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Best Practice on Environmental Policy in Asia and the Pacific: Chapter 4

Policies to Ease the Transition to a Post-Fossil Fuel Era

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The high cost of renewable energy technologies and uncompetitive prices of power from renewable sources under present market conditions are among the factors impeding a necessary shift away from fossil fuels. This research examines policy options that could help to overcome these obstacles, focusing on two driving factors: the policy framework and market conditions, and institutions that promote, support, and service developers and suppliers of renewable energy. It is based on analysis of case studies of successful environmental policies in the areas of promoting the use of biomass energy use and innovative financing for renewable energy development. In particular it looks at promotion of renewable power, both in areas connected to the power grid and those that are not. The case studies were collected by the project Research on Innovative and Strategic Policy Options (RISPO), which was led by the Institute for Global Environmental Strategies (IGES), Hayama, Japan. It is one of the series of eight linked papers in this special issue of the *International Review for Environmental Strategies* (*IRES*) describing a study to draw from the RISPO Good Practices Inventory useful lessons for environmental policymakers in developing countries.

Keywords: renewable energy, environmental policy, RISPO

1. Introduction

In 2000, 1.64 billion people, or around 27 percent of the world's population, did not have access to electricity. More than 99 percent of people without electricity were living in developing countries, and four out of five lived in rural areas. Many developing countries are now embarked on programmes to bring electrification to all such areas. At the same time, urban and industrial electricity use is also often rising. Energy use in Asia is fueled by rapid growth and dominated by fossil fuels. In 2004, total primary energy supply (TPES) for Asia was 3.1 billion tons of oil equivalent, representing about 25 percent of world total energy supply. TPES in the same region is projected to more than double to 6.2 billion toe (tones of oil equivalent) in 2030, due to expected drastic economic growth (Ito et al, 2006). Unless there is a significant change in electricity generation technologies, which today are almost exclusively based on fossil fuels, meeting the future energy demand will have major environmental impacts, especially contributions to climate change. It will also require huge investment. Governments

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around the world need to ease their countries' transitions away from reliance on fossil fuel, with as little economic, social, and environmental impact as possible.

For a large proportion of rural populations and for many poor urban communities, biomass in the form of firewood, charcoal, crop residues, and animal wastes is the main fuel used for cooking and heating. Some 92.5 percent of all the renewable energy consumed in developing countries of Asia comes from combustible biomass used as domestic fuel (IEA 2005a). Overall, renewable energy contributes 47.2 percent of the TPES in Asia in 2004 (IEA 2007). By comparison, in the same region, hydroelectricity accounts for 16.1 percent and geothermal, solar, wind, and tide power generation together a mere 3.6 percent (IEA 2007). Although most biomass fuel is used in traditional applications such as domestic woodstoves, the trend is for families to move up to more modern applications and energy sources—and directly or indirectly to electricity.

In the Bali Declaration on Asia-Pacific Perspectives on Energy and Sustainable Development, the member countries and associated members of the United Nations Economic and Social Commission for Asia and the Pacific (ESCAP) stressed that "renewable energy sources, particularly through the increased use of modern technologies, could play a key role in enhancing energy supplies, particularly in the rural areas of the Asian and Pacific region. To that effect, we will strive to initiate policies and strategies to focus on and facilitate the optimal commercial exploitation of renewable energy resources," (ESCAP 2001). However, while renewables account for a significant share of TPES in Asia-Pacific, such modern technologies—including power generation—have hardly had any impact on local energy markets, and still remain peripheral in the total energy mix of most Asian countries.

The slow pace of penetration of renewable power has been attributed to a variety of internal and external, technical, institutional, and financial constraints (ESCAP 2001). These include the high initial costs of such technologies, geographical and seasonal variations in energy resources, insufficient energy market development, and a weak regulatory framework. The factors that influence success or failure in the development and implementation of renewable energy policies in developing countries are often different from those in industrialized countries, since specific characteristics at national and local levels play an important role in determining the barriers in each country (Wilkins 2002). This study focuses on lessons to help developing country policymakers to find policies that support modern renewable energy technologies in a way that is appropriate to their national situations.

