Renewable Power Generation-

Conflicts in Micro, Macro, and Global Economic Decision Making

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Abstract

Renewable energies are the basis for a sustainable electricity generation. Interdependent decision making processes in industry, state and federal governments, and in the global context impose obstacles against an environmentally friendly restructuring of the electricity sector.

This paper discusses state-of-the-art renewable electricity generation technologies and restraints from creating a new energy system.

Strategic alliances between proactive utilities, state and federal politics and legislation, as well as global institutions would speed up the commercialization of renewable electricity generation and could prevent irreversible negative impacts to social and environmental systems.

A Strategic Approach towards Sustainability

The World Summit of Rio de Janeiro in 1992 advocated a sustainable global economy to cope with both current and future environmental and social problems. Fossil fuels used to generate electricity contribute significantly to environmental damage and may even change the world climate. Power produced from renewable resources such as solar, wind, and hydropower does not emit sulfur dioxide, nitrogen oxides, particulate matter, volatile organic compounds, or the greenhouse gas carbon dioxide.

The electric power industry in America and Europe is on its way towards a competitive market. Former vertically integrated monopolies are debating on how to separate the generation of electricity from other electric services, in order to allow customers to shop for the electric supplies of their choice. Markets for vertically unintegrated distribution utilities are feasible for achieving lower prices and costs [1]. Restructuring could be a chance for renewable energies to contribute a significant share to our future electricity supply.

Renewable technologies such as wind and waterpower or biomass have been used for centuries to provide energy. New high-tech technologies such as photovoltaics (PV), wind turbines, and micro hydropower generation are on the edge of commercialization. However, renewables have significant economic and political obstacles to surmount before they will be able to change our power base.

Companies, governments, and global institutions often discriminate against renewable technologies when making decisions. Short-term oriented economic decisions, conventional calculation methods, and political lobbying set up barriers against the market penetration of renewable energies.

Reshaping the electricity sector in an environmentally friendly way requires a comprehensive approach. As long as consumers, utilities, politicians, and environmentalists do not develop cooperative strategies to promote renewable energies and to overcome discrimination against non-fossil fuels by decision conflicts in the micro, macro, and global economy, the electricity sector will favor conventional power generation over renewable resources.

Consumer Economics – the Customers' Perspective

I. Consumers as Power Producers

Micro and macroeconomics were the first research areas of modern economics. Initially, consumers were regarded as end-users of the products produced by industry and service providers. Increases in productivity have surpassed the demand of consumers, resulting in an aggressively competitive climate. Economists now recognize consumers as an integral part of the economic environment. Because Utility services are different from one another, electric consumer, are classified based on the service they receive: Residential, Commercial, Industrial, etc. Some scientists even hold the opinion that modern industrial nations are shifting towards so-called consumer societies where people mainly have the function of consuming an ever-increasing amount of commodities produced by a highly productive industry. As a result, investment by Independent Power Producers (IPP's) is growing rapidly. Whereas the public sector can barely afford to be in business, consumers as power producers present an attractive alternative because of their potential for investment, Investment by IPP's is growing rapidly in Asia, Africa, South and Central America [2].

But consuming goods and services is not the only role consumer's play in today's economy. They can choose to buy commodities or to produce them themselves. People living in remote locations have produced their own power for decades using more and more efficient generation technologies such as small wind turbines, photovoltaic systems, or small hydropower generators. Advances in these technologies will make it soon economically viable even for grid-connected customers to produce their own current. A variety of grid connected Photovoltaic, have been installed throughout the world. Thailand introduced in 2002, a Very Small Power Producer (VSPP) legislation, where Solar, micro hydro, biomass and biogas generators, up to 1 MW per installation, are allowed to connect to the utility grid. Generators that produce less than they consume monthly, receive the retail tariff rate for electricity fed into the grid [3].

Emerging legislation on direct access and net metering offers commercial, industrial and residential consumers the possibility of setting up their own generation systems and selling power back to the grid. California was one of the leaders in electric restructuring and offered direct access for electric

customers. The self-generation incentive program rebate is provided through the California Solar Initiative. This initiative involves the installment of 3000 MW grid connected solar systems by the year 2016. Directed by the California Public Utilities Commission (CPUC), this program provides rebates in solar systems to customers. These rebates combined with other federal tax incentives lower the cost of solar systems. In April 2008, the CPUC raised the cap on cash incentives for individual clean energy projects available through the program, from 1 MW to 3 MW [4].

Residential photovoltaic systems, however, are not economical unless consumers use a long-time evaluation period to calculate the cost-effectiveness of their high up-front capital investment. As a technology that is evolving rapidly, PV systems are now being integrated directly into building roofs, envelopes and surrounding spaces. [6].

Savings on utility bills, federal and state solar tax credits, and other tax benefits will compensate for today's high system costs for residential off-grid or grid-connected PV systems [7]. The new energy policy act (EPACT) of 2005 directs federal government to increase its renewable energy use with a goal to use 3 % or more from 2007 through 2009, 5% from 2010 to 2012 and 7.5% or more by 2013.Cooperation with utilities such as in green pricing programs could make it easier for consumers to finance and operate residential photovoltaic systems. An electric utility could act as the financing agent because most residential and commercial customers would be unlikely to devote a large amount of up-front cash to purchase a photovoltaic system. Many Utilities have a voluntary program that allows customers to sign up to purchase renewable energy. Even in states with competitive electricity markets, federal agencies can purchase renewable power through competitive electricity procurement [8]. A strategic partnership between utility companies and customers could benefit both sides and speed up the commercialization of renewables technologies.

