is characteristic of modern industrial products like the automobile or the microprocessor. The widespread use of these was made possible by low cost, per passenger or per logic gate, of very advanced products. For the widespread use of renewable energy, low cost per unit of power or energy will be equally essential. For the eventual adoption of renewable energy by private users the cost of energy must be low. Its renewable character will be a secondary attractor for the vast majority of users in developed countries that we want to engage.

This argument applies to all sources of renewable energy produced in large quantity, whether in distributed or in central, bulk, form. Taking advantage of our own experience we employ photovoltaics (PV) as the vehicle for making our point. The present cost of PV is $ 3/W of module, and $ 6/W or more for the whole system. $ 3/W systems cost is the target for opening large markets for distributed systems. A system cost

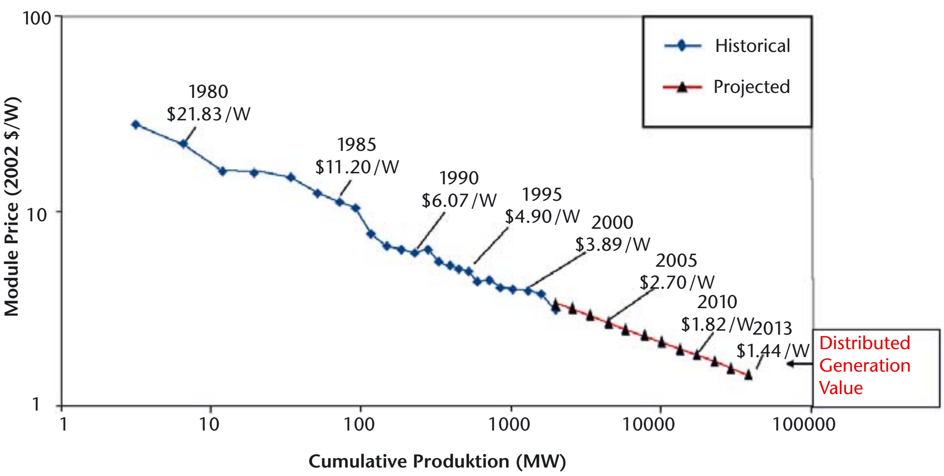

Figure 1
The experience curve for photovoltaic module price, and its extrapolation to the year of 2013.

The module cost of $ 1.44/W will open a large commercially viable market for distributed generation of photovoltaic electricity. From ref. [1].m ref. [1].

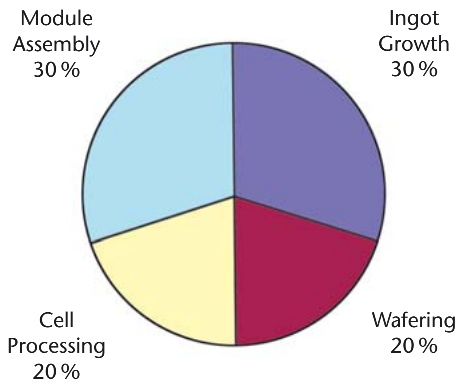

Figure 2
Main components of crystalline silicon PV module cost. From ref. [1].

of $1.30/W is expected to introduce PV to the bulk power market. (We use $/W here to denote the cost per Watt of output power under peak insolation, which corresponds approximately to $0.25/We, the average output of a conventional power plant.)

Renewable energy cost reduction to date – the photovoltaic example

Like many mass-produced products, solar electric modules have come down in price with manufacturing experience. On average, the panel price has dropped to 81 % of its value at the beginning of each period of doubling of cumulative production. The cumulative production counts all modules ever produced. This historical record is illustrated by *Fig. 1*, which also includes a projection of cost reduction anticipated over the next ten years. [1] (It is assumed but not assured that future cost will follow the historical trend of *Fig. 1*). While economists do not yet understand the semi-logarithmic dependence shown by this "experience curve," it is clear that the cost is coming down in part by R&D.

To understand the role of R&D in past cost reduction, and its leverage on cost reduction in the future, let us look at the components of module cost. The four main steps of module fabrication are reflected in the pie chart of *Fig. 2* on cost components of a PV module. These are (i) silicon refining and crystal growth, (ii) wafer cutting, (iii) cell fabrication, and (iv) module assembly. *Tab. 1* illustrates how each of these steps has contributed to the cost reduction depicted in *Fig. 1*. The manufacturing processes of all four steps have been improved.

Improving the cell efficiency is particularly important to cost reduction because of its leverage on the cost of the entire system. Raising the cell efficiency brings down the cost (per Watt) of the entire system, that is, it reduces the cost per watt of all manufacturing steps and of the balance-of-system.

Prognosis for further cost reduction – the photovoltaic example

The silicon solar cell roadmap foresees further improvements in cell and manufacturing efficiency, with module cost projected to reach $1.50/W by the year 2012. PV manufacturers are confident that the necessary technology can be developed. Cost reductions are anticipated in all steps of module manufacture, as described in the rightmost column of *Tab. 1*. Taking the balance-of-systems cost to be equal to the module cost, in 2012 the PV systems cost will become competitive for distributed application of PV. In other words, at this cost distributed PV no longer will need subsidies because it will be profitable.

Table 1
Improvements in silicon PV module manufacturing: history and projection

Process step	Material/process	Improvement to date	By2012
Silicon crystal	Polysilicon price	$300/kg → $30/kg	
	Larger diameter	75 mm → 150 mm	**200 mm**
Wafer Cutting	Wire sawing	< $ 0.25/W	
	Thinner Wafers	375 µm → 150 µm	**120 µm**
Cell fabrication	Higher efficiency	10 % → 16 %	**23 %**
	Volume manufacturing	1 MW → 100 MW annual production	**500 MW**
Module assembly	**Automation**	**None → some**	**More**

The forecast for reaching the goal of PV to bulk power generation is less certain. For competitive bulk power generation the module cost will have to drop to $0.65/W, and the systems cost to $1.30/W. The scientific and technical path to this goal is not known, and finding it will need new discoveries, inventions, and manufacturing techniques.

Renewable technologies are complex products of advanced industrial societies

The preceding sections illustrate our main point: Because of their large numbers and extreme cost constraints, distributed systems for the generation of renewable power will have to be industrial mass products. Their introduction will follow that of other mass products made by demanding technologies, such as automobiles and microprocessors. They are invented, engineered, made, and first used in developed countries. In the past such advanced industrial products first have been imported to developing countries as status symbols of the wealthy. Because they turned out to meet basic societal needs and became affordable, large markets opened up for them in developing just as in developed countries. These markets were supplied with standardized products, which were adapted to local conditions in a kind of mass customization. When local markets in developing countries became sufficiently large, developed countries manufactured products tailored for export. Local manufacture in developing countries followed, which entrained the buildup of local base of suppliers. This flow of technological development that eventually becomes mutual is laid out in *Tab. 2*. Until sufficient income is generated locally from renewable energy sales, much of the sequence is financed by capital from developed countries.

How much subsidy is needed to make distributed PV power commercially viable?

Extrapolating the experience curve of *Fig. 1* shows that the commercially competitive module price of $1.50/W is attained when the cumulative production has reached 30,000 MW. *Fig. 1* allows to calculate the subsidy needed for reaching commercially viable distributed PV power. Assuming that manufacturers and installers are subsidized to receive $6/W of system, the total subsidy for bring systems cost to $3/W is $25 billion. This amount suggests that PV financing also will remain in the domain of the industrialized countries for some time to come. It is plausible that this need for subsidies, and their source, extends to several other renewable energy technologies.

Industrialized countries →
Exploratory research → invention → applied research → → product development → pilot production → field test → manufacture → → systems development → applications development → use
← Developing countries

Table 2
Entry points and growth directions in renewable energy industries of developed and of developing countries.

R&D entry for developing countries

While the need for mass production at low cost places the burden of development and financing renewable technology squarely on the shoulders of the industrialized countries, many developing countries have technology bases that enable them to make significant R&D contributions to renewables. *Tab. 3* lays out one possible approach.

Developing countries →
Energy conservation → heating/cooling → wind power → liquid fuels → PV electricity

Table 3
A possible division of labor in the development of renewable energy technology

Consequences on the division of labor in research and training

The preceding discussion served to highlight the most important need in R&D on renewable energy technology: to reduce its cost to a commercially viable level. Low cost is the key to successful market development. Once cost is low self-motivated and self-financed markets will spring up in developing countries, which then will begin moving in the direction from application to manufacture to R&D.

Reduction of the cost/power ratio must drive the research agenda for developed countries. This agenda will cover all aspects of the renewable technology, ranging from materials to physical function, to manufacturing, to systems development and installation. In technologies without local expertise in developing countries, developed countries will train local experts for applications and customization of systems. Where local expertise in renewable applications already exists, developing countries can help best by strengthening their R&D capability that helps local entry to cost effective manufacturing.

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The Challenge of Renewable Energies Integration in Energy Distribution Systems

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Introduction

Despite the global abundance of renewable energy resources, renewable energy generation capacity constitutes a small share in the global power capacity. The renewable energy capacity in 2000 was estimated to be around 102 GW (excluding large hydroelectric power) representing 3% of the world's installed power capacity. Since the past decade, however, there has been a renewed interest in many countries on renewable energy for power generation. Governments have intervened to promote renewable energy investments. In several developed countries, renewable energy policy interventions were driven by policy objectives such as greenhouse gas emission mitigation, internalisation of environmental externalities and energy security. The renewable energy capacity in EU member countries, for example, has grown 5 times from 1990 to 2001.

The integration of increased renewable energy capacity in electricity distribution systems could be held back by the limitations of the centralized power generation systems in accommodating distributed generation and by the full electricity market liberalization. The technical and regulatory frameworks of centralized power generation systems appear to be inadequate to provide support and incentives to distributed energy generation. While market liberalization increases opportunities for small and medium-sized renewable energy generators, it also exposes them to competitive market risks, thereby reducing the attractiveness of renewable energy generation.

The paper briefly reviews distributed energy generation, issues and options for power integration in electricity distribution systems and outlines research strategies for renewable energy.

Power generation integration in electricity distribution systems

Electricity generating plants utilizing either renewable energy or conventional fuels, integrated into distribution networks are broadly categorized as distributed generation. Renewable energy technologies suited for small to medium-sized distributed generation include photovoltaic cells, wind power and biomass-based technologies. Technologies fuelled by fossil energy are conventional steam turbines, combustion turbines, internal combustion engine generators, micro turbines, and fuel cells.

