Renewable Energy Markets: Global Overview and Lessons from Developing Countries

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Abstract

This paper surveys investment flows and existing markets for renewable energy, both globally and in developing countries. Wind and solar power generation and solar hot water are growing rapidly. Total global investment was $22 billion in 2003. Rural energy and transport dominate developing country markets. The paper draws lessons from past attempts to promote renewable energy in developing countries, related to development impacts, affordability, subsidies, entrepreneurship, power-sector policy, and market facilitation.

1. Global Renewable Energy Markets

Global renewable energy markets have grown tremendously in the past decade. Few people realize that some forms of renewable energy have become big business. Annual investment in renewable energy was an estimated $22 billion worldwide in 2003, up from $6 billion in 1995 (Martinot, 2004). And cumulative investment of at least $110 billion was made in renewable energy during the period 1995-2003, far surpassing investment in the decade prior to 1995. This growth has been driven first and foremost by supportive national and local policies, many of which have effectively overcome the barriers that continue to put renewable energy at a competitive disadvantage to fossil fuels. Aggressive technology improvements and cost reductions, better market information, growing awareness of global climate change, local environmental concerns, and rural development needs in the poorest countries have also been important drivers of this growth. The fact that renewable energy offers freedom from future fossil-fuel price uncertainties is also poised to become a market driver.

The fastest growing renewable energy markets are for wind power and solar photovoltaics in a handful of developed countries, notably Japan, Germany, and Spain, with a recent resurgence in the United States (Sawin, 2003). These markets have seen annual growth rates of 15-40% in recent years. Solar hot water markets in a few countries have been growing equally rapidly, with more modest investments in geothermal, small hydro, and biomass. Overall, technology shares for the $22 billion total invested in 2003 are estimated at 38% wind, 24% solar photovoltaics, 21% solar hot water, and 17% for remaining technologies: geothermal power and heat, small hydro power, and biomass power.

In developed countries, the leading applications of renewable energy are for power generation—from power-grid-connected wind and biomass, and from decentralized rooftop and remote solar photovoltaics. Although installed renewable energy capacity—about 140 gigawatts (GW) in 2003—still makes up only 4% of global installed power generation capacity, this share is growing. Wind power alone accounted for 40 GW of installed power generation capacity in 2003.

The most commercial markets continue to be solar photovoltaic power for remote telecommunications stations and for highway services and signs. But grid-connected wind power has also "come of age." Germany now has over one-third of worldwide wind power installations, and other leading countries are Spain, Denmark, and the United States, with several other European countries also expanding. Growth in all of these countries is expected to continue, with perhaps the exception of Denmark. Germany and Japan lead the household rooftop solar photovoltaic market, now numbering over 250,000 homes.

The use of biofuels for transport is significant and growing in some countries. Germany leads the world in biodiesel use—which worldwide totaled almost 2 billion liters in 2003. Other countries using biodiesel include Austria, Belgium, France, Italy, Indonesia, and Malaysia. Brazil leads the world in ethanol use, about 14 billion liters in 2003, followed by the United States and Canada, with much smaller use in a few European countries. Total global ethanol production in 2003 was 29 billion liters.

Mature and commercial solar hot water markets are also expanding in several countries, particularly China, which alone accounted for three-quarters of global installations in 2003 and saw double-digit annual market growth in the early 2000s. Japan, the United States, Germany, Turkey, Israel, and Australia are also active solar hot water markets. Driving growth in several countries are mandates that new home construction include solar hot water—notably in Japan, Israel, and parts of Australia.

In developing countries, renewable energy markets are more diverse than in developed countries, but could be grouped into five basic categories (Martinot et al, 2002):

Rural residential and community lighting, television, radio and telephony. Roughly 400 million households, or 40% of the population of developing countries, do not have access to electricity. Household and community demand for lighting, television, radio and wireless telephony in rural areas without electricity has driven markets for solar home systems, biogas-fuelled lighting, small hydro minigrids, wind or solar hybrid minigrids, and household-scale wind turbines.

Rural small industry, agriculture and other productive uses. 'Productive uses' of renewable energy are those that increase incomes or provide other social services beyond home lighting, entertainment and increased conveniences. As incomes increase, rural populations become able to afford even greater levels of energy service. The major emerging productive uses of renewable energy are for agriculture, small industry, commercial services and social services, such as drinking water, education, and healthcare.

Grid-based power generation. About 3% of electric power capacity in developing countries is renewables, mostly small hydropower in China and biomass power generation in a group of tropical countries with abundant vegetable oil, sugar cane, and/or forest products wastes. Small hydro power, biomass power, geothermal power and wind farms are all continuing and promising markets for grid-based power generation. India leads the developing world in wind power and continues to expand wind, although not as aggressively as in the 1990s.

Residential and commercial cooking and hot water. Residential and commercial cooking and hot water in rural areas are supplied primarily by direct combustion of biomass—in the form of wood, crop wastes, dung and charcoal.

In recent decades, the decline in forest resources in many countries called attention to more efficient household use of biomass, as well as solar cookers. Markets for more efficient biomass stoves and solar cookers are found primarily in Asia and Africa.