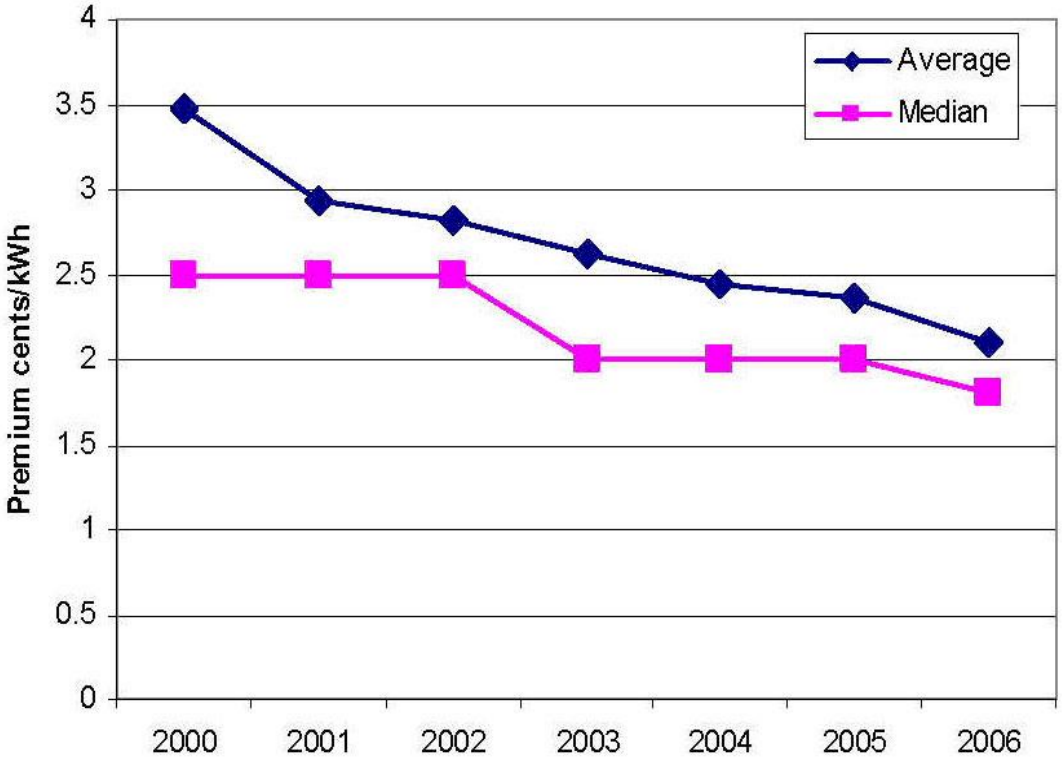
II. Green Pricing Programs

Consumers who do not have the possibility of producing their own electricity still have the option of buying clean power. Renewable electricity generation usually requires a high up-front cost investment, while being less expensive than fossil fuel generation in the later years. Renewable fuels such as solar

radiation and wind or waterpower are free, and not exposed to volatile fossil fuel costs. Signing green pricing contracts with a utility or an electric service provider helps customers to buy renewable energy when they do not have the necessary up-front capital or an adequate location to set up their own power generating system.

Green pricing programs have been established by some utilities even before the restructuring process. Customers can choose additional payments on their utility bill in order to support renewables, one-time-contributions, or even having their own photovoltaic system installed on their rooftop, maintained and financed by their utility. Under these programs, consumers can purchase renewable energy from independent renewable energy marketing companies without switching their electricity service from the default or standard service provider [9]. The acceptance of green pricing programs is highly dependent on the program's reputation of being reliable and non-discriminatory. An electric utility that offered two different green pricing rates for identical service due to cost savings in later green pricing projects had to offer the same low rate to all customers after consumers had realized that they were billed on an unequal basis. Voluntary markets for green power provide a platform for consumers to support the development of renewable energy sources by enabling them to choose cleaner electricity sources for their own energy consumption [10].

Chart 1: Trend in utility green pricing premiums, 2000-2006



Source: Bird and Kaiser (2007)

The free-rider-problem could significantly restrict green-pricing programs or the devotion of consumers towards renewable energies in general. Customers willing to pay more for clean power will bear the full cost but cannot exclude any other resident from the benefits of an improved environment or better human health. This could discourage former participants of green power programs to make future purchasing decisions in favor of renewable energies. Utility green pricing sales continues to show upward trend. In 2006, utilities in regulated market sold about 3.6 billion KWH of green power to customers (Table 1). A considerable growth by 39%, attributed to expansion in customer base and larger purchases by non residential customers [11].

Annual Sales of Green Energy through Utility Green Pricing Programs (Regulated Electricity Market only), in Millions of KWH

	2003	2004	2005	2006
Sales to Residential Customers	874	1,295	1606	2103
Sales to Non residential Customers	400	544	842	1,302

Source: Bird and Kaiser (2007)

Using renewables would have been economical a long time ago, if there had not been inaccurate price signals in the market. Insufficient internalization of such external factors as pollution or negative impacts on human health as well as subsidies on nuclear power and coal made fossil fuels the least-cost alternative for utility decisions on capacity investments. As long as there is no adequate internalization of externalities, renewable technologies will not be cost-competitive with fossil fuels in the short-term view.

