RENEWABLE ENERGY – OPPORTUNITIES AND CHALLENGES FOR THE FUTURE

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Abstract - As the world comes to grips with the challenges of supplying energy to a growing population in a safe and efficient manner, the old paradigm of energy supply based on fossil fuel resources will not be adequate for the demands of the 21st Century. This document analyzes some of the issues faced by Electric Utilities and policymakers in bringing renewable energy into the power mix. The article presents an overview of some of the challenges and opportunities for the widespread introduction of renewable energy as well as some of the policies and mechanisms that have proven successful in stimulating the development of renewable energy in the United States.

1. Overview

Renewable energy (energy generated from the sun, wind, water, biomass and geothermal resources) is not a novel concept. Society initially relied on small-scale renewable energy i.e. hydropower and windmills. It is the industrial revolution of the 18th Century that set the stage for fossil power and propelled us into the fossil fuel dependant economy of today.

Indeed the Western World today relies heavily (about 95%) on large central power stations and complex power grids to deliver the energy necessary to run our daily lives. Over the last three decades we have begun, albeit too slowly, to realize that fossil energy has reached its peak; it is an exhaustible resource for which alternatives must be found both from a practical point of view as well as to ensure our own ecological and economic well being.

Energy, admittedly the most important sector for societal development, however, has not been allowed to develop the diverse potential of renewable resources as part of its portfolio to ensure the success of these resources and integrate them into the grid. A possible reason for that is the reality that renewable energy is not a novel concept. For the average consumer, electricity is the same whether it is generated with fossil or renewable energy as long as the light comes on with the flip of a switch. In addition electricity, although it powers a myriad of appliances, instruments and other various “gadgets,” does not stand as a status symbol or an identifier in and of itself, like the house we live in, the cars we drive, the phones, televisions and computers we use. Electricity, for all intensive purposes has been invisible to most of us and we like it this way.

The common person as a collective has not really been involved in the evolution of the energy industry (except in very rare occasions through concern i.e. acid rain, electromagnetic fields, strip mining, etc. or even outrage over the disasters in Chernobyl, Exxon Valdez, the accidental spill at Three Mile Island, etc). Everyday customer needs have traditionally been accommodated to a much larger extend in the design of vehicles, cell phones, computers and

appliances which we touch every day. Electricity is an intangible commodity or an invisible service we have come to rely on to power our existence.

It is only during the last decade that energy has started to obtain a different image for the average customer. We have seen some interesting concepts develop that cater to an informed customer's needs. Programs such as "green pricing initiatives" which allow a customer to **voluntarily** pay more on their bill every month to ensure that a portion of their energy comes from renewable resources have gained some popularity. In addition customers are eager to turn to solar energy and install systems in their homes if cost considerations are addressed as well as system aesthetics, maintenance and ease of installation. Environmental and health concerns, heightened awareness of the electricity supply and grid, as well as power reliability and security tensions have empowered customers to seek new options and increasingly demand access to renewable energy. The industrial and commercial sectors, motivated mostly by economic concerns, have also focused on distributed generation, energy efficiency and conservation measures to address growing energy concerns, power supply quality and reliability as well as escalating electricity costs.

Some power suppliers are responding to the new customer demand for renewable energy by voluntarily supplying green electrons to their customers (i.e. Green Mountain Energy, Sacramento Municipal Utility District "SMUD," Austin Energy, Los Angeles Department of Water and Power "LADWP," to name a few), however, voluntary programs have had only limited success. To ensure the rapid, large-scale deployment of renewables, there has to be some sort of a legislative mandate (the German Renewable Energy Act, Japan's Solar Program are great examples of successful initiatives as well as policies implemented in the United States, such as California's 20% renewable energy portfolio standard requirement by 2017, etc). Effective public policy and legislative mandates will ensure that renewable resources become an integral part of every utility's portfolio. Certainly there are challenges as well as opportunities when changing the current focus and infrastructure as it relates to energy, however without addressing the challenges and capturing the opportunities, everybody loses in the end.