Key characteristics that differentiate distributed generation from the centralized power supply relates to location, capacity and grid connection. Distributed generators are located near the point at which the power is consumed. Distributed generation technologies are small in scale or can be produced economically in a range of sizes. Traditional electricity suppliers are connected to the grid at high voltage level while distributed generators are connected to the grid at distribution level.

Several developments have influenced the increased interest for distributed generation recently. These are
1) generation and distribution technology development;
2) liberalization in the electricity market;
3) energy supply security concerns; and
4) renewable energy policies driven by environmental concerns.

In Western Europe, particularly the European Union Member States, environmental policies, increased awareness on distributed generation technologies, and electricity market liberalization are the factors that generate increased deployment of distributed generators. In the

US, the growth of distributed generation is driven by issues related to poor power quality and supply security as well as increased recognition of environmental benefits of distributed generation.

The benefits of distributed generation include the following: greenhouse gas emissions reductions particularly for generation based on renewable energy and low carbon fuels; security and diversity of supply since various energy sources will be used in distributed generation; and cost reductions since electricity is generated by more efficient systems and close to the point of consumption. Additional benefits of distributed generation in general include deferral of upgrades from transmission and distribution systems, reduction of losses in the distribution system, and provision of network support or ancillary services.

In countries with liberalized electricity markets, distributed generation becomes attractive since it has short construction lead times, low capital costs, flexibility in operation, and its ability to expand output. It must be noted, however, that these attributes are mainly associated with fossil fuel-based technologies since most renewable energy technologies have intermittent electricity generation, high installation costs and limited flexibility in operation and expansion.

Issues and options

Grid interconnection

The existing electricity supply systems in most countries awre centralized systems where electricity is generated in large power stations and delivered to customers through transmission and distribution networks. Centralized systems support a unidirectional flow of electricity. The integration of small-scale generation at the distribution level can result in technical problems that may affect network stability and power quality. These problems include voltage control, reactive power control and islanding. For countries without grid interconnection standards, this may result in increased transaction costs since distribution network operators often require distributed generators to shoulder the grid impact assessment costs. The development of interconnection standards, guidelines for dealing with interconnection requests and procedures are often seen to reduce transaction costs for network operators and distributed generators.

In countries where distributed generation is growing rapidly, electricity networks are facing new challenges in terms of network stability and power quality. High penetration levels of distributed generation increase risks of serious network failures. In the case of Denmark where the penetration rate of distributed generation is high (around 35 % at present), it has been reported that the costs of network reinforcements have risen considerably. To allow further increase of distributed generation share, it requires new technological development. One possible development is for current passive distribution networks to evolve into actively managed networks. This means that the network must be treated not as a power supply system but as a transport system that provides connection between points of supply and consumption. In this case, bi-directional flows of electricity are possible, local control areas which enables local network areas to act as independent islands are used, and system services become specified attributes of a connection.

Intermittent distributed generation (renewable energy technologies) pose a different technical challenge. High penetration rates of intermittent distributed generation pose a serious technical constraint, which requires some form of back-up power or energy storage. The high share of wind power in Denmark is being backed-up with a large capacity from the Nordic electricity pool. To some extent, combined heat and power (CHP) plants have also provided back-up capacity. There is a revival of interest of energy storage as a technical option for intermittent energy generation. The current particular interest is on the production and storage of hydrogen from electricity at off-peak period and during the times where there is surplus of renewable energy.

Market liberalization

Under a vertically-integrated monopolistic electricity industry structure, electricity produced by distributed generators is purchased by utilities under various contractual arrangements. Under liberalized markets, opportunities for distributed generators are increased since they can sell their outputs directly to customers with the opening of access to networks. Limited reforms, however, may be unfavourable to distributed generators. If reforms are limited to wholesale competition, the conditions will be similar to monopolistic industry structure. In partial retail competition, utilities may practice anti-competitive behaviour by offering price discounts to contestable markets creating entry barrier to distributed generators. Full retail competition therefore is vital for the development of distributed generation. If cross-ownership is allowed under full retail competition, electricity distribution companies owning generators to supply electricity to their customers still have the incentive to discriminate against distributed generators. This incentive to discriminate is removed with the separation of distribution from generation.

The complexity in market structure, operation and pricing is increased with liberalization making it more costly for small-scale distributed generators, particularly small and intermittent producers, in dealing with market competition, in undertaking bilateral contracts with consumers, in meeting electricity dispatch requirements (balancing requirement), and in procuring back-up power. This could be mitigated by developing trading arrangements and market rules that provide correct signals and right incentives to facilitate the growth of distributed generation.

Regulatory frameworks

The integration of distributed generation in distribution networks presents costs and benefits to the network, which needs to be properly valued in order to facilitate the growth of distributed generation. The current regulatory frameworks often fail to recognize, allocate and evaluate most of these costs and benefits. The values (costs and benefits) of distributed generation can be categorized into capital and operational values. Capital values relate to generation and distribution facilities and these include the following: distribution capacity cost deferral, connection costs, metering costs, reserve capacity costs and avoidance of over capacity. Operational values include reduction losses, voltage support, reactive power support and balancing power. It must be recognized that economic values for reliable distributed generation are higher than those for intermittent generation.

A sustainable network regulatory system must provide correct signals to generators. This means that all distributed generation costs and benefits must be properly valued. Distribution network operators must be given regulatory incentives to consider costs and benefits of all network users related to network services. A sustainable regulatory framework uses a charging system that combines shallow connection charges, use of system charges with entry and exit charges, and performance based incentives.

Research Strategies for Renewable Energy Integration

The issues and options discussed above can be broadly categorized into issues related to distributed generation in general and those related more specifically to renewable energy generation. The generic issues affect both renewable energy and fossil fuel-based distributed generation. Research strategies must address both the generic distributed generation issues and renewable energy-specific integration issues. As discussed earlier, flexibility, reliability and low generation costs - attributes that are weak in renewable energy generation – are valued highly in competitive and complex electricity markets. Research strategies to facilitate higher integration of renewable energy generation in distribution networks must focus on these weak attributes.

Flexibility in generation maximizes economic benefits by increasing output at times of high pool prices. Intermittent generation from renewable energy can be mitigated and flexibility can be achieved through energy storage. With energy storage, scheduling of energy dispatch would also become possible for intermittent renewable energy generation.

Scheduled generation provide higher economic returns than unscheduled generation. There are several options for storage, but current industry interest is on hydrogen production and storage. There is a current need for research, development and demonstration of energy storage systems.

Predictability of output is very important in balancing actual and forecasts generation. Penalties are high and producers are required to pay higher prices for imbalances in competitive electricity markets. This penalizes the highly variable renewable energy generators. Energy storage could mitigate variability problems. Another area where there is a need for research, development and demonstration is on the improvement of predictive capabilities, such as the development of better weather forecasting techniques and software. With these technologies the variability of forecasts and actual outputs could be significantly reduced.

In competitive markets, renewable energy generation need to compete with central power generation. At present, small-scale renewable energy generation remain uncompetitive unless subsidized for grid applications. Despite the decline of generation costs of several renewable energy technologies since the past decades, technology costs need to further decline in order to become competitive in displacing grid-power. Continued research on renewable energy technology cost reductions and efficiency improvements remain important.

The above strategies can be reinforced by research strategies on generic distributed energy generation. Technical research strategies can be divided into those dealing with the issues associated with the existing centralized power systems and those related to future system design and operation. The former includes research and development of new control technologies (current fault and voltage) as well as distribution management systems while the latter includes interconnection and active network management. Research strategies for electricity system regulation can be focused on the valuation of distributed generation costs and benefits as well as on various regulatory incentives to distribution network operators to connect distributed generation.

Integrating Renewable Energy Into Society

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Introduction

This paper summarizes some of the non-technical aspects of renewable energy, from local and national to regional and global. How both technical and non-technical knowledge of renewables is used in the societal, political and economic processes of development, and how these processes might be managed to achieve the transition to more sustainable energy systems. Due to space and time limitations, this paper focuses primarily on grid-connected bulk renewable generating facilities. That does not in any way diminish the value and importance of solar design in the building sector, solar water heating, small on-site generation, or the future use of renewables in the transportation sector some of which I will only lightly touch upon.

Integrating Renewables into the Electric Utility Structure

Probably the largest use and the greatest impact of renewable energy is for the generation of power in the electric utility sector. This includes grid-connected bulk power (most commonly wind, solar, biomass/biogas, geothermal, and hydro), and grid-connected, on-site generation most commonly from solar electric (PV) and small wind generators. In rural areas, both in developed and developing countries there is also widespread use of solar electric, small wind, small- and micro-hydro, biomass and biogas that are sometimes developed through electric utility programs, through special rural utility districts, and cooperatives. Each of these has their own set of benefits and issues. The following are some of the significant non-technical issues in the electric utility sector.

Socio-Economics – The economics of bulk renewable power generated into the electricity grid has improved dramatically over the past five years. This is due to the reduction in the cost of renewables and the increase in the cost of some conventional fuels, particularly as environmental controls become more stringent. In addition, the volatility of fossil fuel prices, particularly natural gas, makes many sources of renewable power competitive today with conventional sources. Added to that is the need to diversify the power generation mix while also reducing dependence on imported sources of fuel. As a result, domestic renewable resources become a more attractive choice than ever before. The environmental benefits of renewables come as a bonus. Here is a summary of some of the benefits:

- **Renewable Technology Costs:** Improved technology performance and reduced installed costs are continuing to improve renewables competitive position;
- **Environmental Compliance:** Increased costs of conventional fuels and costs of the technical requirements to meet modern generation performance standards bring the costs of conventional power generation within a similar range as renewables;
- **Competition for Water:** Increasingly short supplies of water needed for conventional power plant cooling (and washing of coal) will put more and more pressure on the siting of new thermal plants;
- Stabilize Electric Portfolio Costs: Volatility of natural gas prices and shortages of natural gas supply – renewables tend to have 80 percent or more of their costs fixed and thus can help to stabilize electricity rates;
- Balance of Trade: Desirability of using domestic renewable resources to generate power, while selling domestically produced fossil fuels for hard currency;
- Economic Development: Interest in local jobs and potential for domestic renewable energy manufacturing;
- Rural Development Costs: Renewables are frequently more cost effective than extending transmission lines from central generating stations into rural areas.

Transmission / Distribution System (T / D) – Even with favorable economics, there are many barriers to renewable development and several of those are related to the electricity T/D system. This is a topic that could consume a whole paper. Here are some of the issues.