Apart from distorted price signals, consumer faces difficulties making decisions due to insufficient information on energy options. Education efforts will be necessary to enable consumers to make informed buying decisions in a future competitive market. Competing electric utilities and power providers will use marketing strategies which may confuse the customer and make price and quality comparisons difficult. Renewable energy sources could benefit from marketing strategies such as branding. Although the final electrons used by the consumers cannot be traced back to their origin, electricity providers may well be able to attract customers by promising renewable electricity generation for the amount of power purchased by the customer. Whether marketing strategies will be an asset or a liability for renewables is yet unclear and depends on the consumers' commitment and responsibility.

Microeconomics – the Utilities' Perspective

I. Decision Practices in Utilities

In a regulated environment, utilities did not have to fear competition since they were guaranteed a monopolistic status in their own service territories. In those days the electric utility industry was seen as a natural monopoly and utilities could easily invest and expand generation capacities without assessing the actual future energy demand or legislative restrictions. Traditional rate-of-return regulation guaranteed utilities to cover any expenses and yet allowed them to make reasonable profits [12]. The utilities' ratepayers and the nation's taxpayers had to bear the risk and costs of shortsighted decisions and miscalculations.

Deregulation changed the structure of the electric power industry. Utilities have to compete against each other as well as against new competitors such as industrial cogenerators, power service providers, and small power producers. Utilities take over the decision patterns of other industrial companies such as institutionalized and bounded rational decision patterns. As in any competitive industry, the introduction of new technologies will mean restructuring the utility's organization. Since restructuring often reduces hierarchies and simplifies the organizational structure, changing a utility's business strategy towards renewables may be rejected by the middle management that fears to lose its current leading position.

Decisions in a liberal and highly dynamic market tend to be focussed on a short-term rather than a long-term orientation favoring investment alternatives with low up-front costs such as fossil fuel generation technologies. Also, fossil fuels receive subsidies through favorable tax treatment [13]. The values of renewable energies that do not show benefits until the long run might be underestimated. Traditional cost analysis techniques do not regard the benefits of renewable technologies. External effects have rarely been taken into consideration when deciding for future generation capacities since utilities usually did not have to pay for the damage their production process caused [14]. However, restrictive environmental legislation such as the introduction of carbondioxide taxes, pollution standards, tradable emission permits, and efficiency regulation could lead to a change. Modern risk-management calculations try to address the

specific features of renewable energies by estimating the value of uncertainties in environmental regulations, fuel prices, future energy demand, capital cost, electric outages, and the dynamics of a competitive market. Energy politics will soon be dominated by climate protection measures and an even include the development of early co2 reduction strategies so that corporations will have edge over others. [15].

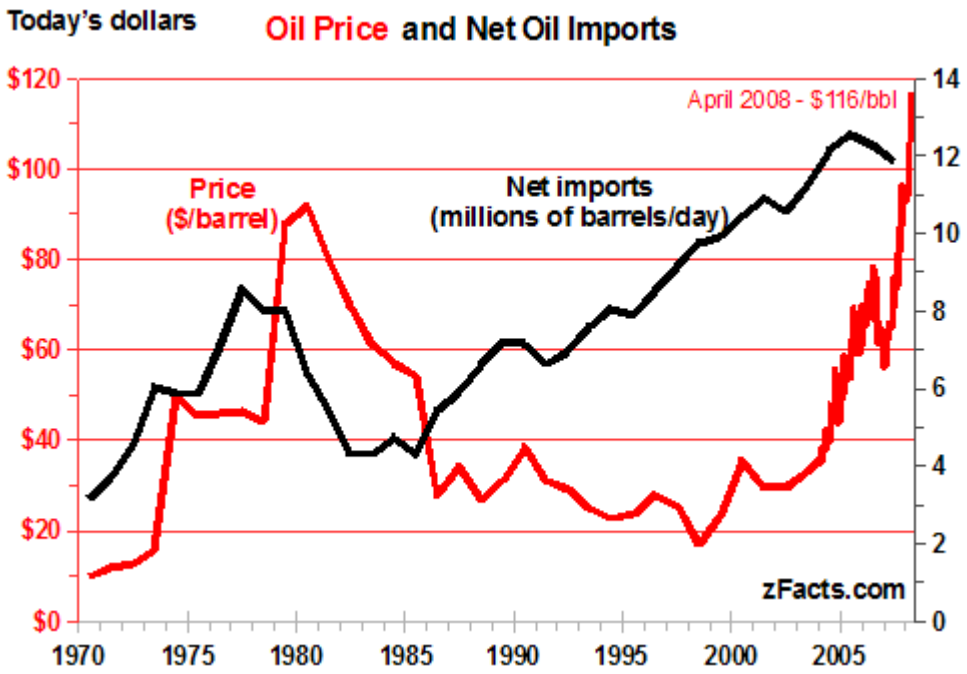
Investments in large power plants tend to exceed the preliminary cost frame of the planning period, especially when the investor is a publicly owned entity. Renewable projects such as small-scale wind and solar projects, microhydro generation, and even larger central solar stations are much more predictable in their economic evaluation since they are not dependant on volatile fuel prices or restrictive legislative decisions in future periods. Renewable energy technologies offer commercial and operational advantages as well. Remote areas not yet served by electric utility have an advantage due to their modularity and lack of fuel requirement [16]. Because of this , many renewable technologies also offer the advantage of incremental capacity additions that can easily be adapted to the actual demand of electricity.