2. Challenges and Opportunities

Challenges and opportunities facing the widespread deployment of renewable energy technologies will be examined in three aspects: technology, customer and economics.

2.1 Technology

Conventional fossil fuel energy resources are technologically complex and it often takes decades to build a large-scale power plant, related transmission and distribution infrastructure and fuel supply chains. The operation and maintenance of such equipment is costly and time consuming. Traditional electric utility companies have gained a certain expertise in deploying large-scale power plants over the last century and thus, we rely on a complex often outdated and highly complex power supply system. Renewable energy technologies are often much more simple to build (solar and wind power systems can be installed in a matter of days) and long term fuel supply is not an issue, thus operation and maintenance costs over the life of the equipment are considerably lower. Nevertheless, renewable energy technologies have not made their way into the energy mainstream and are still considered costly, inefficient and cumbersome.

Traditional energy suppliers are accustomed to dealing with energy in high volumes -- hundreds of Mega Watts in size and in a very centralized manner. Renewable energy and

distributed generation technologies are small – typically a few kilowatts, highly scalable and very flexible. Electric utilities are not structured to accommodate small-scale distributed energy into the electricity grid and balk at the idea that customers may opt to do it for themselves instead of seizing upon the situation as a new market opportunity, particularly in a context of electricity deregulation. Therefore, new industries and business structures for renewable energy, similar to those that encouraged the development of cell phones and computers must be developed.

The main problem that seems to hinder the development of renewables during the last 20 years in comparison to cell phones, computers and other micro-technologies is that renewable energy did not emerge as a commodity to fill a vacuum. When personal computers and cell-phones first emerged in the 1980s they commandeered a market unto themselves and specific business structures to accommodate them evolved. Originally heavy, bulky, not very attractive or user friendly they were quickly perceived to provide a heretofore unmet "need" and filled a niche in which they were the only "game in town." This new market spurred the infusion of massive research and resources to shrink the equipment to a size that is a fraction of the early version. With improved efficiency and user friendliness, prices fell and now PCs and cell phones have become ubiquitous almost overnight. Additionally, the phone companies did not stand in the way of the development of a new "wireless" network and new companies were allowed to grow and prosper

Renewable energy shares some of the features of wireless technologies, such as scalability, flexibility, customer contact and ability to integrate with other products – i.e. building integration, in the case of solar, mobility, scalability and flexibility, yet their deployment is vastly underutilized. Perhaps now is the opportunity to tap into a resource that has remained relatively neutral in the energy game – the customer.

2.2 Customer

In the context of an energy void, the customer exercises tremendous powers and can create history and necessitate market development i.e. PCs and cell phones. The impetus for the development of electricity itself began by popular demand. For instance the Columbian exposition at the Chicago World's Fair of 1893 was the start of an energy revolution. This is the venue where both the incandescent light bulb and the alternating current proved that they were ready for large-scale applications. Some of the people responsible for the success of the Fair were George Westinghouse, Nikola Tesla and Thomas Edison… Roughly 26 million tickets were sold during the Fair's six-month exhibition when the total population of the United States in 1893 was about 65 million. None of the visitors had ever seen such an incredible display – the exteriors of the Grand Buildings were white, illuminated by 8,000 arc lights and 130,000 incandescent bulbs – as a matter of fact few had ever seen electricity, however, after having witnessed the dazzling electrical display, naturally all of them wanted electricity and they all wanted it NOW. The nation was extensively electrified within just a few short decades.

Popular demand, government support and programs, as well as the evolution of new industries, ensured the successful development of the electric industry. We now face the renewable energy era and need to marshal all resources to enable customers to utilize the technological breakthroughs of renewable energy. The task is not easy and there is a highly demanding, often skeptical consumer population still feeling the burn from the failure of the very unaesthetic solar thermal systems and the stigma associated with energy conservation in the 1970s as well as a utility industry unwilling to embrace change and new technology.

Although the consumer base is enthusiastic and prepared to embrace renewables as well as a host of improved energy efficient appliances as part of the energy chain, manufacturers and policymakers still need to ensure that the technologies are cost effective, that no artificial barriers are imposed, such as exit fees, interconnection requirements, etc. and that the full value of the technology is accounted for. In addition new industries and consumer focused energy providers should be given an opportunity to grow and develop in a still largely monopolized energy field.