Transmission / distribution interconnection – Though the technical issues of renewable interconnection into the electricity system are pretty straight forward, how the costs are calculated and who should pay what costs can involve years of political wrangling. Because the existing electricity transmission system has, in almost all cases, been designed to accommodate large central station conventional power generation, revising that system to accommodate small, embedded generation, intermittent and renewable facilities located where the resources are located (rather than load) can be challenging and expensive.

In addition, the transmission and distribution system operating rules can be written in a way that adds more costs than are necessary to small, embedded, and intermittent resources. It is important that T/D operating rules be based on performance rather than technical specifications (i. e. what performance you need from the system rather than what piece of hardware has always been used in the past).

Distribution system upgrade and support – Many renewable generators (as well as co-generators – CHP) are interconnected at the distribution rather than transmission system level. This means that the distribution system may require system reinforcement in order to accept the power and avoid a situation where the renewable generator is not able to operate for significant periods of time. The issues are: Who decides what reinforcements will be made, and who should pay for these system reinforcements? In addition, when renewables are interconnected at the distribution system level, they may bring a variety of benefits to the system, are those benefits calculated and netted against the costs?

Intermittency and control – Probably the most vexing T/D issue has had to do with the intermittency of some types of renewable generation. This debate often expands outside the bounds of technical fact and into the realm of myth. Many utility transmission operators believe that anything above some specific percentage of intermittent resources (some believe this is as low as 5 percent) will totally disrupt their system. Resource planners everywhere need better information, hard data and knowledge of the variables that affect those data. In addition, the fact that smaller generators (often renewables) and intermittent generation is not controllable like large conventional central generation causes more upset and debate than is justified by the actual facts of the situation.

Line extension versus off-grid and mini-grid installations – The politics of transmission line extensions drive much of the rural renewable energy development in developing countries. The determination of where transmission lines will be extended is often determined by political considerations. Moreover, politicians like to make campaign promises about delivering rural electrification. But those promises may never be met. As a result, many rural communities do not support renewable facilities because they think they will soon have 'real' electricity from the grid (but that electricity never comes). The simple requirement that electric utilities announce several years in advance their line-extension plans and then be compelled to follow those plans could help rural communities make more informed decisions about their energy options.

Institutional Culture – The institutional culture within some electric utilities mitigates against the incorporation of renewable resources. Some utility managers still believe 'bigger is better.' They did not get into the utility business to build 'wimpy' renewable energy and energy efficiency projects. "Real men build nuclear and large central fossil generating plants. Countries that are going to move economically and be a power in the world must have nuclear power plants not renewable power plants. That might bring into question the judgment and potential influence of the utility manager."[1] This type of thinking buttressed by myths about how renewables will 'screw-up the electricity system,' pervades many parts of the electric utility industry serving as a silent barrier to the incorporation of renewables into the affected utilities.

It is important to note that many of the barriers faced by renewable technologies are likely to be faced by any new generating technology whose proponents and/or manufacturers do not already have a market share and where the technology is different in size (e.g. modular), pattern of use (e.g. behind the meter), or ownership structure (e.g. non-utility). Incremental changes to existing technologies that are already well established in the energy sector generally have few problems of acceptance and implementation. But because new technologies introduced by new players upset the status quo and conventional ways of thinking, they can face significant barriers.

Integrating Renewables Through Government Policies & Programs

More and more, robust government policies and programs are being put into place to stimulate the development of sustainable renewable resources. The expanding use of these policies by OECD countries is documented in a soon to be released report by the IEA – Renewable Energy Market and Policy Trends in IEA Countries, 2004. Meanwhile, many emerging economies and developing countries are also creating innovative renewable energy policies and legislation. The Renewable Energy Promotion Law being developed by the People's Republic of China is an example of that trend.

Overview of Policies – Countries, states and provinces have introduced a variety of policies to support the deployment of renewable energy technologies. The following figure shows some of the Market Deployment Policy Instruments used to stimulate renewable energy development and use. (This diagram was borrowed from the draft IEA report cited above):

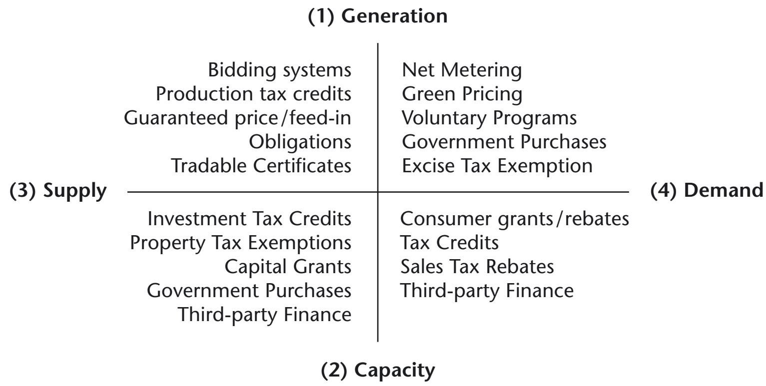


Figure 1
Market Deployment Policy Instruments

This figure illustrates the type and application of market instruments used to stimulate: (1) Generation (energy production); (2) Capacity additions; through (3) Supply-side incentives; and (4) Demand-side Incentives

Looking at the broader spectrum of policy instruments, there are seven primary types of regulatory and legislative renewable energy strategies:

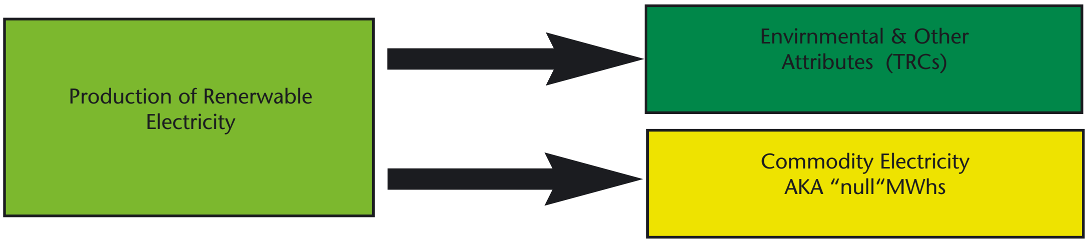
- Research, Development and Demonstration (RD&D) Incentives
- Investment Incentives
- Tax Measures
- Incentive Tariffs
- Voluntary Programs (e.g. Green Tariffs)
- Mandatory Programs or Obligations
- Tradable Certificates (these can also be combined with either voluntary or mandatory programs)

Initially OECD countries tended to adopt these different types of measures and programs more or less sequentially. More recently, countries/states/provinces have tended to adopt a package of policy measures at one time. Many of these policies are complementary and not necessarily mutually exclusive. Through experience we have found no single policy addresses all the market barriers and that a combination type policy framework can be more effective.[2]

Separation of Energy from Environmental and Social Attributes – A few years ago, the concept was conceived of separating the social and environmental characteristics of renewables

[1] This was actually told to me by the CEO of a large electric utility company.
[2] For more information on this report, contact Rick Sellers, Renewable Energy Director, International Energy Angency, Paris, France

Figure 2
Relationship between Renewable Energy, TRCs, and Commodity Energy



from the commodity energy (electrons). This separation is facilitated through the issuance of tradable renewable certificates (called: TRCs, or RECS, or Green Tags, or certificates). These certificates represent the non-electricity related attributes associated with the generation of one MWH of power. They provide for a liquid certificate market separate from the commodity energy market and thus a second potential source of revenue for renewable generation plants. These certificates have become an important financial instrument in the wholesale renewable energy market in the U.S.

Establishing Legal Ownership of the Attributes – One of the challenges with renewable energy certificates is establishing the legal ownership of the attributes as well as the ability to ensure they are not being double counted. The solution to this problem is the development of renewable energy certificate tracking systems. These systems, developed in Europe and the United States, provide a platform through which a variety of renewable energy transactions can be supported. These systems can verify compliance with renewable energy mandates, support Green Pricing and resource labeling programs, as well as support a variety of voluntary 'green' markets and product certification.

These tracking systems are also compatible with greenhouse gas registries and other types of air pollution abatement programs and can help measure and establish the validity of pollution mitigation claims from renewables. These tracking systems can be adopted to small renewable generating systems as well as large as well as thermal solar systems.[3]

The Role of Renewable Certificates in International Financing – Another new concept is the use of renewable certificates to support the financing of renewable projects particularly in developing countries. The diagram *(Fig. 3)* illustrates how such a system might be designed.

Integrating Renewables for End-use Customers

Up to this point, the discussion has been almost exclusively about the supply-side of the energy equation, but the demand-side – the end-use Consumer – deserves some attention as well. The following is a very brief description of some of the socio-economic concepts in the retail energy market.

The Building Sector – Renewable energy and energy efficiency is coming of age in the building sector. Building codes and standards have resulted in the recognition of the importance of the design and materials being used in new buildings from both an energy and resource sustainability perspective. Through codes and standards as well as through green building recognition programs like the Leadership in Energy and Environmental Design, or LEED program, passive solar design is being reintroduced and recognized as the appropriate way to design sustainable buildings.

Laws like the proposed California Solar Law requires some percentage of new housing to have solar electric panels, could change the future housing landscape. This could be partic-

[3] Though collection of credible measurement data is more difficult for small to very small systems. The concept could also be applied to energy efficiency though agreement on measurement and the issuance of certificates is more difficult than for power generation from metered systems.

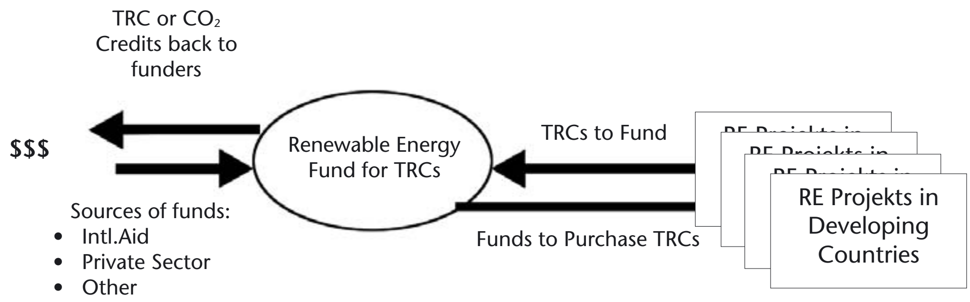


Figure 3
TRC Based International Financing Mechanism

ularly powerful when combined with lending institutions that provide incentives for energy efficiency and renewable energy options that are integrated into the building and its financing.