2. Literature review: making renewable power more competive

From a review of the literature, two factors appear to be crucial to efforts to make renewable power more competitive in developing countries: the policy and market conditions under which renewable power has to compete against other sources of power, and the institutions available to provide financing, technical, and managerial support and services (IEA 2002b; Martinot et al. 2002; Vipradas 2001). Renewable energy competes in a market that is heavily biased in favor of fossil fuels. This is largely because the energy policy frameworks, laws, and systems built up over the last century were primarily designed with fossil fuels in mind (IEA 2002b). Current markets in energy services thus do not account for the value of environmental and social benefits associated with renewable energy—in fact, there is no

established market for the environmental benefits created by renewable energy (von Moltke, McKee, and Morgan 2004). As for any new technology, there are no well-established business models for renewable energy, much less information is available about renewable energy than about fossil fuels, and the public and investors are not yet familiar with it. Institutional infrastructure has not grown up to address these gaps, making cultural and social acceptance slow and leading to low demand and poor economies of scale. Renewable energy projects also have difficulty accessing credit and other financial instruments. However, some projects can access international financing—through intergovernmental organizations and bilateral cooperation, the relatively large amount of about US$500 million goes to developing countries each year as development assistance for renewable energy projects, training, and market support (REN21 2005).

2.1. Pricing and market conditions

Any intervention aimed at improving policy and market conditions in support of renewable energy needs to take into account contextual factors, notably whether the intention is to promote renewable energy in areas that are connected to the power grid or in areas that are not. In grid-connected areas, renewable energy faces an uphill struggle because of past state subsidies to support the establishment of the grid and the sunk costs of existing technologies such as coal and oil power generation. In off-grid areas, renewable energy may have the advantage, as the only, or the most appropriate, form of electrification. It may also provide opportunities for income generation and thus improve livelihoods and promote rural development (IEA 2002; UN Development Programme 2005; WorldWatch Institute 2006).

For grid-connected areas, a prime objective of policy intervention to promote renewable energy is to create a level playing field, neutralizing the unfair advantages enjoyed by existing technologies and so allowing renewable energy to compete more fairly with existing technologies (IEA 2002b). Appropriate policy instruments would include such policies as price setting and quantity forcing; cost reduction; public investment and market facilitation; and providing access for renewable energy producers to the power grid (Beck and Martinot 2004). In many cases, a mix of demand-pull and supply-push policies is applied in combination (Johansson and Turkenburg 2004). Renewable power feed-in laws—which give renewable power producers access to the grid with a guaranteed price for their power and specify a minimum amount of renewable energy that must be included in the portfolio of electricity resources of licenced electricity suppliers serving a state or country—have been adopted in several countries in Europe, Brazil, Japan, and many others (Johansson and Turkenburg 2004; Sawin 2004). Green procurement policies ensure that bulk purchases by government authorities or private businesses help to establish and strengthen markets for clean energy technologies (Geller 2003).

According to the Renewable Energy Policy Network for the 21st Century (REN21), at least 48 countries, including 14 developing countries, now have some sort of renewable energy promotion policy (REN21 2005). In these countries, it is common for targets to be set for renewable energy power production as a share of TPES, typically 5–30 percent over a decade, while mandates for blending biofuels into vehicle fuels have been enacted in at least 20 states and provinces worldwide as well as in three key countries: Brazil, China, and India.