2.3 Economics

With technological improvements we typically also see a reduction in price, particularly when there is mass production and widespread product application. To this extent renewables have a good position. The present arrays of renewable energy technologies have virtually been perfected. Small-scale hydropower is as efficient as it will ever be and costs no more than fossil powered generation; windmill technology has made tremendous strides over the last 10 years, particularly in countries, such as Germany with a strong national commitment to renewable energy. Solar power has been perfected in space over the last 20 years and we now need to bring it back to Earth and make it cost effective for all.

Most renewables are still considered costly, but costs have steadily decreased over time and will continue to do so. For example, the annual electricity in Germany supplied by wind power in 2002 was 12.001MW, compared to 1.094 MW in 1995.[8] Meanwhile solar photovoltaic energy (PV), apart from being perfected in space, has improved its efficiency over the last 20 years from 8 percent to 16 percent. Production costs have also decreased from $25,000 per kilowatt to $3,000 per kilowatt. Worldwide sales of solar energy in the 1970s were around $2 Million; today it is a billion dollar industry.[9]

Aesthetics have also improved dramatically, as modern renewable energy technologies are integrated with the landscape – in the case of windmills and hydropower, while solar electricity is increasingly blended in building integrated materials such as rooftops, facades, awnings, atriums and windows.[10] Solar architecture has become an ever-popular trend among architects and with the availability of flexible, textured materials, will have growing applications for substituting building material. In addition widespread renewable energy deployment means local jobs and economic development.

In a world filled with concern over power supply, grid failures, environmental disasters and security concerns, customers are becoming increasingly used to the notion of energy conservation and conservation no longer means drinking warm beer and sitting in the dark. Local, homegrown, clean, fossil free energy is becoming increasingly appealing and desired. A recent Newsweek poll indicates that 85% of Americans nationwide favor increased funding for the development of solar and wind power. This is a significant majority that cannot be long ignored.

Thus the customer base is poised and enthusiastic to embrace renewable and energy today. It is our insurance policy against price spikes, grid failures, dwindling fuel supplies and global warming. Renewable energy is also the fastest and safest way to bring energy and with it education, jobs and healthcare to remote areas of the world. It is no longer a technological

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[8] Bundesministerium fur Umwelt, Naturschutz und Reaktorsicherheit, *Umweltpolitik, Erneuerbare Energien in Zahlen,* Stand – March 2003. See also, Attachment A for additional data.

[9] Projections from; California Energy Commission 2001-2012 Energy Outlook Report. In addition, see Attachment B for specific market projections related to solar PV.

[10] See Attachment C for examples.

challenge and the price reductions will continue to make it increasingly affordable for those already connected to the grid and accessible to those in impoverished remote areas. In addition, solid public policy and related legislation will always play a major role in the development and deployment of technologies.

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3. Public Policy

Although customer demand and acceptance is critical, sound public policy and long-term commitments are also an absolute necessity for the development of renewable energy resources. Programs that have proven to be most successful in the past are those with solid national commitments for the development of renewable energy such as the programs in Japan and Germany. As a result of national programs Japan is now the world leader in solar energy, while Germany has established a leadership role in wind power. Voluntary green pricing programs, mostly utilized in the United States have limited success. Overall an average of 3-5% of a utility's customer base actually signs up to pay for the premium, although an overwhelming 80% support the development of renewable energy. The reality is that people may be supportive, but few will pay more voluntarily. Therefore, it appears that a strong legislative mandate will yield better results.

Success is almost always guaranteed when there is a government demand for a specific application, for example the seat belt laws, and fire safety and energy efficiency standards. It was government policy that set the stage for the development of these technologies often over the protests of the manufacturers. Even in such cases, success is not always absolute, for example the electric vehicle initiative in California was not as successful due to strong opposition from the automobile manufacturers, lack of a nationwide program, technology limitations and small-scale customer support. However, the advance of the now highly popular hybrid vehicle is a direct result of California's stumbling electric vehicle program.