Another innovative approach is exemplified by the proposed Chinese Renewable Energy Promotion Law that would mandate all new buildings (in areas where the annual sunlight exceeds 1500 hours / year) must have installed solar hot water systems or be plumbed to allow for such systems to be easily installed at a later time.

The Voluntary Green Market – In the United States, voluntary green markets (where electricity consumers voluntarily purchase a higher proportion of renewable energy than they would otherwise receive from their regular utility supply) are growing rapidly. There are over 300 electric utilities that offer Green Pricing programs to their customers. In addition, one of the fastest growing markets is for the purchase of renewable energy by commercial / industrial customers who now purchase more then 23 % of the Green-e certified renewable energy sales. Green-e certified renewable energy sales topped 2 million MWh in 2002 (40 percent of the market) and are expected to double again in 2003.

The Role of Certification / Verification – Credibility is the foundation of the voluntary renewable energy market. The voluntary renewable energy market's credibility depends upon the certification and verification of the renewable energy products sold to end-use customers. There is almost no way individual customers can verify for themselves whether they are receiving what they paid for when they purchased renewable energy: Was the renewable energy actually generated and put into the electricity grid proportional to the amount purchased? Did the power actually purchased come from the type of renewable facility claimed by the seller? Are the product claims reasonable and verifiable? Is there a quick and credible way the consumer can tell if the renewable energy being sold meets some reasonable minimum environmental standard? Certification / verification are critical to the establishment and maintenance of retail green power markets.

The Environmental Market – No discussion of renewables would be complete without mentioning their environmental benefits and the market that is developing around those benefits. Though as everyone knows, the US has not ratified the Kyoto Protocol, nonetheless, concerns about climate change are a key driver for the U.S. renewable energy market. Commercial / industrial customers purchasing renewable energy do so because of their environmental benefits. Most renewable energy incentive policies are rooted at least partly in the desire to capitalize on renewables' environmental benefits. TRCs can be disaggregated and their environmental benefits (e. g. CO_2 , NO_x, mercury) sold separately.

The Role of Outreach and Education – Public education to increase the awareness of the renewable energy options available in our society goes hand in hand with political support for favorable renewable policies and with the public's acceptance of renewables that are available in the marketplace today. You need demand-pull as well as supply-push to establish a sustainable environment for renewable energy development. The following are some examples of the types of innovative outreach campaigns we are seeing in the retail renewable energy market:

Clean Energy Advertising Campaign – This public education campaign is designed to inform the common person (not just an environmental elite) about the benefits of renewables. The purpose is so renewable programs are not viewed as just another government program but seen as something that benefits all parts of the population. One example is the "Clean Energy Advertising Campaign" launched by five northeast/mid-Atlantic states and is expected to eventually expand into several other states in the region. This is a basic advertising campaign with a 'public good' – renewable energy – as the product being advertised. It has funding from state renewable energy funds as well as a number of private foundations. It is a model of cooperation that we hope will provide useful results.

Product Labeling and Made With Renewables – An exciting concept is the "Made with Renewable" label that can be put on consumer products that have 50 percent or more of the electricity used to manufacturing of the product comes from renewable power. Claims such as **"Made with Renewable Energy"** and **"We Buy Certified Renewable Energy"** will appear on consumer products, accompanied by the Green-e logo and website. The Product Labeling Initiative opens up a new communication channel for company promotion of renewable energy purchasing, and through package labeling, brings renewable energy to the attention of millions of diverse consumers. Green-e is in the process of launching this program in the U.S. and we have more than twenty companies who have applied to use this logo. They include several food companies (rice products, natural juice, energy bars, etc.) as well as a carpet company and some beverage firms (beer and wine). By using the Made with Renewables logo and label on the products they sell, they are setting an example that can encourage their customers to do the same. The companies are interested in showing their environmental responsibility as well as setting an example for others both industry peers and customers.

Point of Purchase Tags (POP Tags) – Earlier there was a discussion about the purchase of renewable certificates to "green" the electricity used by the purchasing customer. But a new product has entered the market, the use of mini-tags (certificates less than one MWh in size) that are being sold at the point of purchase (also called POP Tags) specifically to offset the carbon emitted by the drive to the ski resort, or by the electricity used to power the rock concert, or the carbon emitted by the airplane flight to a vacation resort. These types of products allow the consumer to offset the carbon that results from many of their leisure activities. Because these POP Tags are in small sizes (and therefore a small cost – <$5), and sold at the point of sale/use, they become an 'impulse' purchase by the more affluent population.

Summary and Conclusions

We sometimes think that the public, utility managers, building contractors, government officials and others will just see the logic of integrating renewables into our daily activities once they have the facts. But integrating renewables into the electricity, building and consumer products sectors is a labor-intensive task that requires sticks as well as carrots and a lot of outreach and education. Making these types of fundamental changes in our energy and building infrastructure is challenging and time consuming. But we have come further in a shorter period of time than I had thought possible thirty years ago at the dawn of the renewable energy market. The non-technical activities that go hand-in-hand with technology innovation are absolutely necessary if we are to achieve a transition to a sustainable energy system.

Promotion of Renewable Energies for Heating and Cooling

The Background

The promotion of renewable energies is a worldwide crucial challenge. Those sources contribute to the security of the energy supply as they reduce the use of fossil resources and nuclear energy, thus alleviating dependence on energy imports. This is an important fact, regarding costs, balance of trade, political autonomy, economic security, etc., for most of the industrialised countries in the European Union as well as for most developing countries. Renewable energies are as well the important strategy to reduce greenhouse gases and to gain energy, therefore essential to meet the Kyoto-goals, to mitigate climate change and to build up a sustainable energy system.

The European Union as a leading region in renewables has shown at the world summit in Johannesburg and in its white paper and renewable energies-directive that the promotion of renewables is an important political issue. The EU instructs the member states to increase the share of renewable energies of the total electricity supply to 12 per cent in the year 2010. However most of the activities of the EU-member states concerning regulations and other promotional actions are addressing only the power sector – due to the directive 2001/77/EC. For instance the German Act on Granting Priority to Renewable Energy Sources (Renewable Energy Sources Act) as the most important regulative initiative worldwide addresses only the power sector. This successful instrument has led to a renewables share of more than 8 per cent to the overall power consumption.[1] The reason for the focus on the power sector so far is lying in its less complex structure compared to the heating and cooling sector: the widespread and nearly complete power supply system (grid) makes regulatory instruments work easily compared to other sectors.

The Challenge – Promotion of Renewable Heating & Cooling

Although there is a huge potential for using renewable energies for heating and cooling in nearly every industrialised country, only a few of them explore this option seriously.

Renewable heat is produced from
- the traditional resource **wood and other biomass** with old and innovative technologies (local space-/hot water heating, combined heat and power-plants and distributed heat, district heating)
- active **solar systems** (e.g. local space-/hot water heating)
- **geothermal sources** (including heat pumps).

The untapped potentials of renewable heat are large. *Fig. 1* shows the example of Germany. In the year 2003 only 58 TWh of renewable heat were produced, resulting in a percentage of 3.9 % of the total heat consumption in Germany. Studies have identified a potential of 820 TWh per year. This corresponds to a rate of 55 % of the present heat consumption. Considering that the total heat consumption is going down due to increases in efficiency, the rate of renewables can get even higher.

Regarding the expansion of renewables in the power sector we see some success stories in countries like Germany, but we also see the overall EU target to reach 12 % renewables of the electricity consumption by 2010 likely to fail if no progress is made in the heat sector. The European Commission itself states in its evaluation report about the contribution of renewable energy sources in the EU: „With the measures that have been put in place, the Commission estimates that the share of renewable energy sources in the EU 15 is on course to reach 10 %

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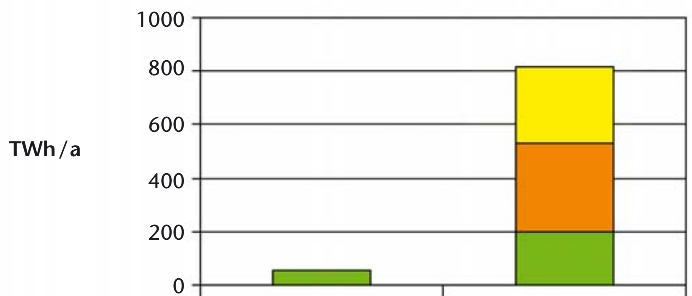
[1] See Hirschl, Bernd et al. (2002): Markt- und Kostenentwicklung Erneurbarer Energien. 2 Jahre EEG – Bilanz und Ausblick. Erich-Schmidt-Verlag, Berlin; and Hirschl, Bernd et al. (2004): Gutachten zum 2. EEG-Erfahrungsbericht (forthcoming).



	2003	Potential
solar thermal	2	290
geothermal heat	2	330
biomass	54	200
Percentage of total heat consumtion	3,9 %	55 %

Source: own diagram, data from Nitsch et al. (2004): Ökologisch optimierter Ausbau der Nutzung erneuerbarer Energien in Deutschland, BMU, Berlin.

Figure 1
Present use of renewable heat in Germany compared to potential use

in 2010. The shortfall compared to the 12 % target is caused by sluggish growth of renewable energy markets for heating and cooling, leading to the conclusion that considerable additional action is needed in this sector to allow the full 12 % target to be reached."[2]

Discussion on instruments

Renewable heating and cooling technologies cannot reach significant market shares without political support. This is a crucial regulatory challenge of the years to come, because – as mentioned before – the heating & cooling market situation is much more complex than in the power sector. Innovative instruments with a wide-scale impact are rare as well as national regulatory attempts are.

The production of heat shows some specific problems that complicate the search for suitable solutions. First, in most countries there is an insufficient grid system. While in European countries electricity grids are almost everywhere, heating grids are concentrated in big cities and densely populated regions. The systems are mostly decentralised and, second, private resulting in a considerable amount of actors involved in the production of renewable heat, thus making it difficult to address these actors by political measures. Third, the demand for heat is unsteady due to seasonal influences and the possibilities to store heat during a longer period are still a matter of research.