Transport fuels. Over 40% of automotive vehicle fuel used in Brazil in 2000 was ethanol—a liquid fuel derived from biomass (sugarcane in Brazil). Indeed, Brazil represents more than two thirds of global ethanol consumption, due to extensive policies and infrastructure development over the past 20 years that have fostered both pure ('neat') ethanol cars and conventional cars using ethanol-petrol blends. Biodiesel fuel is produced in Indonesia and Malaysia from palm oil.

2. Developing Country Markets: Six Sets of Emerging Lessons

A review of the experience with commercial projects, multilateral and bilateral development efforts, entrepreneurship, government programs, and other forms of renewable energy development suggests six sets of emerging lessons relevant to future market growth in developing countries (see Martinot et al, 2002, for a full discussion).

2.1. Impacts on Rural Development

After decades of renewable energy programs and investments in rural areas of developing countries, relatively little is known about the ability of renewables to deliver services that will raise incomes and provide other social benefits. Certainly there are social benefits from lighting, TV, and radio powered by solar home systems, mini-grids, and biogas, and even some economic benefits from reduced kerosene and candle use. Biogas for cooking and improved biomass stoves may also reduce expenditures for fuel wood, either in time or money, as well as create jobs. On balance, however, the literature does not offer a strong case that large rural development benefits have occurred from renewable energy, even though some studies do point to clear benefits. And it is not clear how welfare and quality of life benefits will drive demand for renewable energy systems beyond the wealthiest rural households. Applications of renewable energy that provide income-generation and social benefits, such as clean drinking water, cottage industry, distance education, and improved agricultural productivity, may appeal to increasing segments of rural populations.

Lessons suggested by experience are that: (a) social benefits and quality of life, rather than income and economic benefits, have driven markets for renewable energy in rural areas; (b) experience with "productive uses" of renewable energy is still in its infancy and deserves much greater attention from donors, development agencies, and governments; (c) economic benefits from renewables are more likely in rural areas that can incorporate the additional energy dimension into existing development activities for water, health, education, agriculture, and entrepreneurship; and (d) published studies of income generation and economic benefits from renewable energy are still limited and call for further research.

2.2. Affordability, Consumer Credit, and Sales vs. Rentals

The affordability of rural household systems like solar home systems and biogas digesters has received much attention. Many argue that households can afford to substitute solar home systems for candles and kerosene lighting if the monthly costs for each are comparable.
So consumer credit is one approach to affordability. A few notable examples of consumer

credit for solar home systems have emerged.
In Bangladesh, Grameen Shakti has offered 3-year credit. In Sri Lanka, Sarvodaya, a national microfinance organization, has offered credit on terms up to 5 years. However, the total number of systems sold for credit is still very small compared to "cash" markets. It appears that the prospects for consumer credit are specific to local cultural, legal and financial factors. Rentals can also improve affordability. In this case, an "energy service company" supplies households with equipment and service for a flat monthly fee. However, rental models have been employed in just a few countries.

Lessons suggested by experience are that: (a) historically, affordability of rural energy has been addressed through government subsidies, donor programs, and private cash sales of small systems; (b) new approaches to affordability are emerging, including vendor-supplied credit, microcredit, and rental models, but are still largely untested; (c) credit risk is a serious concern of both financiers and dealers and makes credit sales challenging; (d) lower income rural households will need long-term credit or rental options; (e) even with credit or rentals, lower incomes groups will only benefit with targeted policies, including subsidy policies, justified by development goals.

2.3. Equipment Subsidies and Market Distortions

Subsidies for renewable energy equipment have been driven by four interwoven factors: (i) donors using equipment installation as a visible and politically viable approach to development aid (particularly "tied aid" that requires equipment to come from the donor country); (ii) the need for subsidies to build market volume on the premise that costs will decline as volume increases, due to economies of scale and learning; (iii) government goals for addressing poverty and economic development in rural areas, and (iv) renewables must often compete against "hidden" subsidies for conventional fuels. One lesson emerging is that "donations without any cost-recovery destroy markets." Donors are still undermining markets with capital cost subsidies and donated equipment. Donor projects are still valuable—they can help familiarize governments with technologies and demonstrate market viability. But donors need to better understand existing private activities.

Lessons suggested by experience are that: (a) subsidies are unlikely to lead to sustainable markets unless they explicitly create the conditions whereby they are no longer needed (i.e., "smart" subsidies); (b) subsidies can undermine private investments and business in new markets and should be applied with attention to private-sector conditions in a particular market; (c) subsidies can be used effectively to build up initial market volume, local expertise, user awareness, appropriate technology adaptation, quality standards, and entrepreneurial activities; (d) subsidies are more effective when tied to operating performance rather than investment; and (e) continuing subsidies may always be needed for poorer segments of the population.