II. Competition – Price and Quality

Deregulation promised lower electricity prices. But there is yet another aspect of attracting new customers, often forgotten in the confusion of the restructuring process. The quality component of commodities and services is at least as crucial as the price in a competitive marketplace. While most utilities focused on how to recover sunk costs or how to gain a bigger market share by mergers and acquisitions [17], some utilities have begun to address the quality component of the electricity they want to sell. Quality components such as reliability, availability, and service offered by a utility will decide the price it can set for its electricity. Although industrial customers might be interested in lower rates initially, there is ample evidence that especially for the residential market, but also for parts of the industrial and commercial sector, other attributes might be even more attractive. Surveys with residential consumers have shown an increasingly strong preference for energy conservation, energy efficiency, and renewable energy resources augmenting from less than 40 percent in the 1970s to more than 70 percent of the participants in recent surveys. Industrial and commercial customers are buying green energy for a higher price and use

their hereby-expressed “commitment to the environment and to the community” as a marketing argument, which is positive for their profits and, through the use of renewable resources, also benefits ecology. According to different estimates, technology advances in PV will bring down cost more than 40% in next three years [18]. Global production of solar photovoltaic(PV) cells has risen sixfold since 2000 and grew 41% in 2006 alone [19].

Chart 2: Oil Prices and Oil Imports



III. Proactive Utilities

Utility managers with a strategic vision build on renewables for their future energy portfolio, even while everybody else in the industry seems to take another approach. Many utilities have assessed renewable energy generation options in pilot studies and found them not yet competitive with fossil fuel technologies.

The Sacramento Municipal Utility District (SMUD) invests in renewable energies against all odds. SMUD did not set up a pioneer program to only investigate today’s cost-effectiveness of solar energy, but to actively bring down the cost of photovoltaic technologies. This strategic approach integrates consumers willing to participate in SMUD’s Photovoltaic Pioneer Program, industrial manufacturers, government

institutions, research foundations, as well as other utilities that are offered SMUD's photovoltaic system solutions in order to gain larger purchase volumes and hence exploit economies of scale. SMUD calls its strategy "Sustained Orderly Development" (SOD) and signed long-term contracts with industrial manufacturers and 5-year-contracts with the residential customers of the PV Pioneer Program who receive a grid-connected rooftop PV system for a monthly premium of $ 4. The SMUD approach is a long-term commitment to bring down PV system costs while not waiting for photovoltaics to become cost-effective by themselves. The Sacramento Municipal Utility District calculates its PV systems will be cost-competitive without subsidies in the residential market [20].

IV. Utility and Non-Government Organization (NGO) Partnerships

Electric utilities and non-government organizations have developed partnerships to investigate performance, cost-effectiveness, and market acceptance of renewable technologies. In the photovoltaic industry, three major programs have been established: Photovoltaics for Utility-Scale Applications (PVUSA), the Utility PhotoVoltaic Group (UPVG), and Photovoltaics for Utilities (PV4U) .

In 1987, a dozen electric utilities, the Electric Power Research Institute (EPRI), and Federal and State government agencies established PVUSA as a cooperative research effort to evaluate PV technologies and offer U.S. utilities hands-on experience in designing, purchasing, and operating PV systems.

PV4U is formed by a loose confederation of State-level working groups including electric utilities, universities, photovoltaic manufacturers, and State energy offices.

The Utility Photovoltaic Group was established in 1992 with support from EPRI, the American Public Power Association (APPA), the Edison Electric Institute (EEI), and the National Rural Electric Cooperative Association (NRECA). UPVG efforts seek to accelerate cost-effectiveness of PV applications, stimulate market demand, and demonstrate currently feasible market niches. UPVG has set up a comprehensive action plan for stimulating demand in those markets.

These microeconomic partnerships provide a valuable pool of information on renewable generation technologies. Utilities that are members of these information networks can benefit from the accumulated knowledge and experience in emerging technologies and profit from this expertise by evaluating future

business opportunities. A recent entry to the world of renewable economics is renewable energy certificate (REC). REC is associated with electricity generated from renewable energy, which has shown promise in improving viability of renewable energy [21].

Macroeconomics – State and Federal Policies and Legislation

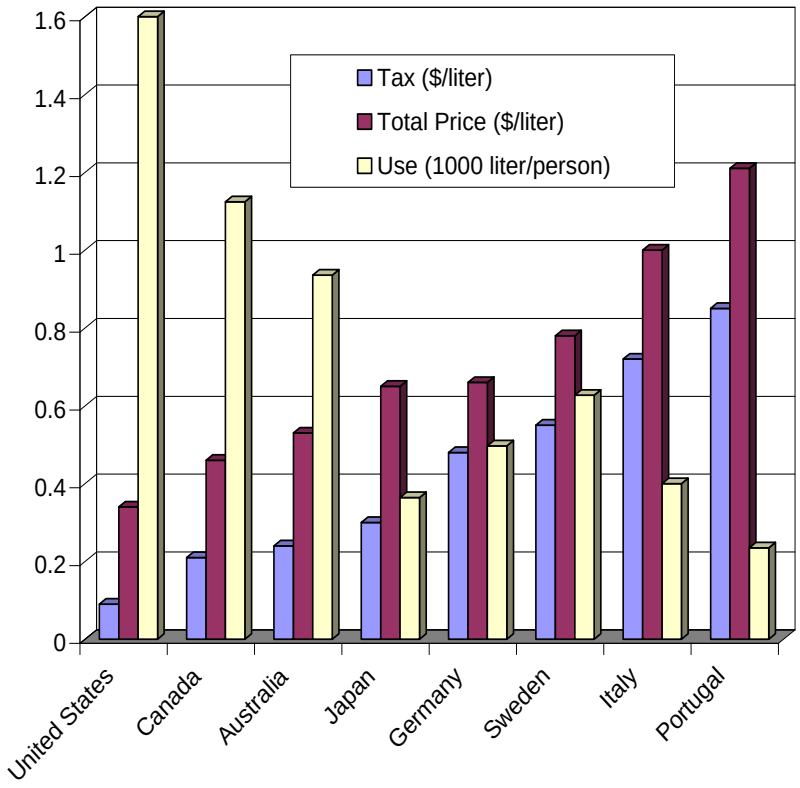
I. Assets and Liabilities of Renewable Energies in the Macroeconomic Perspective

Clean generation technologies can reduce state expenses for health, social, and environmental damages. Utilities contribute to air pollution with sulfur dioxide and nitrogen oxide. Carbon dioxide releases are considered to cause global warming. Thermal power plants degrade the quality of rivers through thermal pollution and wastewater discharges [22].