Along with such policies that discriminate in favor of renewable power, creating a level playing field in energy markets also requires addressing the problem of so-called perverse subsidies to oil, coal, gas, and nuclear power (Pershing and Mackenzie 2004; IEA and UN Environment Programme 2002). Subsidies are usually provided by governments to reduce the unit cost of electricity and thus make it more affordable. In the countries of the Organisation for Economic Co-operation and Development (OECD), it is common for these subsidies to go to fossil fuel and nuclear power producers, whereas most of the subsidies in developing and transition economies go to consumers (von Moltke, McKee, and Morgan 2004). In China, the world's largest producer and consumer of coal, coal price reform, which started in 1996, together with a tax on high-sulfur coal to encourage a switch to natural gas and renewable energy, contributed to a 5 percent reduction in coal use between 1997 and 2001 (Brown 2003).

In non-grid-connected areas, policy and market interventions for renewable energy aim to create and develop new energy markets. Policies may include financial incentives to producers or consumers of renewable energy. Subsidies to support renewables are generally considered to be justified when the social or environmental gains exceed the economic cost of the subsidies (von Moltke, McKee, and Morgan 2004). While subsidies have proved their value in promoting renewable energy, international experience suggests that they are not a panacea. To be effective, argue Pershing and Mackenzie (2004), renewable energy subsidies should be well targeted, have a set end date (sunset provision), be predictable, be as direct as possible (close-to-market), and be provided through competitive mechanisms. In rural areas, subsidies have often been used to induce a shift from traditional biomass fuels like crop waste, dung, and wood—which have harmful environmental and health impacts—towards more efficient and cleaner fuels such as liquefied petroleum gas (LPG) and modern biofuels such as ethanol and methanol. Although modern fuels tend to be more costly—at least in monetary terms—than traditional fuels, they do provide people with greater opportunities for income generation (UN Development Programme 2005), such as electric lights allowing people to study or work at night.

Three types of policies have been applied in developing countries of Asia aimed at minimizing and optimizing the use of subsidies: (i) competitive approaches in the provision of subsidies, for example through bidding (IGES 2003a); (ii) financing models combining the provision of a subsidy with loan ownership (IGES 2004a); and (iii) public financial support that leads to long-term private investment and market growth (IGES 2003c). Successful examples of gradual reduction and removal of subsidies as economies of scale are achieved can be found in solar-powered homes programs in Japan (New Energy Foundation 2001), Australia (Australian Greenhouse Office, Department of the Environment and Heritage 2006), and some other countries (Martinot et al. 2002).

2.2. Supporting institutions

As noted above, there is generally very little established institutional infrastructure to support renewable energy. However, especially in rural areas of developing countries, the challenge of making modern energy available to the very poorest households is considered to be primarily the responsibility of governments (UN Development Programme, UN Department of Economic and Social Affairs, and World Energy Council 2000). Current commercial financial markets offer a wide range of financial

instruments, from credit to equity finance and bonds, but due to perceived risks make these available to renewable energy projects only under severely restrictive terms and conditions, if at all (Lindlein and Mostert 2005).

Although there remains a significant gap to fill, public- and private-sector institutions, consumer groups, non-governmental organizations (NGOs), and other institutions dedicated to renewable energy promotion are appearing worldwide. These provide financial, managerial, marketing, technical, and business development services (Martinot et al. 2002). The emergence of such institutions is an indication of a long-term commitment to renewable energy technologies and confidence in their economic, social, and market potential, in both the public and private sectors. Such a strategic orientation has helped countries such as Germany and Japan to take a leading role in the field of renewable energy (Mez 2004).

Public-sector institutions are at the forefront of renewable energy promotion, especially in developing countries with large populations that have no access to electricity. India's Department of Non-Conventional Energy Sources was set up in 1982 as the government's nodal agency for the promotion of non-conventional/renewable energy, and was upgraded to a ministry 10 years later. The establishment of the Ministry of Non-Conventional Energy Sources is perhaps the most far-reaching attempt to bring renewable energy into the heart of public institutional infrastructure. In 1987, the ministry set up the Indian Renewable Energy Development Agency Ltd (IREDA) as a concessionary financial institution to support the renewable energy sector. In Japan, the New Energy and Industrial Technology Development Organization (NEDO) was established in 1980 to develop new oil-alternative energy technologies. NEDO is Japan's largest public research and development management organization involved in new energy and energy conservation technologies, including solar-photovoltaic, solar thermal, wind, and other new energy technologies (NEDO 2005).