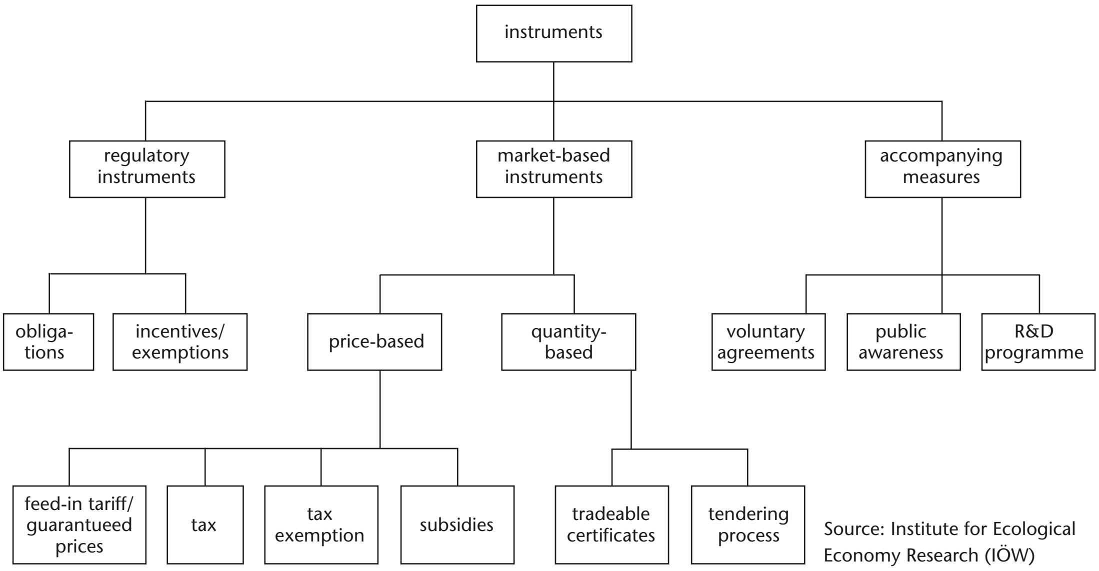
In contrast to the electricity sector, there exists almost no systematic approach to political support systems for heating or cooling. Some countries address parts of the market, such as Israel, Spain and Australia that have regulations on solar thermal heat. Other countries like Germany and Austria search for solutions but are still in a conceptual phase.[3]

Fig. 2 gives an overview about possible political instruments for the heat sector. They can be distinguished in regulatory and market-based instruments, as well as accompanying measures.

Regulatory instruments are obligations and incentives or exemptions. Israel and some communities in Spain have applied obligations to install solar thermal systems when constructing or rehabilitating a building.

Market-based instruments can be distinguished in price-based and quantity-based instruments. Price-based instruments steer by the price. These are for instance feed-in tariffs, which are applied in the electricity sector. The German Renewable Energy Sources Act is an example for such a feed-in-tariff together with the prioritisation of grid-supplied electricity from renewable sources. It is difficult to adopt such a regulation for the heat sector that has no comparable grid, infrastructure and "simple" value chain. Thus, guaranteed prices for heat production are discussed. Other examples, which are already applied, are taxes (e.g. on

[2] Communication from the Commission to the Council and the European Parliament: The share of renewable energy in the EU Commission Report in accordance with Article 3 of Directive 2001 / 77 / EC, evaluation of the effect of legislative instruments and other Community policies on the development of the contribution of renewable energy sources in the EU and proposals for concrete actions. COM (2004) 366 final, Brussels, 26.5.2004
[3] The Institute for Ecological Economy Research (Institut für ökologische Wirtschaftsforschung IÖW)is currently working on a policy advice project on renewable heat instruments. the aim of the project is to develop assessmant criteria, to assess different instruments and to develop alternative instruments. The project is commissioned by the German Environmental Ministry and the German Environmental Protection Agency.



Source: Institute for Ecological Economy Research (IÖW)

Figure 2
Possible political instruments for the renewable heat sector

fossil fuels or carbon dioxide), tax exemptions, and subsidies. In Germany, for instance, the present approach is a large subsidy programme which includes subsidies for the construction of solar thermal, geothermal and biomass heating systems. In times of decreasing public budgets, subsidy programmes are criticised and they are usually not sufficient to reach a significant market share of the supported technologies.

Quantity-based systems steer by the quantity. These are for instance tradable certificates and tendering processes. Australia has a certificate system for renewable electricity that additionally addresses parts of the heat market since solar thermal systems are included if they replace electrical heating systems. Tendering processes or bidding systems have so far been applied in the electricity sector, only.

Accompanying measures consist of voluntary agreements, public awareness campaigns, R&D programmes, and other measures. The city of Berlin went into a voluntary agreement with the local housing sector and the local industry, in 1997. This voluntary agreement contains the installation of solar thermal systems, thermal insulation of buildings, and the installation of district heating. Hitherto, this voluntary agreement did not meet the targets set for the installation rate of solar thermal systems. Public awareness campaigns are a useful tool for increasing the knowledge on and the interest in renewable heating systems. Moreover, eco-labelling can be used to promote renewable heating systems. Since renewable heat technologies are rather young, R&D is needed to improve the systems and for cost cutting. The companies involved in this sector are mostly small or medium-sized and need financial support for R&D. In addition, the education and training of engineers, architects, and craftsmen have to be improved.The instruments most discussed for the heat sector are tradable quota-based certificates, guaranteed prices, and obligations. As shown above, obligations and tradable certificates are already applied to a certain extend, but larger experiences have to be made to get the possibility to assess them.

The side-event at the renewables

Against that background the Institute for Ecological Economy Research (Institut für ökologische Wirtschaftsforschung IÖW) organised together with the German Renewable Energy Federation (Bundesverband Erneuerbare Energien BEE) and the European Renewable Energy Federation (EREF) a side event at the RENEWABLES 2004 in Bonn, titled:
Promotion of renewable energies for heating (& cooling) – Innovative instruments in industrialised countries and initiatives in the EU

The intentions and objectives of the planned side event were

- to provide an overview on innovative instruments/mechanisms to promote renewable heat (with the focus on industrialised countries)
- to show good practise examples (selected countries and models respectively experiences) to foster discussion between politicians from different countries
- to stimulate/present national and EU-initiatives

Therefore a wide range of speakers had been invited to give "good examples" and to discuss perspectives and needs for the promotion of renewable heating and cooling.[4]

The first speaker was Esther Hoffmann from the Institute for Ecological Economy Research. She opened up the side-event by giving an overview on the subject. Main intention of her lecture was to show the points which are important to discuss within the field of renewable heat production and instruments to support it. She gave a short introduction about the situation in other countries. Although there is no systematic instrumental approach to promote renewable heating and cooling, some countries do already address parts of the market (e.g. Israel, Spain, Australia). Some countries like Germany and Austria are working on the development of broader instruments (see IÖW-project mentioned above). Esther Hoffmann explained also briefly the technologies available, the possibilities to use them and the main problems regarding a support-mechanism, which are: an insufficient grid, often decentralised and private systems and an unsteady demand.

The following speakers reported about the national situation concerning renewable energy instruments addressing heating and cooling in different European countries that can be named as "good practises" or instructive examples. All speakers are high representatives from national or international renewable energies associations.

Christiane Egger from an Austrian association (Oberöstereichischer Energiesparverband) focussed on biomass heating, which is a very fast growing field in Austria since many years now. So 14 % of total energy consumption comes from biomass at present. Main instruments to support renewable heating in Austria are legal and administrative measures and financial support as well as consulting for business and private sector to improve the awareness for possibilities of using renewable energy sources. She pointed out that positive and target group oriented communication and marketing was and is a crucial point to the success of any measures.

The example of Sweden was reported by **Peter Danielsson**, president of the European Renewable Energies Federation (EREF). In Sweden a share of 21 % of total heat consumption is provided by biomass and biofuels. Whereas renewable heat has been supported in an indirect way by raising taxes on fuels, certificates are introduced at present to ensure a further growth of this share. The certificates mainly address larger plants. Therefore further improvements concerning the renewable heat in general and for smaller plants in particular are needed.

The third national example – Spain – has been depicted by **Raffaele Piria** from the European Solar Themal Industry Federation (ESTIF). He focused on solar thermal heating and explained an action plan, which has allowed a very fast rising of installed capacity of solar thermal installations in Barcelona. In this example, an ordinance on solar thermal installations were given, which made solar thermal installations obligatory in case of new buildings or major renovations of such buildings which have a great demand of hot water. Within 15 months the capacity of solar thermal installations rose from 1,1 m^2 up to more than 10 m^2/1000 inhabitants. Advantages of this so called "Barcelona model" are lower prices for solar thermal energy, awareness about the possibility of using renew-

[4] The side-event was moderated by Bernd Hirschl (Institute for Ecological Economy Research) and Johannes Lackmann (German Renewable Energy Federation)

able energy sources, a consolidating of market structures and of course several long-term effects. Piria introduced a Joint Declaration as well, presented in January 2004 at the European renewables conference in Berlin, the so called "RES-H initiative".[5] A broad coalition of European industry, research and NGOs called for:

- Verifiable national and EU targets
- Strong regulations
- Financial incentives
- Promotion campaigns
- R & D

Burkhard Sanner from the German and European Geothermal Association put a focus on geothermal power. The principal advantage of geothermal power compared to most of the other renewable energy sources is the stability of availability. However there is no possibility to transport geothermal power. It has to be used very close to the place where it surfaces. Sanner reported about some good examples concerning grid-use and supporting instruments in Sweden and Italy.

The situation and possible measures in Germany have been discussed by Hans-Josef Fell, member of the German Parliament (Green Party, Eurosolar). He pointed out the problems with national finances and subsidies when households are short of cash. Possible instruments for Germany could be a modification of the German building act, to obligate people to use renewable energies, as well as increased prices through taxes for fossil energies.

Karl Kellner from DG TREN (transport and energy) of the European Commission explained the EU-policy for renewable heating and cooling. In his presentation he accentuated the relevance of cooling besides renewable heating and prospected the consideration of cooling within the next EU research program (FP 6). Kellner agreed that a legal base is needed, one example he mentioned is the European building directive. Furthermore he stresses the need of using cogeneration. The new member states of the EU have started wide-spread activities in this field.

Finally **Mechthild Rothe**, member of the European Parliament (her paper was represented by an assistant) pointed out the role of EU policy for renewable energies and presented a second declaration for the promotion of renewable heating and cooling that was passed at a conference in Bielefeld, Germany (the "Bielefeld declaration"[6]).

The final discussion about national good practises and instruments for supporting renewable heating and cooling was dominated by the agreement, that a legal framwork at a European level like the directive for the renewable power sector is needed. The side-event closed with recommendations for the further national development of instruments, the sharing of good practises, the development of differentiated and integrated approaches for all relevant renewable technologies and the creation of a framework and the expression of binding targets on a European level.