National accounting practices, however, mostly regard the use and deployment of natural resources as a positive credit to the gross domestic product. Ecological pollution is not considered to decrease the wealth of a nation. Furthermore, the costs of repairing ecological and social damages are calculated as assets in national accounting. These national accounting practices ignore the negative macroeconomic impacts of polluting technologies and hinder the development and market penetration of renewable energies.

Taxation of fossil fuels such as oil and coal adds a notable share to the federal budget. As the use of renewable resources such as wind, solar, and waterpower is free and accessible to everyone who has invested in renewable generation technologies, a shift towards renewable energy generation and consumption may cut tax revenues [23].

Chart 3: Total Prices, Use and Tax for Industrialized Nations



II. Political Impediments

Varying with the length of election periods, the perspective of political decision making generally does not exceed four or five years. As soon as a new election is approaching, politicians alter plans and policies. This short-term view conflicts with long-term problems that need to be addressed by a long-term commitment rather than opportunistic decision patterns.

The consequences of burning fossil fuels and the depletion of natural resources as well as the dangers of nuclear waste disposal are not yet "touchable" and far beyond the horizon of today's political decision makers. Unpopular decisions such as structural changes which may even lead to a rise in

unemployment in the short run while not guaranteeing more jobs in the long view can endanger the next election campaign of a party or an individual running for a political position.

The electric utility industry, representing an annual 200 billion dollar market has a significant influence on politics. International oil and gas companies spend a lot of money on lobbying and advocacy campaigns. Representatives of the oil and gas lobby contribute in the political decision making process in the House of Representatives and the U.S. Senate. Industrial leaders invited to political conferences take political influence in favor of their core business. These industry experts are mainly interested in short-term profits to satisfy their companies' share and stakeholders. Nobody disagrees that India and China's exponential demand for crude oil compared to a year ago cannot be explained only in terms of demand and supply [23]. Environmental and social issues are employed only for marketing reasons and are otherwise commonly ignored until forced by legislation. With the gasoline price hitting high profits for oil companies, the oil lobby has launched multi-million dollar campaign to project their image. Recently, the U.S. senate Judiciary committee showed their wrath on oil industry executives, by planning to propose legislation that would impose stiffer margin requirement on energy trading [24].

III. State and Federal Legislation

Social and environmental costs are hardly reflected in today's energy and electricity prices. Especially Americans have strong feelings about cheap end-use energy. Other countries such as European and Asian nations are much more easily inclined to increase taxes for fossil fuels, although the additional tax revenues may be used for fiscal purposes rather than for environmental goals.

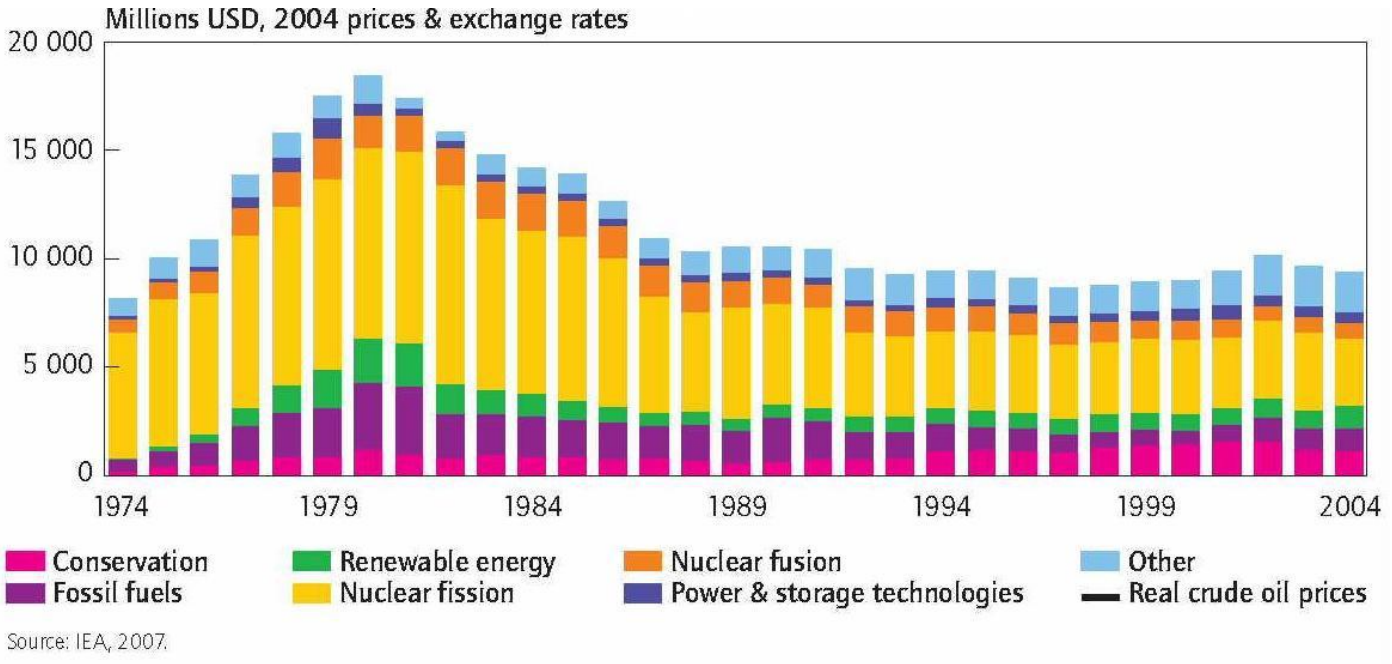
U.S. legislation has addressed the role of renewable and fossil fuel electricity generation in a variety of state and federal acts. The Public Utility Regulatory Policies Act of 1978 (PURPA) advocated the conservation of electric energy and created a new class of nonutility generators, the small power producers, from which, along with qualified cogenerators, utilities were required to buy power. The Clean Air Act Amendments of 1990 (CAAA) established a new emissions-reduction program and aimed at reducing annual sulfur dioxide emissions by 10 million tons and annual nitrogen oxide emissions by 2