Renewable energy service companies (known as RESCOs) are private-sector organizations that provide services such as the sale, set-up, operation, maintenance, and repair of renewable energy systems, in addition to serving as financial intermediaries. The creation of renewable energy enterprises in developing countries is helping to hasten not only access to clean energy but the emergence of an indigenous chain of business and marketing services that will be crucial for the long-term viability of new energy technologies.

Several civil society organizations (CSOs), including consumer groups, now operate in the area of renewable energy promotion. Consumer-driven demand for environmentally friendly power is stimulating the development of renewable energy. Over 4.5 million consumers in Australia, Canada, Europe, Japan, and the United States purchased renewable electricity retail or via certificates in 2004, indicating that there is a viable market (REN21 2005). Microfinance institutions that provide small-scale lending to rural consumers for the purchase of energy devices such as solar lanterns, solar home lighting systems, and solar cookers now operate in some of the world's poorest regions (Global Development Research Centre 2006).

Much of the institutional development achieved at the national level in developing countries has been supported by a range of international mechanisms involving the UN Development Programme (UNDP),

the UN Environment Programme (UNEP), the World Bank, and regional development institutions. The Global Environment Facility, the largest source of funds for renewable energy in the developing world, has supported initiatives to address problems such as inadequate policy frameworks, inadequate financing and business support, and lack of technical capacity (Global Environment Facility 2005). Through programmes such as the Rural Energy Enterprise Development (REED) initiative, UNEP has supported the creation of dozens of RESCOs providing clean energy technologies and services in rural areas and semi-peripheral urban areas in Brazil, China, and some African countries (UN Environment Programme and UN Foundation 2002, 2003).

3. Approach and methods

3.1. Research question and hypotheses

The central research question that this strand of research sought to answer was what policies will hasten the adoption of renewable energy technologies in developing countries, and so ease the transition to a post-fossil fuel era, without major social disruption or environmental harm.

The primary starting hypothesis was that an ideal set of policies to ease the transition to a post-fossil-fuel era in developing countries would hasten the widespread adoption of renewable energy by effectively helping to remove national barriers to the competitiveness of renewable energy with fossil fuels.

This hypothesis implies three propositions covering the main internal barriers to widespread adoption of renewable energy in Asia and the Pacific:

Hypothesis 1: Policies that help to create a level playing field in energy markets for renewable energy to compete with fossil fuels will hasten the widespread adoption of renewable energy.

Hypothesis 2: The creation of public and private institutions that provide increased financial and technical support will promote development and marketing of renewable energy and thus help to hasten its widespread adoption.

Hypothesis 3: In developing countries, the initial focus of policies should be on promoting renewable energy in non-grid-connected areas.

3.2. Methodology

This study looked at good practice case studies in two of the RISPO subthemes: innovative finance for renewable energy development, and promoting biomass energy use. Both topics were considered to be at the cutting edge of policy development in the area of renewable energy and, therefore, more likely to contain innovative policies that could promote renewable energy and make it more competitive with fossil fuels.

The research was conducted in two stages. First a review was made of the available literature to understand the background and produce a conceptual framework for analysis. Next, the selected case studies were analyzed both through individual reading of each study and a textual pattern-matching technique. This latter method centred on 540 “success factors”—factors believed likely to affect the success of environmental policies—which were identified by the RISPO researchers based on the

literature review. Appearances of these factors in the case studies were counted in order to identify patterns. It was assumed that those factors that occurred in a large proportion of the case studies were more likely to be important for the success of the policy. A full description of the methodology used in the study can be found in chapter 3 of this linked series of papers (King and Mori 2007). More information about the case studies examined in each subtheme can be found in table 1. All case studies can be found in the RISPO Good Practices Inventory (http://www.iges.or.jp/APEIS/RISPO/inventory/db/index.html).

