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Networked Knowledge for Renewable Energies

Research, Development and Education – Basis for Wide-spread Deployment of Renewable Energies

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Integrating Renewable Energy Into Society

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.

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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.

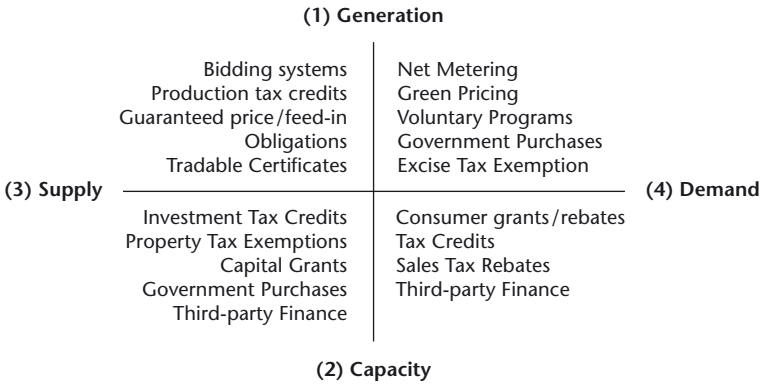

Figure 1
Market Deployment Policy Instruments

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

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):

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

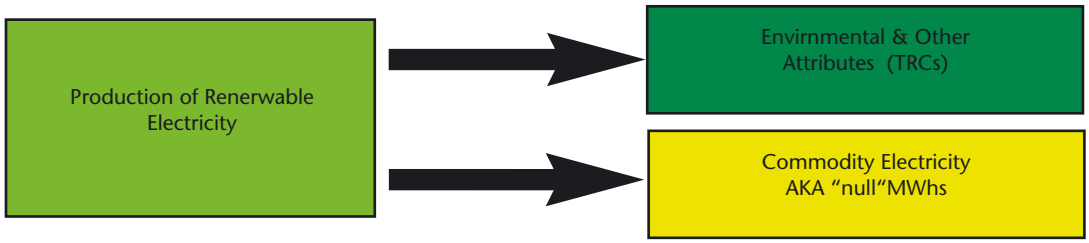

Figure 2
Relationship between Renewable Energy, TRCs, and Commodity Energy

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.

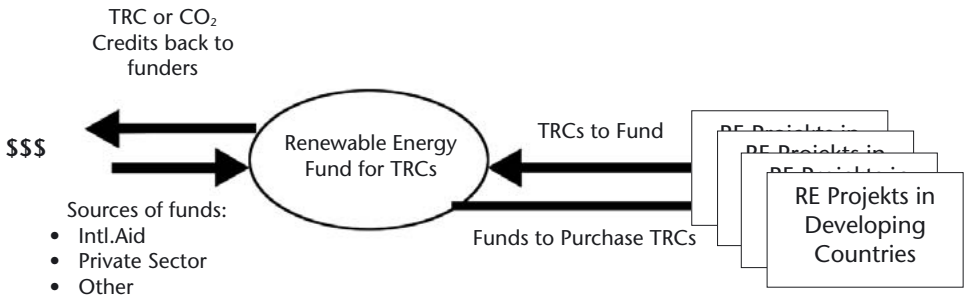

Figure 3
TRC Based International Financing Mechanism

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.