million tons from 1980 levels. Fossil fuel power plants were held responsible for large portions of the sulfur dioxide and nitrogen oxide emissions [25].

In California, state legislation has advanced far in electric restructuring issues. Assembly Bill 1890 (AB 1890), enacted on September 23, 1996, deregulated the industry and established funding and allocation guidelines to support renewable power generation. Over the period 1998 through 2002, US$ 540 million will be collected from existing investor-owned utility ratepayers to support existing, new, and emerging renewable electricity generation technologies . Critics argue, however, that this amount does not exceed the funding of former years and that fossil fuel technologies are still subsidized on a much larger scale by government grants for research and development of fossil and nuclear technologies as well as by taxation practices [26].

Chart 4: Government Research and Development Spending

in International Energy Agency Member Countries (Total, 1974-2004)



Since the market mechanism apparently does not lead to internalization of environmental and social costs, state and federal legislation is necessary to support clean technologies that cannot surmount

market barriers. Competition and regulatory legislation are both important issues for the future electricity market. Competition may lead to lower customer rates and offer the choice of clean energies. Although European countries such as Germany are still at the very beginning of their restructuring process, they have already achieved significant improvements in regard of clean power generation. German legislation obliges utilities to pay up to 10 cents per kWh for renewable energy fed into the utility grid [27].

Nobody knows exactly what the electricity system will be like after restructuring. Today's trial-and-error methods of state legislation are a way to examine various legislation alternatives. However, the adoption of the strictest possible standards on federal level will be necessary. A less restrictive federal environmental legislation will only shift pollution from one region to another, dependant on state laws and political issues such as unemployment and taxation practices.

Ecological taxation that quantifies and internalizes external effects of resource depletion, as well as environmental and social damages can reduce future cost for compensating and repairing the negative impacts of fossil fuel power generation [28]. It may also create new jobs by increasing the cost of capital relatively to the cost of labor. Investments would be directed toward labor intensive technologies which could benefit renewable technologies which employ more labor in research, manufacturing, and installation of solar or wind generating facilities than fossil fuel plants do [29].

Global Economics – Who is Advocating the World?

I. The United Nations' Agenda for a Sustainable Development

Environmental issues such as pollution and global warming are not limited by geographical or national boundaries. Emissions of industrialized countries deteriorate the quality of air and water in the emitting state as well as in its neighbors. Due to the atmospheric circulation of air, non-polluting countries can even be more affected than the emitting state or nation. Global warming threatens countries situated at ocean level altitude. Economists meanwhile try to calculate the effects of an increase in the atmosphere's temperature and set up win-and-lose scenarios [30].

The UN Earth summit in Rio- Brazil (1992)

The United Nations conference on environment and development at Rio de Janerio in June of 1992 set up an agenda 21 which had 2500 item program to approach sustainable world economy. The Rio declaration proclaimed 27 principles for reaching sustainability such as the Nations right to exploit the natural resources while addressing their responsibility towards the environment.Agenda 21 advocated stabilizing green house gas emissions at 1990 levels, starting 2000 for industrialized nations.Industrialized nations expected to take first steps to mitigate climate change because of being responsible for increase in green house gas emission in the atmosphere and emission trading was established. Also, a new UN body, the united nations commission on sustainable development (CSD) was created, which has been an active forum to review and organize discussions on implementations of agenda 21.

UN Conference Rio Plus 5 in New York

The development of the world economies & ecological issues since the Rio Conference were discussed at the earth summit plus 5-a UN conference n sustainable development held in New York in June 1997. Government representatives and experts discussed the state of the world and expressed disappointment about current legislative and economic developments. Developing countries struggle with growing poverty and environmental problems, while industrialized nations are not very successful in reducing greenhouse emissions. Agenda 21 required governments to prepare national sustainable strategies; many countries formed national commissions and issued various reports on national sustainable developments. However, the majority of reports entailed advancements already achieved and having critical issues too vague to set up useful and practical instrument. Also, the willingness to provide financial help for developing countries and various environmental and social programs in the industrialized nation began to fade. Many UN programs faced budget cuts.