The biomass energy promotion good practices covered a variety of related policy areas, including technology development, information-based capacity development, and financial support. The good practices in the area of innovative financing included combinations of government and community financing in India; market development for solar lanterns in the post-subsidy regime in India; the first Clean Development Mechanism project in renewable energy in China; and funding of rural electrification through international competitive tender in China.

Table 1. Details of the case studies used in the study on policies for accelerating the societal shift to a post-fossil fuel era

Subtheme	Case studies	Countries	Partner institutes
Innovative finance for renewable energy development	17	China, India	Energy Research Institute (China), Energy and Resources Institute (India)
Promoting biomass energy use	11	India, Thailand	Energy and Resources Institute (India), Thailand Environmental Institute, National Centre for Genetic Engineering and Biotechnology (Thailand), National Institute for Environmental Studies (Japan)

4. Findings

4.1. Policies to make renewable energy affordable

All countries included in this study have developed new policies specifically to create market conditions favorable to renewable energy. These policies have proved effective in enabling renewable energy projects to attract investment, increasing their share in energy markets, and increasing affordability. Each has sought to bring electrification to rural areas that currently are not connected to the national power grid (off-grid areas). Rural electrification programs in China and India have involved large amounts of public spending in support of producers and consumers of renewable energy-based power.

Table 2. Frequency of occurrence of financing variables, as percentages of all case studies

Variables	IFRED cases (n = 17) (%)	BIEPS cases (n = 11) (%)	Total IFRED + BIEPS (n = 28) (%)	All cases in the Good Practice Inventory (n = 139) (%)
3.4 Funding	100	64	86	68
3.4.1 National government	47	36	43	27
3.4.2 External sources	47	0	29	28
3.4.3 Local government involvement	47	18	36	22
3.4.4 Private sector	41	36	39	35
3.4.5 Users pay	76	9	50	21

Note: IFRED = innovative financing for renewable energy development; BIEPS = biomass energy promotion.

Table 3. Frequency of occurrence of policy content variables, as percentages of all case studies

Variables	IFRED cases (n = 17) (%)	BIEPS cases (n = 11) (%)	Total IFRED + BIEPS (n = 28) (%)	All cases in the Good Practice Inventory (n = 139) (%)
8. Policy Content	100	73	89	75
8.1 Command and Control	35	36	36	32
8.1.5 Incentives/disincentives	35	36	36	18
8.2 Market-based instruments	94	64	82	44
8.2.1 Aimed at producer behavior	65	27	50	30
8.2.1.2 Choice of energy sources	6	27	14	5
8.2.1.6 Producer subsidies	6	36	18	5
8.2.1.7 Green procurement	0	27	11	6
8.2.2 Aimed at consumer behavior	35	9	25	7
8.2.2.4 Subsidies/Cross subsidy	12	9	11	2
8.6 Creations of new markets	53	18	39	29
8.6.2 Facilitating market creation	35	18	29	12
8.6.2.1 Preferential treatment	12	0	7	2
8.6.2.2 Seed funding	18	9	14	3

Note: IFRED = innovative financing for renewable energy development; BIEPS = biomass energy promotion.

The case studies included successful uses of innovative financing models for the promotion of renewable energy, especially in off-grid areas, combining funding from the public sector, the private sector, and end users. While public spending remains important (a factor in 43 percent of the cases studies), private-sector finance also makes a significant contribution (39 percent of cases). Perhaps most surprisingly, the frequency of user payment appearing as a factor (50 percent) is a strong indication that even poor consumers are willing to pay for reliable products and services when flexible financing terms are provided (table 2).