[5] See http://www.estif.org
[6] See http://www.rothe-europa.de

Speakers at the Side-event Promotion of RE for Heating & Cooling – Innovative Instruments in Industrialized Countries and Initiatives in the EU

Bernd Hirschl/Johannes Lackmann
(IÖW, BEE)
Short welcome by organisers, facilitation

Esther Hoffmann
(IÖW)
Introductory input – the importance of renewable heat and instrument overview

Peter Danielsson
(EREF)
National example 1: Sweden & focus biomass

Christiane Egger
(Oberösterr. Energiesparverband)
National example 2: Austria & focus biomass

Raffaele Piria
(ESTIF)
National example 3: Spain & Focus solar thermal

Burkhard Sanner
(Geothermal Association e.V. GtV)
Focus on Geothermal Energy

Hans-Josef Fell
(Member of the German Parliament (Bundestag) Green Party; Eurosolar)
National example 4: Germany & policy for renewable heat

Karl Kellner
(DG TREN)
EU policy for renewable heating & cooling – state of the art and perspectives

Mechthild Rothe
(MdEP, Eurofores)
EU policy for renewable heating & cooling – the need for new initiatives

Transitioning to a Renewable Energy Future

Rian van Staden
ISES – International Solar energy Society
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ISES is one of the world's largest scientific and technical non-governmental organisations in the field of Renewable Energy. It is recognized by the United Nations as a consulting, non-governmental organisation (NGO) and is a member of the United Nations Economic & Social Committee (ECOSOC).

Founded in 1954 as an international, non-profit organisation, the International Solar Energy Society was formed with the goal of promoting the use of solar and renewable energy world-wide. It has some 30,000 members in more than 110 countries. They are interested in all aspects of the environmentally friendly use of energy, especially Renewable Energy. ISES sees itself as a forum for everyone who deals with this topic.

The goal of ISES is to support sustainable development world-wide with the intelligent, appropriate use of Renewable Energy technology. The Society promotes the research, development, and use of technologies dependent either directly or indirectly on the sun that reduce the damaging effects of energy use. In this context, ISES has focused on three basic fields for the future: cities/urban areas, rural areas, and social responsibility. In the process, ISES also aims to raise awareness both among the public and decision-makers in politics and the industry of newest developments and findings in the research and application of solar energy. This awareness is aimed at furthering the growing understanding of and willingness to use solar energy in everyday life. ISES has internalised the concept of "thinking globally and acting locally" as an intrinsic part of the Society's structure.

Since the Rio Conference in 1992, ISES has launched a multitude of projects and initiatives in conjunction with economic, political and research leaders to support the increased use of Renewable Energy and to help industry to realise them.

The members of ISES form the foundation upon which the ideals, goals and activities of the society are built. A rich source of knowledge, experience and ideas, it is commitment and participation that set the ISES membership apart. Drawn from all over the world, our members form a global community, unified through common goals. Their service requirements drive the services and products the Society offers.

Communication between researchers, industrialists and politicians is actively supported by ISES through activities such as journals, magazines, meetings, conferences, congresses and a website. With the help of partners, ISES has established a communication system called WIRE (World-wide Information System on Renewable Energy, http://wire.ises.org/) to allow the creation of a global 'one stop shop' for renewable energy information with links to all other important renewable energy sites.

The ISES journal (Solar Energy Journal) and conferences allow excellent technical exchange to occur between renewable energy engineers, architects and physicists. ISES also welcomes non-specialists to participate in ISES congresses and conferences, as well as to exchange viewpoints in the magazine (Refocus) and meetings. ISES is rapidly and proactively increasing its project programme to ‚seed' renewable energy technology world-wide. It co-operates with many other international organisations.

Transitioning to a Renewable Energy Future

At the Science Forum in Bonn, ISES used the opportunity to introduce the salient points of its new white paper of the same title.

The White Paper provides a rationale for effective governmental renewable energy policies worldwide, as well as sufficient information to accelerate effective governmental policies. It is the thesis of this White Paper that a worldwide effort to generate the renewable energy transition must emerge at the top of national and international political agendas, starting now.

In the history of human energy use, the White Paper records that sustainable resources were the sole world supply, even in nascent industrial development well into the 1800s, and that the world will necessarily again have to turn to sustainable resources before the present century is over. The fossil fuel period is therefore an "era", not an age, and highly limited in time in comparison with the evolution, past and future, of civilizations and societies. Accordingly, it is critical for governments to view what remains of the fossil fuel era as a transition.

The White Paper reveals that policies now in existence, and economic experience gained by many countries to date, should be sufficient stimulation for governments to adopt aggressive long-term actions that can accelerate the widespread applications of renewable energy, and to get on a firm path toward a worldwide "renewable energy transition", so that 20% of world electric energy production can come from renewable energy sources by 2020, and 50% of world primary energy production by 2050. There can be no guarantee for this to happen, but the White Paper presents compelling arguments that show it is possible, desirable, and even mandatory.

The window of time during which convenient and affordable fossil energy resources are available to build the new technologies and devices and to power a sustained and orderly final great world energy transition is short – an economic timeline that is far shorter than the time of physical availability of the "conventional" energy resources. The White Paper argues that the attractive economic, environmental, security and reliability benefits of the accelerated use of renewable energy resources should be sufficient to warrant policies that "pull" the changes necessary, avoiding the "push" of the otherwise negative consequences of governmental inaction. There is still time left for this.

The White Paper presents three major conditions that are driving public policy toward a renewable energy transition: 1) newly emerging and better understood environmental constraints; 2) the need to reduce the myriads of risks from easy terrorist targets and from breakdowns in technologies on which societies depend; and 3) the attractiveness of the economic and environmental opportunities that will open during the renewable energy transition.

The renewable energy transition will accelerate as governments discover how much better the renewable energy policies and applications are for economies than the present time- and resource-limited policies and outmoded and unreliable centralized systems for power production and distribution.

Today, it is public policy and political leadership, rather than either technology or economics, that are required to move forward with the widespread application of the renewable energy technologies and methodologies. The technologies and economics will all improve with time, but the White Paper shows that they are sufficiently advanced at present to allow for major penetrations of renewable energy into the mainstream energy and societal infrastructures. Firm goals for penetrations of renewable energy into primary energy and electrical energy production can be set by governments with confidence for the next 20 years and beyond, without resource limitations.

Specifically, with regard to the renewable energy technologies, the White Paper shows the following:

Bioenergy:
About 11% of world primary energy use at present is derived from bioenergy, the only carbon-neutral combustible carbon resource, but that is only 18% of today's estimated bioenergy potential. Estimates for world bioenergy potential in 2050 average about 450 EJ, which is more than the present total world primary energy demand. Fuel "costs" for the conventional resources become instead rural economic benefits with bioenergy, producing hundreds of thousands of new jobs and new industries.

Geothermal Energy:

Geothermal energy has been used to provide heat for human comfort for thousands of years, and to produce electricity for the past 90 years. While geothermal energy is limited to those areas with access to this resource, the size of the resource is huge. Geothermal energy can be a major renewable energy resource for at least 58 countries: thirty-nine countries could be 100% geothermal powered, with four more at 50%, five more at 20%, and eight more at 10%. Geothermal energy, along with bioenergy, can serve as stabilizing "baseload" resources in networks with the intermittent renewable energy resources.

Wind Power:

Global installed wind power capacity exceeded 32,000 MW by the end of 2002, and has been growing at a 32% rate per year. Utility-scale wind turbines are now in 45 countries. The price of wind-produced electricity is now competitive with new coal-fired power plants, and should continue to reduce to where it will soon be the least expensive of all of the new electricity-producing resources. A goal of 12% of the world's electricity demand from wind by 2020 appears to be within reach. So is a goal of 20% of Europe's electricity demand by 2020. This development pace is consistent with the historical pace of development of hydroelectric and nuclear energy. The 20% penetration goal for the intermittent renewable energy resources is achievable within present utility operations, without requiring energy storage.

Solar Energy:

The energy from the sun can be used directly to heat or light buildings, and to heat water, in both developed and developing nations. The sun's radiant energy can also directly provide very hot water or steam for industrial processes, heat fluids through concentration to temperatures sufficient to produce electricity in thermal-electric generators or to run heat engines directly, and produce electricity through the photovoltaic effect.

It can be used directly to enhance public safety, to bring light and the refrigeration of food and medicine to the 1.8 billion people of the world without electricity, and to provide communications to all regions of the world. It can be used to produce fresh water from the seas, to pump water and power irrigation systems, and to detoxify contaminated waters, addressing perhaps the world's most critical needs for clean water. It can even be used to cook food with solar box cookers, replacing the constant wood foraging that denudes eco-systems and contaminates the air in the dwellings of the poor. Buildings: in the industrial nations, from 35% to 40% of total national primary use of energy is consumed in buildings, a figure which approaches 50% when taking into account the energy costs of building materials and the infrastructure to serve buildings. Letting the sun shine into buildings in the winter to heat them, and letting diffused daylight enter the building to displace electric lighting, are both the most efficient and least costly forms of the direct use of solar energy.

Data are mounting that demonstrate conclusively enhancements of human performance in day-lit buildings, with direct economic and educational benefits that greatly multiply the energy-efficiency "paybacks". The integrated design of "climate-responsive" buildings through "whole building" design methods enables major cost-savings in actual construction, normally yielding 30% to 50% improvement in energy efficiency of new buildings at an average of less than 2% added construction cost, and sometimes at no extra cost.

Serious long-range goals for the application of solar domestic water and space heating systems need to be established by all governments, totalling several hundred million square meters of new solar water heating systems world-wide by 2010. A worldwide goal of 100,000 MW of installed concentrating solar power (CSP) technology by 2025 is also an achievable goal with potentially great long-term benefits.

Photovoltaic (PV) solar electric technology is growing worldwide at an amazing pace, more than doubling every two years. The value of sales in 2002 of about US$ 3.5 billion is projected to grow to more than US$ 27.5 billion by 2012. PV in developed and developing nations alike can enhance local employment, strengthen local economies, improve local environments, increase system and infrastructure reliability, and provide for greater security. Building-integrated PV systems (BIPV) with modest amounts of storage can provide for continuity of essential governmental and emergency operations, and can help to maintain the safety and integrity of the urban infrastructure in times of crisis. PV applications should be an element of any security planning for cities and urban centres in the world.