Mandates can be effective on a national, regional and local level. Indeed individual states and municipalities, which have implemented renewable energy incentives, have witnessed the development and deployment of technologies on a wider scale. The two versions that have yielded the best results are programs based on a renewable energy portfolio standard (RPS) or direct subsidies.

3.1 Renewable Energy Portfolio Standard (RPS)

Several states have implemented an RPS program (California, Arizona, Illinois, New Jersey, New York, etc), which requires that a certain amount of the energy mix (usually 20%) be provided by renewable resources. These programs are focused on all renewables and only Arizona differentiates among some of the resources and requires a set aside for solar energy. As a result over the last few years over 7 MW of solar power generation has been deployed in Arizona and system costs have been reduced by over 40%. [11]

Generally, what we have experienced as a direct result of the RPS approach is that utilities will naturally gravitate towards the lowest cost resource (hydro, wind, biomass) and ignore the more expensive applications such as solar power, in an understandable effort to bring the largest percentage online at the lowest possible cost. Arizona requires that a portion of the RPS (about 5%) be supplied by solar energy and as a result the State has seen an increase in solar installations. The outcome is exactly the opposite if there is no set aside for the more costly resources or if no separate program to encourage their deployment exists.

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[11] SEPA UPEX Solar 2003 Annual Conference, Keynote address, Janet Napolitano, Governor of Arizona, October 8, 2003.

The same theory holds true abroad. The first version of the German Renewable Energy Act provided the same level of incentives for all renewable resources and although there was a tremendous boost in wind generation, increase in solar generation was negligible. The current version of the legislation provides for a larger incentive for solar PV (40 cents per kWh generated into the grid, the largest in the world) and production has skyrocketed from almost nothing in 1995 to 262 MW_p by the end of 2002,[12] proving that not all renewable resources are "equal" and that we need to be cognizant of the results if specific provisions for differentiation are not implemented.

3.2 Incentive Programs

Incentive programs or subsidies are also an effective tool to promote the development of a specific resource. Tax incentives have provided a good basis for the development of bio fuels and renewable energy technologies in the United States. Specific local incentive programs have also been successful. For instance California's statewide buy- down program for solar systems of $4.0 per watt was instrumental in stimulating the deployment of solar energy.

Several Cities that have taken a leadership role and developed the basic State program further to meet their specific needs were: San Francisco which passed a $100 Million dollar bond for the construction of solar on government facilities; Sacramento Municipal Utility District (SMUD), with its evolution of the PV Pioneer Program, which allowed customers to "host solar systems on their roofs;" and the Los Angeles Department of Water and Power (LADWP) which has an additional incremental buy-down for local manufacturing. Thus if a solar system is manufactured and installed in LA, there is an additional incentive of $1.5 per watt (on top of the ($4.5) for a total of $6 per watt. LADWP also provides incentives for building integrated PV materials, which has spurred an interesting architectural development related to solar. Currently there are several architectural programs at LA Universities, which have curriculums devoted to solar architecture.

In addition, several landmark buildings have visibly incorporated solar power: including the LA Convention Center, LADWP headquarters, Johnson and Johnson Corporation, Loyola Marymount University, etc.[13] Perhaps the most notable of all will be the new California Department of Transportation Building due to open in late 2004, which will consist of over 80 kilowatts in the form of a south facing translucent solar façade, the largest in the country.

Incentive programs do work. As a result of the manufacturing incentive established in 2000, Los Angeles is now the center of solar power, with three major manufacturing facilities in the City (Shell Solar, PowerLight, Solar Integrated Technologies), thousands of additional jobs and the fastest growing PV program in the nation, with almost 4 MW of solar generation installed in three years. As with any program, the commitment to an RPS or incentive program should be solid, long term and transparent. If the incentives are arbitrarily and/or prematurely removed, industry will suffer and the public confidence will diminish.