The case studies also indicate that public financial support for purchase of renewable energy technologies early on can contribute significantly to creating a market for renewable energy. In China's western province of Inner Mongolia, subsidies were provided towards purchase of small wind turbines between 1986 and 1999, with the aim of developing the market. The state contributed US$60 towards the cost of 300-watt wind turbine systems in 1986, and the subsidy amount was gradually reduced to reach US$25 in 1999. By the time the policy was terminated in 2000, a local small wind turbine industry had appeared where there had previously been none. Inner Mongolia became the largest market for small wind turbines in the world and accounted for over 90 percent or 150,000 units of small wind turbines produced and installed in China by the end of 2000 (IGES 2003b).

A policy of public investment in renewable energy promotion at the national level in China in the 1970s and 1980s was similarly successful. Public funding of research, application, and expansion of household methane tank biogas generators and mini-hydropower technologies led to installation of 10 million household methane tanks, with an annual output of 3 billion cubic meters of methane, and installation of 28.5 GW of mini-hydropower by the end of 2002, making China the world leader in the design, construction, management, and equipment manufacturing of these technologies (IGES 2004c).

In many parts of India where agriculture has long relied on diesel-powered water pumps, the central government and local energy-development agencies have committed large amounts of public funding to inducing a shift among local people towards pumps running on solar photovoltaic power. In the state of Punjab, such programs have now achieved economies of scale, reducing the price of pumps by 25 percent in two years and significantly reducing public spending while at the same time attracting private financial institutions to provide consumer loans (IGES 2004a).

Another approach used successfully in India has been a gradual shift from capital subsidy to interest subsidy, thereby combining subsidy schemes with mainstream financing and user contributions. This has resulted in gradual replacement of government funds with private-sector funds; increased availability of public funds; and delivery of subsidy programs with lending by private financial institutions. In the commercialization of solar thermal technologies, the approach led to a doubling of the market for solar water heating of systems and doubling of the number of manufacturers, from 40 to 80, over a period of four years (IGES 2004b).

In India's West Bengal state, a market for solar photovoltaic mini-grids has been stimulated through a combination of the central subsidy for renewable energy, state-level subsidy, and local-area development funds in the ratio of 70:20:10. In addition, each consumer invests about US$45 towards application fees for receiving the connection and internal wiring. The monthly fixed tariff is about US$2.50 for consuming 18–20 kilowatt hours of electricity (IGES 2003c).

4.2. Market creation

Policy initiatives aimed at creating and maintaining markets for renewable energy have been taken (and documented) in most of the countries from which case studies were drawn (table 3). These initiatives have aimed to create a more level playing field for renewable energy. Mechanisms that guarantee a particular price of access to a given share of the market and targets to achieve specified amounts a energy generation

from renewables are common policy instruments. The analysis indicates that market-based instruments – such as performance based incentives (occurring in 82 percent of the case studies) and the creation of new markets (39 percent) are given greater emphasis than other instruments.

Table 4. Frequency of occurrence of actor variables, as percentages of all case studies

Variables	IFRED cases (n = 17) (%)	BIEPS cases (n = 11) (%)	Total IFRED + BIEPS (n = 28) (%)	All cases in the Good Practice Inventory (n = 139) (%)
2.Stakeholders	100	82	93	77
2.2 Civic engagement and public partnership	100	82	93	75
2.2.1.3 Private sector involvement	94	45	75	30
2.2.1.9 Multiple stakeholders	76	45	64	37
3. Institutional factors	100	100	100	91
3.1 Government economic and environmental agencies	65	9	43	14
3.1.1 Both involved	12	9	11	4
3.2 Sectoral agencies	6	27	14	19
3.3 Sub-national/local government	65	9	43	25
3.6 Consultants/researchers/think tanks	35	18	29	30
3.7 Local/regional civil society organizations and non-governmental organizations	24	0	14	35

Note: IFRED = innovative financing for renewable energy development; BIEPS = biomass energy promotion.