The Kyoto Protocol, Kyoto Japan, 1997

In December 1997, scientists, politicians, and business representatives as well as non-governmental groups attended a highly important conference on global climate issues in Kyoto, Japan, to access the targets at the Rio Conference in 1992 and to analyze advances in global climate policy. The climate summit in Rio aimed

at reducing green house gasses to the 1990 level, until the year 2000. However, in 1997, scientists calculated not lower but higher emission rates for all countries. In the Course of the conference it became clear that Japan and the U.S. were not willing to set other restrictive target of emission reductions. Under the threat of a complete failure of this conference, the nations finally agreed to a compromise. The EU to reduce greenhouse emissions by 8%, the United States by 7%, and Japan by 6% compared to 1990 levels. This Protocol entered into force in 2005 and first commitment lasts fro2008-2012.The protocol allowed the trading of emission rights and established Cap and Trade meaning different emission caps assigned to industrialized countries and may trade amongst themselves to meet the targets. Industrialized countries can earn credits by undertaking emission reduction projects in developing countries. Developing countries don't have emission commitments under the Kyoto agreements. This market based approach to meet the commitments wills not put any constraint in mitigating their own emissions among the largest greenhouse gas emitters. India and China have no emission commitment.

United Nations Climate Change Conference, Bali, 2007

The Bali conference charts the course of a new negotiations process to be concluded by 2009; that will lead to post 2012 international agreements on climate change. This roadway includes the launch of adaptation funds, ways to transfer technology, and ways to reduce emission through deforestation- all essential to achieve a secure climate future. This also will include,

• Attracting new countries to such treaties and strengthen the Kyoto Protocol

• Progress in stabilizing emissions can be achieved through technological advances and looking more carefully into the energy sector

Many diverse interests prevent the world's nations from joining together and deciding unanimously. Industrialized and developing countries have dissimilar views on how to reach sustainability, but even third world countries quarrel with each other. OPEC countries are mostly in favor of fossil fuels which are a major share of their national income, while Non-OPEC countries see the global energy economy based on fossil fuels rather as a barrier for further development as their national resources are mostly renewable resources such as favorable solar radiation.

II. International Financing for Renewable Energy Projects

Developing countries are often blessed with abundant renewable resources such as hydro, solar, and wind power. Financing renewable energy projects can fail due to insufficient capital. International funding helps to finance renewable energy projects. Multilateral development banks provide consulting, funding, and contacts to industrial manufacturers and expert organizations in the field of renewable energies [31].

After World War II the World Bank was established and since then supports developing countries with loans and credits. Today, the bank typically finances about 40 percent of a project's cost. In 1994, the World Bank started its Solar Initiative Program to support the commercialization of renewable energy in developing countries.

The International Finance Corporation is a member of the World Bank Group. It finances up to 25 percent of a project's cost and is considering setting up an Investment Fund for Renewable Energy and Energy Efficiency.

The Global Environment Facility was established in 1990 by the World Bank and the United Nations and provides grants and technical assistance for projects in developing countries addressing global warming, depletion of the ozone layer, and other topics of sustainability.

Multilateral development banks such as the Inter-American Development Bank, the Asian Development Bank, the African Development Bank, and the European Bank for Reconstruction and Development support grants and expertise for renewable energy projects in their countries or continents.

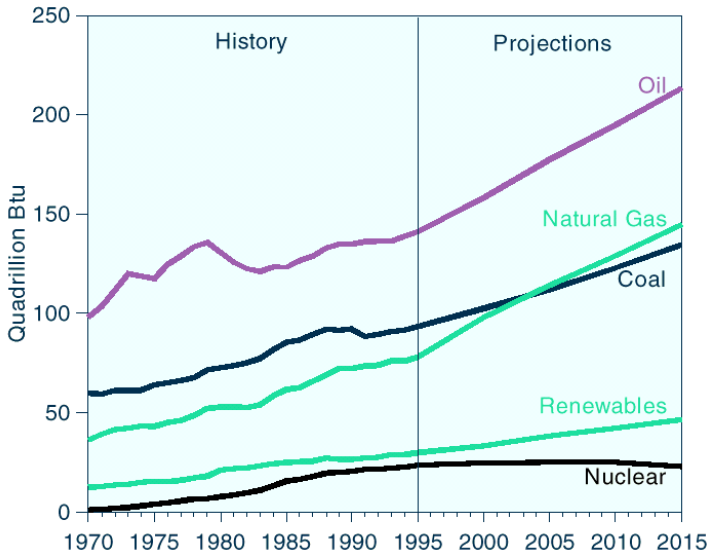
Considerable amounts of money are available for renewable energy projects, but the bureaucracy of the funding institutions can slow down the implementation process. To improve their chance of accessing money from these funds companies of developing countries are looking for alliances with companies in industrialized nations that have a good reputation. Renewable Energy Project Support Offices (REPSOs) help to find partners for joint ventures and provide technical and financial support for identifying, evaluating and implementing renewable energy projects. Nonprofit and government organizations such as the International Fund for Renewable Energy and Energy Efficiency (IFREE), the

U.S. Trade and Development Agency (TDA), the Environmental Enterprise Assistance Fund (EEAF), USAID's Private-Sector Energy Development Program, and US/ECRE also support renewable energy projects in developing countries [32].

Summary and Conclusion

A growing world population that may well reach a number of 10 or 20 billion in the next centuries will have an impact on the global environment. With developing countries and nations in transition imitating the consumption patterns of industrial countries, the use of energy will increase dramatically [33]. Which forms of energy resources will eventually be used is yet unclear. Long-term forecasts claim the depletion of fossil fuels as well as climate changes due to high emissions of greenhouse gases.