Conclusion

It is important for policymakers, manufacturers and consumers to actively work together to establish a workable framework for renewable energy that appropriately balances the value and potential of all technologies. New structures, programs and policies to accommodate the development and deployment of renewable energy technologies should be encouraged. The dawn of the renewable age is here and if the collective will is there to demand better more

[12] For a detailed breakdown, please see Attachment A.
[13] See Attachment C for examples.

flexible, highly scalable, cleaner, local, inflation proof, fossil free, unlimited, renewable energy generation, it is only a matter of time before we see a paradigm shift in the right direction.

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Attachment A

Development of Energy supply from Renewable Energy installed power in Germany from 1990-2002

	Wasserkraft[1]		Windenergie		Biomasse Strom[2]		Fotovoltaik		Biomasse Wärme[3]	Solarthermie		Geothermie[3]	Biodiesel	Summe
	[GWh]	[MW]	[GWh]	[MW]	[GWh]	[MW]	[GWh]	[MW_p]	[GWh]	[GWh]	[1.000 m^2]	[GWh]	[GWh]	[GWh]
1990	15.908	4.403	40	56	222	190	1	2	k.A.	113	338	k.A.	k.A.	k.A.
1991	14.652	4.403	140	98	250	k.A	2	3	k.A.	145	466	k.A.	2	k.A.
1992	17.317	4.374	230	167	295	227	3	6	k.A.	189	582	k.A.	52	k.A.
1993	17.676	4.520	670	310	370	k.A.	6	9	k.A.	240	749	k.A.	103	k.A.
1994	19.495	4.529	940	605	570	276	9	12	k.A.	305	940	k.A.	259	k.A.
1995	20.865	4.521	1.800	1.094	670	k.A.	12	18	k.A.	380	1.156	k.A.	465	k.A.
1996	18.380	4.563	2.200	1.547	803	358	18	27	k.A.	476	1.453	k.A.	621	k.A.
1997	19.274	4.578	3.000	2.082	879	400	27	40	k.A.	599	1.817	k.A.	1.034	k.A.
1998	19.215	4.601	4.489	2.875	1.050	409	37	52	45.000	855	2.191	820	1.034	72.500
1999	21.798	4.547	5.528	4.444	1.170	448	48	67	45.000	1.036	2.638	870	1.344	76.794
2000	25.141	4.572	9.500	6.112	1.625	585	71	111	51.000	1.278	3.283	970	3.516	93.101
[4]2001	23.570	4.600	10.456	8.754	3.785	825	116	179	52.000	1.627	4.207	1.000	4.654	97.208
[4]2002	24.000	4.620	17.200	12.001	4.200	900	176	262	52.500	1.955	4.754	1.050	5.688	106.769

Name of Energy Sources from right to left:

Hydropower, Wind Power, Biomass Electricity, Solar Photovoltaic, Biomass, Solar Thermal, Geothermal, Bio-Diesel.

The last column represents the Total.

k.A. means no information.

Source: Bundesministerium fur Umwelt, Naturschutz und Reaktorsicherheit, *Umweltpolitik, Erneuerbare Energien in Zahlen,* Stand – March 2003.

Attachment B

SOLAR ELECTRIC MARKET POTENTIAL

Projected growth of the utility tie solar electric market

Year	California	National	International	Total Global
	Millions of Dollars			
2001	$85	$140	$1,755	$1,980
2002	$101	$203	$2,275	$2,579
2003	$121	$262	$2,781	$3,164
2004	$156	$350	$3,594	$4,100
2005	$178	$445	$4,367	$4,990
2006	$244	$567	$5,631	$6,442
2007	$287	$696	$6,802	$7,785
2008	$375	$891	$8,757	$10,023
2009	$451	$1,064	$10,515	$12,030
2010	$576	$1,361	$13,519	$15,456
2011	$719	$1,662	$16,752	$19,132
2012	$922	$2,105	$21,516	$24,543
2013	$1,138	$2,561	$26,601	$30,300
2014	$1,433	$3,253	$34,139	$38,824

Market Projections derived from data:

CAL SEIA - A Strategy for Widespread PV Deployment in California, 2/2001

CEC - Future of the Emerging Renewable Resources "Buy down" Program, 10/2002

CEC - 2002 - 2012 Energy Outlook Report

Solar Electric Power - Industry roadmap; National renewable Energy Laboratory (Department of Energy)

Solar Electric Power Association - Business Models Report, 12/2001

Solar Power Industry Association - Residential PV Systems Cost Report, 12/2001

IEA PVPS Program - Report 'Trends in photovoltaic applications, 2002'

Solarbuzz.com - Solar Energy Statistics

Attachment C

Integrating Renewable Energy Technologies into the City and Landscape

Los Angeles Convention Center (LACC)

Phase I - “LADWP” spelled out with dark solar cells

Neutrogena Corporation’s 200 kW system

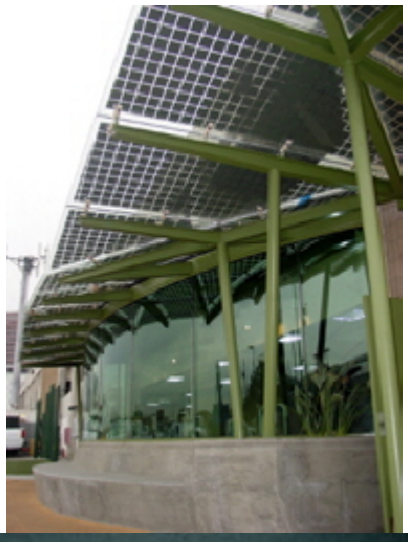
Largest PV installation in Los Angeles

Our Lady of the Angels Cathedral and Cardinal Mahoney

“Ra” - 150 kW system at LADWP headquarters:

PV power, car shade, EV charging station

Architecture students from Woodbury University designed a 4 kW system, which transformed an abandoned lot in Hollywood into a vibrant community garden.

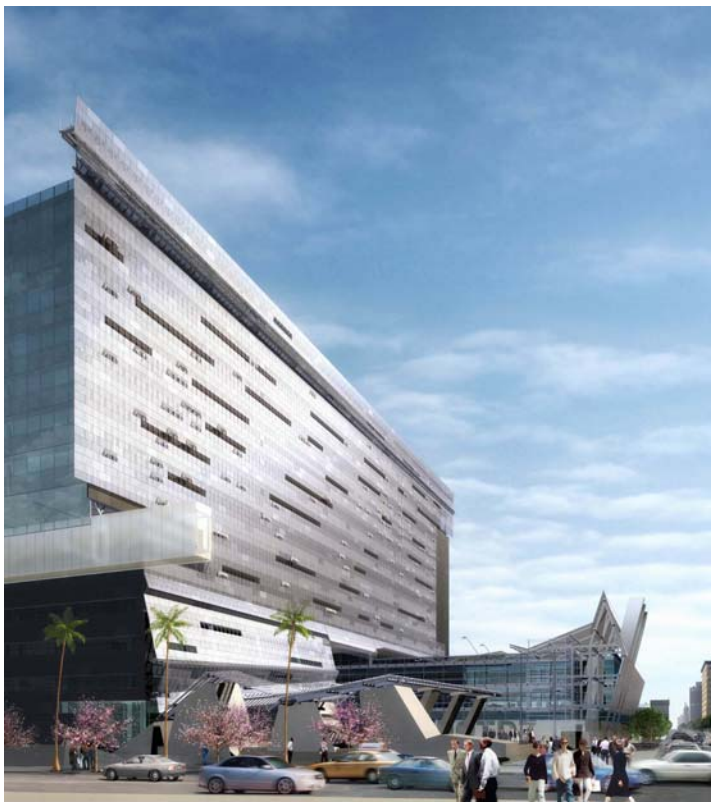


Designed for the physical well being of LADWP employees, the Temple-Duco fitness center features a glass photovoltaic skylight canopy. This BIPV (Building Integrated Photovoltaic) is the first installation of its kind in California.

Building Integrated Façade, Japan

California building integrated residential roofing – 3 kW systems

Wind farms close to San Francisco



California Department of Transportation Building, Downtown Los Angeles due to open 2005