Table 5. Frequency of occurrence of factors related to level and location of implementation, as percentages of all case studies

Variables	IFRED cases (n = 17) (%)	BIEPS cases (n = 11) (%)	Total IFRED + BIEPS (n = 28) (%)	All cases in the Good Practice Inventory (n = 139) (%)
6.7 Location of implementation	100	100	100	53
6.7.1 Village level	18	45	29	18
6.7.2 Watershed/ecosystem level	0	9	4	2
6.7.3 Urban level	12	27	18	22
6.7.4 Sub-national level	88	9	57	12
6.7.5 National level	0	9	4	4

Note: IFRED = innovative financing for renewable energy development; BIEPS = biomass energy promotion.

In particular, market-based instruments that aim to change the behavior of producers and consumers seem to have been very successful. Seed funds and preferential treatment for industries have proved important for creating renewable energy markets. Market mechanisms feature prominently as instruments for attracting private-sector investment.

In China, a policy to introduce competitive tender for supply of village solar power systems resulted in about 25 percent reduction in price, from about US$20 per watt peak in 2002, prior to implementation

of the policy, to less than US$13 per watt peak in 2003. Over 70 percent of Chinese townships without access to the power grid are now expected to use competitive tender in their bids to become electrified (IGES 2003a). The findings demonstrate that bidding and other competitive market approaches in the provision of subsidies are an effective way of providing public support to renewable energy projects at the least cost to taxpayers. Given the large number of villages still without access to power, financial support from the government will almost certainly be necessary for another five to ten years.

In Japan, a renewable portfolio standard system was adopted as part of a new energy policy implemented partly under the 2003 Special Measures Law Concerning the Use of New Energy by Electric Utilities. The new energy policy sets a target of 3 percent for the share of new and renewable energy in national TPES by the year 2010. The Japanese renewable portfolio standard system requires 1.35 percent of each retail supplier's electricity sales in 2010 to come from renewable energy, generated by solar, wind, biomass, geothermal, or small hydropower (Japan Agency for Natural Resources and Energy 2005).

In February 2005, the Chinese government promulgated the Renewable Energy Law, which came into force on January 1, 2006. The law encourages the construction of renewable energy power facilities and requires power grid operators to purchase resources from registered renewable energy producers. It aims to boost China's renewable energy capacity by 2020 and outlines a commitment to invest US$180 billion in renewable energy over this period (WorldWatch Institute 2006).

The Indian government aims to increase the share of renewable energy in the country's installed power generation capacity by an additional 10,000 MW by 2012. One of the major application areas is the electrification of 18,000 remote villages. The Ministry of Power aims to complete electrification of all villages by 2012 using local renewable energy sources and decentralized technologies. The 2003 Electricity Act empowers state electricity regulators to promote renewable energy and to specify a percentage of the total consumption of electricity that each distribution licensee should aim to purchase from renewable energy sources (Chaurey, Gueye, and Babu 2003).

4.3. Supporting institutions

The promotion of renewable energy brings into play a wide range of public and private actors and institutions (table 4). These include central, local and provincial government bodies; multilateral development and financial institutions; private-sector institutions, including financial institutions, marketing and distribution companies, and energy service companies; and civil society organizations such as NGOs and consumer groups.

Most renewable energy promotion projects are commissioned by central governments, often through their main economic or environmental agency. In 43 percent of the case studies, the economic agency or the environmental agency was involved. However, there are the enormous differences between IFRED and BIEPS in terms of actor variables. Only 18 percent of BIEPS projects had involvement of central environmental and/or economic agencies, while 65 percent of IFRED project involved those agencies. In fact, sectoral agencies played a much bigger role that environmental and economic agencies in BIEPS, i.e. technology and policy development related to biomass energy.