Policy:

The White Paper stresses the importance of governmental policies that can enhance the overall economic productivity of the expenditures for energy, and the great multiplier in the creation of jobs from expenditures for the renewable energy resources rather than for the conventional energy sources. Utilities are not in the job producing business, but governments are, supporting the need for governments to control energy policies and energy resource decisions.

National policies to accelerate the development of the renewable energy resources are outlined, emphasizing that mutually supporting policies are necessary to generate a long-term balanced portfolio of the renewable energy resources. Beginning with important city examples, the discussion moves to national policies, such as setting renewable energy standards with firm percentage goals to be met by definite dates. The specific example of the successful German "feed-in" laws is used to illustrate many of these points.

Market-based incentives are described in the White Paper, to compare with legislated goals and standards, and discussed in terms of effectiveness. It is shown that various voluntary measures, such as paying surcharges for "green power", can provide important supplements to funding for renewable energy, but that they cannot be sufficient to generate reliable, long-term growth in the renewable energy industries, nor to secure investor confidence. Reliable and consistent governmental policies and support must be the backbone for the accelerated growth of the industries.

It is also shown in this White Paper that the energy market is not "free", that historical incentives for the conventional energy resources continue even today to bias markets by burying many of the real societal costs of their use. It is noted that the very methodologies used for estimating "levelized" costs for energy resources are flawed, and that they are not consistent with the more realistic economic methodologies used by modern industries. Taking into account future fuel supply risk and price volatility in net present valuations of energy resource alternatives paints a very different picture, one in which the renewable energy resources are revealed to be competitive or near-competitive at the present time.

The White Paper concludes with the presentation of two comprehensive national energy policies to demonstrate the method of integration of various individual strategies and incentives into single, long-range policies with great potential returns, including

- National multi-year goals for assured and increasing markets for renewable energy systems, such as „Renewable Energy Standards" (also called, in the U.S., „Renewable Portfolio Standards", or RPS), or the EU Renewables Directive, especially when formulated to support balanced development of a diversity of renewable energy technologies;
- Production incentives, such as "feed-in" laws, production tax credits (PTC), and net metering;
- Financing mechanisms, such as bonds, low-interest loans, tax credits and accelerated depreciation, and green power sales;
- System wide surcharges, or system benefits charges (SBC), to support financial incentive payments and loans, R&D and public interest programs;
- Credit trading mechanisms, such as Renewable Energy Credits (RECs) or carbon reduction credits, to enhance the value of renewable energy, to increase the market access to those energy sources, and to value the environmental benefits of renewables; specific governmental renewable energy "quotas" for city and state renewable energy procurements;

- Removal of procedural, institutional and economic barriers for renewable energy, and facilitation of the integration of renewable energy resources into grids and societal infrastructure;
- Consistent regulatory treatment, uniform codes and standards, and simplified and standardized interconnection agreements;
- Economic balancing mechanisms, such as pollution or carbon taxes (which can then be diverted as "zero sum" incentives to the non-polluting and non-carbon technologies);
- "Levelling the playing field" by redressing the continuing inequities in public subsidies of energy technologies and R&D, in which the fossil fuels and nuclear power continue to receive the largest share of support.

Solar Energy from Then to Now and Beyond

Solar energy is not an "alternative energy". It is the original and continuing primary energy source. All life and all civilizations have always been powered by solar energy. Expanding the technical applications of solar energy and its other renewable energy cousins to carry civilizations forward is simply a logical extension of its historic role, but also the inescapable key to achieving sustainability for human societies.

The White Paper is available from http://whitepaper.ises.org/

More Information about the "Energy Rich Japan" Project (Reports, Simulation, Animation): www.energyrichjapan.info

Full Solar Supply of Industrialized Countries – The Example Japan

It has long been known that to protect people and the environment from both nuclear risks and dangerous levels of climate change, we must phase out the use of nuclear and fossil fuels, and switch to clean energy technology instead. Using Japan as a example, the "Energy Rich Japan" Project illustrates that the vision of a clean, green, energy-rich future is not only possible, but globally feasible.

Renewable energy technologies using regional or global sources, coupled with a reduction in energy use by adopting energy efficient technologies, offer the only safe and proven option open to us for future energy needs. The objective of this study is to show that a region such as Japan is able to supply all of its own energy needs with this option, and to use the report to influence the discussion over the change from fossil and nuclear energy sources to a sustainable energy system.

Japan is a heavily industrialised country, with a population of 127 million living in a small island nation, yet in 1999 it was the world's second most powerful economy, with an industrial base that was recognised as one of the most energy efficient globally.

Japan was forced to become relatively energy efficient because it has very little domestic supplies of what are known as conventional energy sources. This industrial powerhouse meets the bulk of its energy demand by importing nuclear

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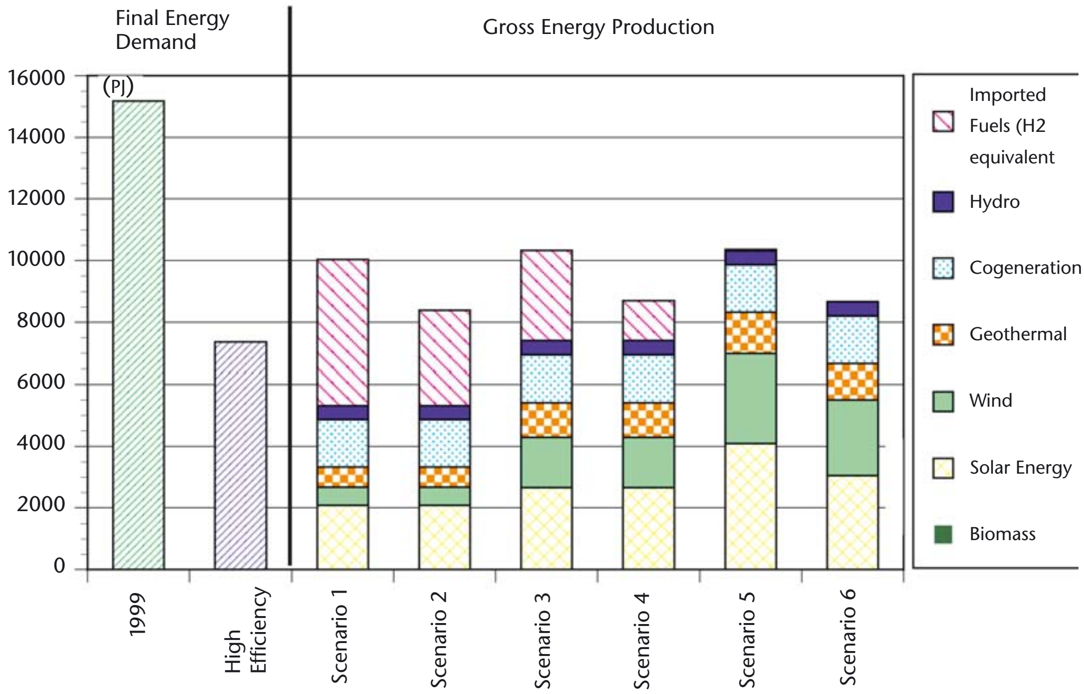
Figure 1
Demand 1999 and the High Efficiency Model



Six Supply scenarios with different dependance from imports (Imported Fuels). Scenarios 2,4 and 6 assume a decreased population of Japan. Biomass is set to zero because of not having enough data about the sustainable potential in Japan. Knowing this potential it can substitute Hydrogen fuels.

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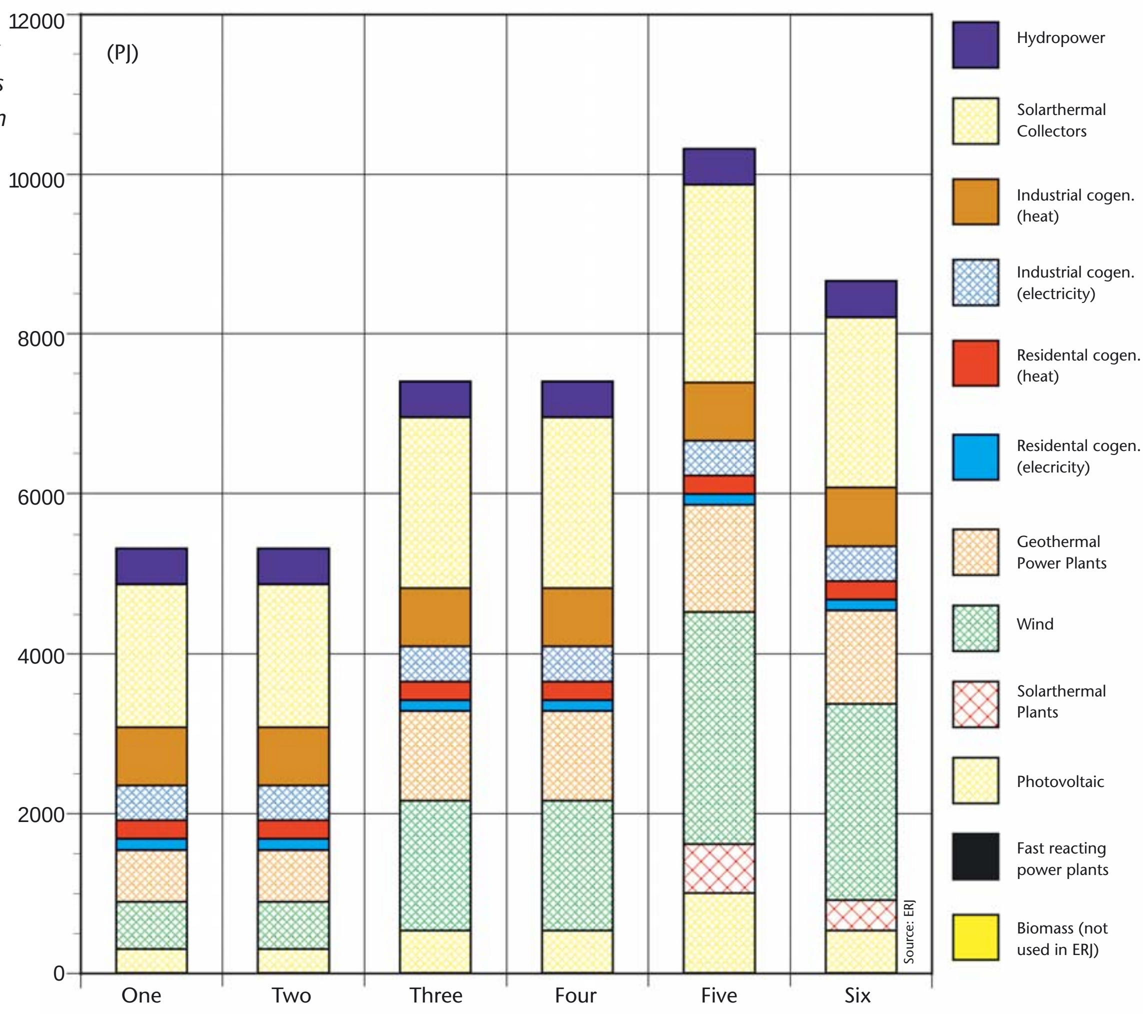
Figure 2
Domestic gross energy production in petajoules using energy conversion technologies from renewable sources in Japan as used in the six scenarios.