Chart 5: World Energy Consumption by Fuel Type, 1970-2015



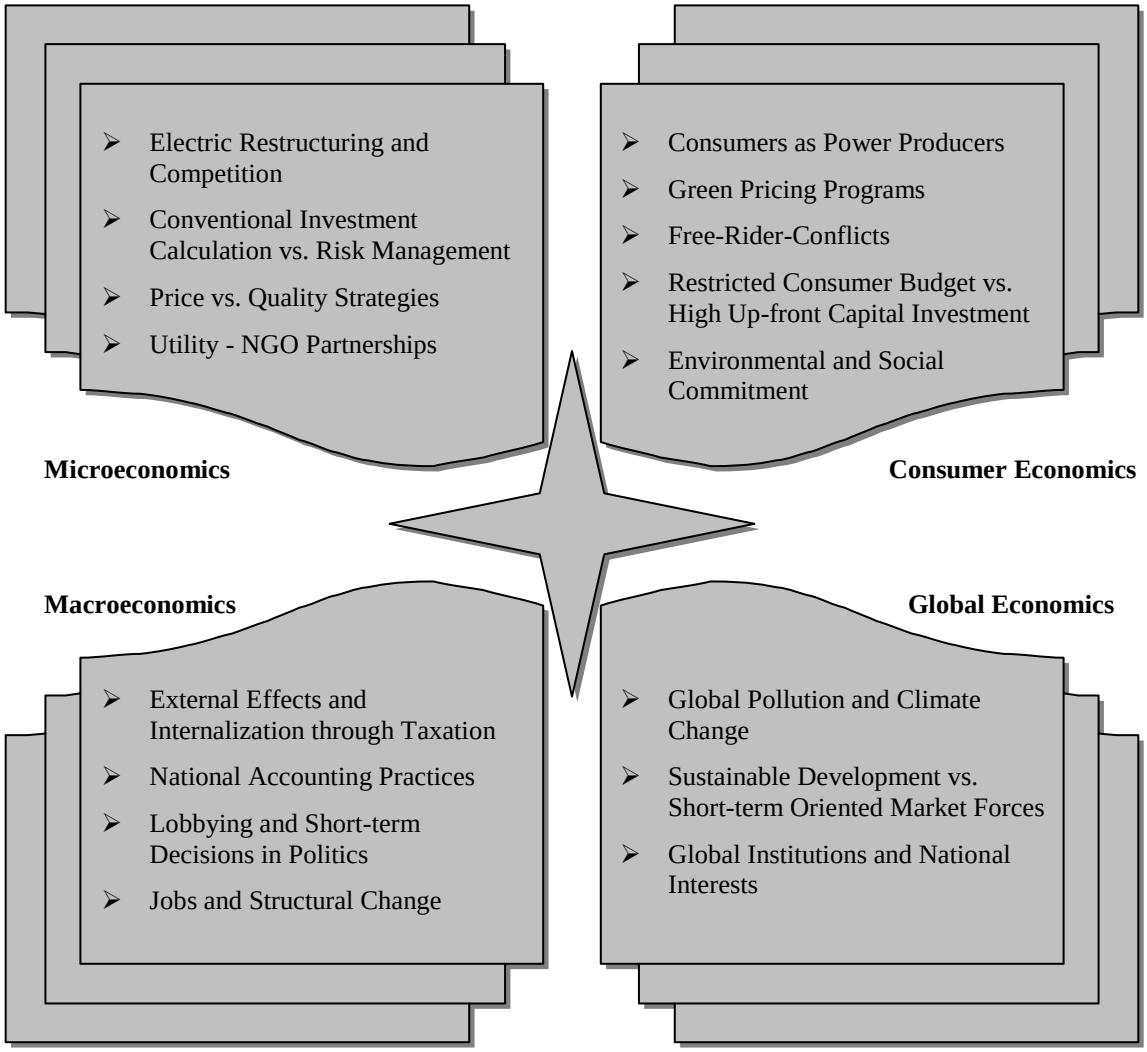
Source: International Energy Outlook (2007).

While the recent downturn in petroleum prices due to the international recession has somewhat reduced consumer interest in energy sustainability, the long term issue of availability must remain a priority for those at the policy development level (34). This is true if for no other reason than national security.

Technological advancement in renewable electricity generation has made non-fossil fuels a viable option to significantly contribute to the world's growing energy demand. Prices of these technologies could be reduced by strategic partnerships and cooperation between utilities, consumers, state and federal representatives, and global advocate institutions such as the UNO and the World Bank.

Chart 6: Crucial Issues in Renewable Power Generation

and Micro, Macro, and Global Economic Decision Makin



Whether renewable can become cost-efficient depends on political decisions and tax legislation. Distorted price signals through insufficient internalization of externalities and a strong fossil fuel lobby are major barriers against structural changes in the electric utility industry.

In order to support renewable electricity generation, the coordination of micro- and macroeconomic as well as global institutions and activities, information and project implementation is necessary. Non-profit organizations are intensively promoting clean energies, but their financial restrictions make them not very competitive with the marketing efforts and political influence of the fossil fuel industry.

Liberal markets tend to favor short-term oriented decisions. A highly dynamic competitive energy market will not reward long-term commitments nor social or ecological concerns without any additional incentives.

Nature itself does not measure in decades, but in millions and billions of years. The crucial question for humanity is if the state of the world will be habitable for humans when the depletion natural resource leads to economic crises. The long-term failure of liberal markets could incite severe social as well as national conflicts [35]. Strategic alliances between proactive utilities, state and federal politics and legislation, as well as global institutions would accelerate the commercialization of renewable electricity generation and could prevent irreversible negative impacts to our social and environmental systems.

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