2.4. *Rural Enterprise Development, Financing, and Business Viability*

Rural entrepreneurship for rural energy is a neglected topic. The track record of donor programs in creating and sustaining enterprises is particularly poor. Some have estimated that tens of thousands of rural enterprises offering renewable energy-based products and services would be required to meet the needs of hundreds of millions of households. The number of such enterprises today is in the hundreds. The challenges are large: entrepreneurs often face high costs in rural areas because of long travel distances, poor transport infrastructure, low

literacy rates, poor communications, and a lack of trained personnel. Fortunately, promising approaches are emerging that support rural entrepreneurs with training, marketing, feasibility studies, business planning, management, financing, and connections to banks and community organizations. These experiences highlight the importance of marketing, business finance, bundling with existing products, and rural electrification policy.

Lessons suggested by experience are that: (a) a few donor programs have effectively assisted rural renewable energy-based enterprises to build a sustainable and viable business; (b) rural energy enterprises face a high-risk, low-margin business with high transaction costs; (c) commercial banks and financial intermediaries are key decision makers, who must understand the technologies and manage risks; (d) demonstration of viable business models that eventually show sustained profits for the enterprise is key to achieving market sustainability.

2.5. Policies and Financing for Private Power Producers

Ongoing power sector restructuring in many developing countries greatly affects the prospects for grid-connected renewable energy. Six key trends occurring are competitive wholesale power markets, self-generation by end-users, smaller-scale generation technologies, privatization and/or commercialization of utilities, "unbundling" of generation from transmission and distribution, and competitive retail sales. More than 25 developing countries now have regulatory frameworks that allow "independent power producers" to generate and sell power to utilities. Some countries, including India and Brazil, have additional policies to facilitate renewable power generation, such as transmission "wheeling" provisions for renewables. Still, renewable energy power developers have faced problems, particularly with financing and with regulatory frameworks that define power purchase tariffs and transmission access. In addition to policy frameworks, availability of financing for renewable power projects is key to market development. Commercial banks must be familiar with the technology and power purchase contracts must be secure enough to guarantee revenues.

Lessons suggested by experience are that: (a) policies that promote production-based incentives rather than investment-based incentives are more likely to spur industry performance and sustainability; (b) power-sector regulatory policies for renewable energy should support IPP frameworks that provide incentives and long-term stable tariffs for private power producers; (c) regulators need skills to understand the complex array of policy, regulatory, technical, financing, and organizational factors that influence whether renewable energy producers are viable; (d) financing for renewable power projects is crucial but elusive.

2.6. *Market Facilitation Organizations*

Market facilitation organizations (MFOs) are public-private entities that support market growth through networking, partner matching, information dissemination, market research, user education, business-deal identification and facilitation, technical assistance, consulting services, financing, and policy advocacy or advise. Common and historical forms of MFOs are industry associations and government agencies. In the past decade, a new generation of MFOs has emerged to support renewable energy markets in developing countries—supported by both international donors and domestic sources. These new MFOs operate with a business interest in the industry, but also with a public interest in seeing the technology widespread for public benefits. MFOs may be non-profit and non-governmental—but their purpose is different than traditional NGOs, which have historically focused on public policy advocacy.

Lessons suggested by experience are that: (a) MFOs can be powerful market stimulants but very few exist; (b) public-private MFOs most likely need full public funding to begin, but eventually can become partly self-supporting through private contracts; (c) very few people are thinking about the power of MFOs to stimulate renewable energy market development.

3. Conclusion

Grid-based wind power, distributed solar photovoltaic, and household solar hot water markets are growing extremely quickly worldwide, and can be expected to continue to do so. Other markets, such as geothermal and biomass for both power and heat, show some growth and offer future promise of more. The use of biodiesel transport fuels could greatly expand. In developing countries, "productive uses" of renewable energy for drinking water, irrigation, other agricultural uses, small industry, education, and health care are very slow to emerge but show great promise. Small hydro power in China and a few other countries continues to expand. Many firms, from large multinationals to small entrepreneurs, are beginning to recognize all of these opportunities.

Technology costs are expected to decrease significantly in the coming decade for wind, solar photovoltaic, and solar thermal power. The International Energy Agency projects that by 2010, the low range of solar photovoltaic costs could decline from the current 18-20 cents/kWh to 10-15 cents/kW, and the high range could decline from the current 25-80 cents/kWh to 18-40 cents/kWh (IEA, 2003). The IEA also projected the low range of wind power costs to decline from the current 3-5 cents/kWh to 2-4 cents/kWh. With these declines, wind power could become competitive with even coal-fired generation and combined-cycle gas-turbine technology. Biofuels costs are also expected to decline through 2010 and beyond, to a range of 30-65 cents/equivalent-liter for ethanol from a variety of feedstocks and biodiesel from vegetable oils (Fulton et al, 2004).

Continued public policies in support of renewable energy are crucial and remain justified by the many barriers and market distortions affecting renewable energy markets (Beck and Martinot, 2004). As to the choice of specific policies, some policies have been more effective than others, and there is a growing literature on assessing the effectiveness of renewable energy policies. Experience with policies around the world is still emerging. Our understanding of this experience must go beyond specific policy provisions, however, to include the impact of policies over the longer term. Assessment of policy experience, and the work to share, adapt, and learn from that experience, is crucial.

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