This is the production of electricity and heat in the installed power plants. Biomass, although listed is set to zero because of the unavailability of the potential of sustainable produced biomass.

and fossil fuels, supplemented by a small amount of domestic oil and gas production, as well as some hydro and geothermal power. Japan's total primary energy consumption in 1999 stood at just over 22,970 Petajoules, (A Petajoule is a 1000 million, million joules). Of those, 18,500 Petajoules (80 %) were imported as nuclear and fossil fuels.

Yet Japan could be independently rich in energy. Using baseline data from 1999, the "Energy Rich Japan" report shows how a combination of the best energy efficiency technologies available today, and a massive investment in renewable energy, could ultimately provide Japan with 100 % of its energy needs from renewables – including transportation fuels – without expensive and environmentally damaging imported fossil and nuclear fuels. Rather than seeking "energy security" through its hugely expensive and polluting nuclear program, for example, Japan could instead build its own renewable energy industry. As an energy-hungry and supposedly "resource- poor" country, Japan could make this transition to clean, renewable energy without any sacrifice in living standards or industrial capacity.

The report takes Japan's current energy use, based on 1999 levels, and shows that demand could be reduced by 50 % with energy efficient technologies that are already available around the world today. The "ERJ High Efficiency Demand Model" showed that using highly energy efficient technologies could save nearly 40 % of today's energy consumption in the

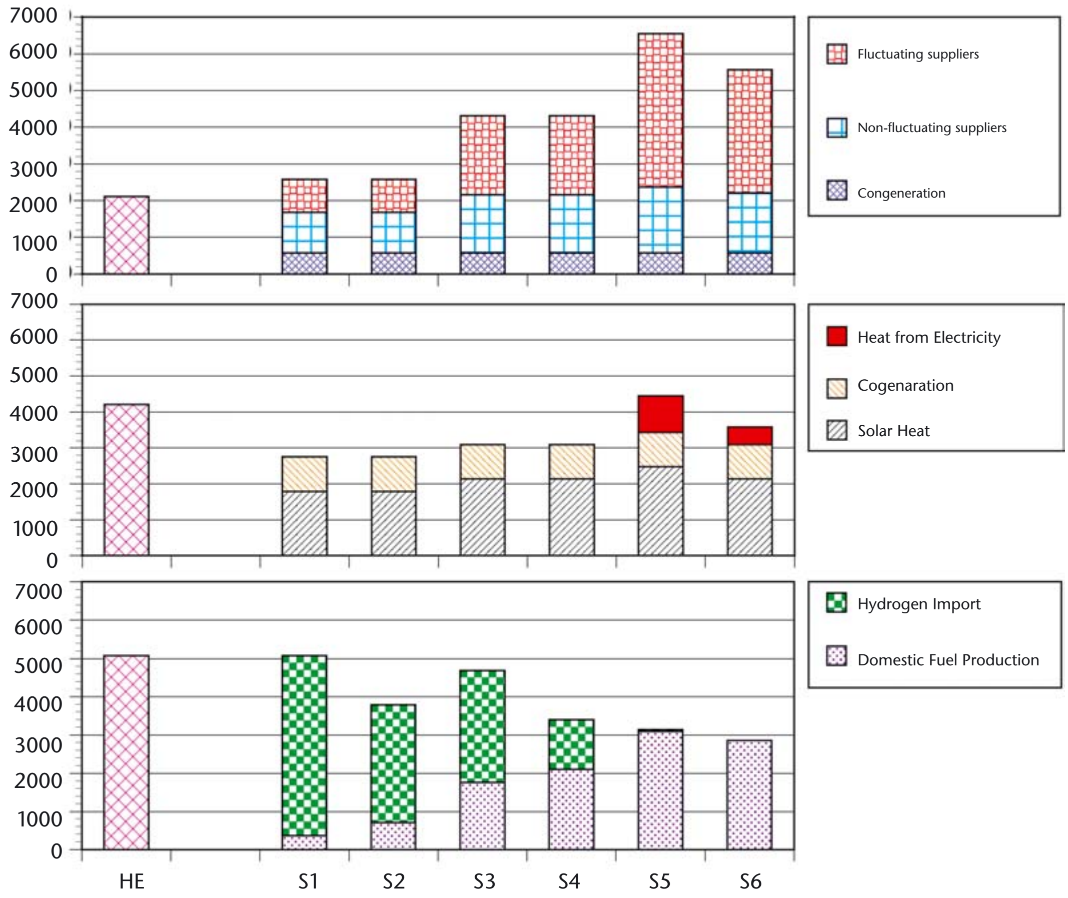


Figure 3

Electricity, heat and fuel production in all six "Energy-Rich Japan" scenarios.

Electricity surplus is used for heat and fuel production. Biomass, although listed is set to zero because of the unavailability of the potential of biomass produced in a sustainable manner.

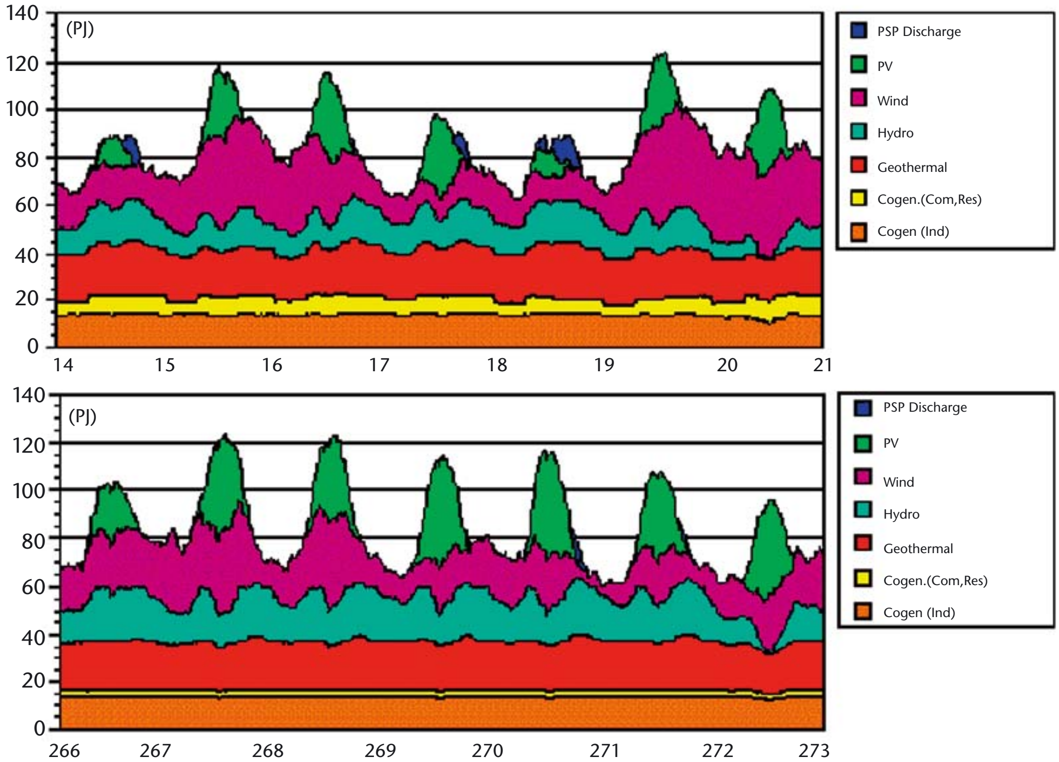
industrial sector, more than 50 % in the residential and commercial sectors and about 70 % in the transport sector.

It then shows how renewable energy could be used to meet that new level of demand, reducing and ultimately eliminating the need for imports. Six scenarios of how this might happen are outlined in the report, all of which can provide 100 % renewable energy for Japan. Starting from a basic model (Scenario One) providing more than 50 % of total energy needs from domestic renewable sources, each subsequent scenario provides variations or expansions on Scenario One, gradually reducing the reliance on imported energy, factoring in different population projections and expected improvements in renewable generation capacity and energy efficiencies, until by Scenarios Five and Six, no energy imports are required.
As supply reliability is most acute in the electricity sector where supply and demand must be fully matched in time, a simulation of the Japanese electrical power system and part of the heating system was done with the computer programme SimREN.

This study does not attempt to answer two key questions: How quickly can such a system be implemented and how much will this system cost? To demonstrate the possibility of a solar energy supply for Japan, it is not necessary to specify the costs and the timeframe such a development will require.

The systems described here provide a framework for a debate about the restructuring of the Japanese energy economy. However restructuring with renewable energy does not need to be limited to the ideas described in this report. Other systems that can supply Japan with renewable energy are also possible.
All of the scenarios are able to be met in Japan, both in technical terms and in terms of natural

Figure 4
The figures show the dynamics of electricity generation for two weeks of the year.



The supply-system always produces enough electricity to cover the demand. If there is low electricity production of windenergy and photovoltaics at the same time, pumped storages get used to guarantee full supply (see days 14, 18, 19 and 271).

resources, such as wind, solar radiation and geothermal capacity. The decisive factors will be public acceptance, priorities set by national policy in terms of energy security and international commitments and the future development of renewable energy technologies. "Energy Rich Japan" is an ambitious concept, yet conservative in its methodology. Admittedly its implementation would involve considerable investment in infrastructure and far reaching changes to the way Japan designs and builds its future industrial, residential, commercial and transport sectors. Compared to the environmental dangers faced globally by climate change and nuclear accidents, the costs of not developing sustainable energy systems, be they in Japan or anywhere around the world, are potentially far greater.

How to achieve to a sustainable energy system is the question, we hope, we have addressed with this study. What we need now is the desire and will to make it happen.

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