Rarely were both the economic and environmental agencies part of the process (11 percent). There was little indication of coordination with, or involvement of, sectoral agencies in the policy formulation process (14 percent). Parallel to central and national government agencies, sub-national institutions featured fairly prominently (43 percent). The role of policies at the sub-national and village levels was evidently important in implementing rural electrification programs employing decentralized renewable energy sources (table 5). The case studies indicated a frequency of 57 percent at the sub-national level, including 29 percent at village level, against only 4 percent of cases under national-level implementation.

The private sector and civil society have been pioneers in the transition to alternative energies. Private-sector institutions (appearing in 75 percent of cases), including financial institutions, manufacturers, generators, distributors, and energy service companies, have made technological, financing, and marketing contributions to the development of renewable energy. In many cases, the private sector has intervened through obtaining concessions under contracts concluded with central or local governments. There are many examples of private-sector institutions, particularly energy service companies, providing the whole repair and maintenance infrastructure for renewable energy installations, especially in rural areas. Dozens of RESCOs have been set up to provide sale and installation and maintenance services for household solar photovoltaic systems in China and in India, as well as solar water heating in India.

Advocacy by civil society organizations, especially NGOs, has brought renewable energy to the centre of energy policy and political debates. The number of cases involving multiple stakeholders (64 percent) in both BIEPS and IFRED reveals the the importance of diverse actors which are involved in renewable energy projects, comparing to other projects. The involvement of civil society organizations, however, is relatively low when it comes to policy implementation (14 percent). Comparatively, consultants, researchers, and think-tanks have more significant involvement (29 percent), especially in conducting feasibility studies for the introduction of new energy technologies, as some of the cases indicate.

The findings reflect a general trend towards public-private partnerships in developing and implementing renewable energy projects, already demonstrated by many successful examples of public-sector and private-sector institutions dedicated to the promotion of renewable energy. In the Indian state of Tamil Nadu, the Indian Renewable Energy Development Agency (IREDA) has supported policies of the Tamil Nadu State Electricity Board to promote renewable energy in attracting private-sector investment in grid-connected wind farms. Along with various other fiscal and financial incentives offered by central and local governments, financing from IREDA—covering up to 70 percent of project costs or 75 percent of the cost of the wind energy generation equipment—has helped in achieving installation of 210 grid-connected wind-powered electricity generators producing a total of 475 megawatts in Tamil Nadu alone—22 percent of the wind power projects it has financed in the whole of India. The cumulative installed capacity of wind power generators in Tamil Nadu was 895 megawatt hours as of September 2002, representing more than half of India's installed capacity in the wind sector. IREDA has also financed wind power projects in other states—Maharashtra, Andhra Pradesh, and Gujarat—with similar success, stimulating the private sector and other financing institutions to participate in the wind power sector (IGES 2003d).

In the states of Karnataka, Kerala, and Andhra Pradesh, SELCO-India, a solar energy service company operating in southern India since 1995, provides services ranging from solar lighting and electricity to

clean water, wireless communications, and consumer financing. SELCO-India's business model involves partnering with local financial and microfinance institutions, local solar entrepreneurs, and technicians, and using re-financing from IREDA (at 2.5 percent per annum), through a World Bank lending program, to enable consumers to borrow at affordable rates. Consumers are offered a lease-to-own scheme wherein they pay one-quarter of the system cost upfront and take a loan for the rest at a priority-sector lending rate of 12.5 percent per annum. This approach has proved successful in responding to consumers' willingness to pay for better lighting services with staggered payment (IGES 2002).

Consortia have developed in various sectors and tend to remove technological and financial constraints to the development of markets for renewable energy, especially biomass energy. In Japan, entrepreneurs with insufficient finance and knowledge have worked with business partners and end users in a collective and complementary manner and successfully developed technology innovations that not only meet local needs but can also compete in the existing energy market (IGES 2006).

In very low-income communities, microfinance institutions have often been the most affordable source of loans for securing clean energy devices such as solar lanterns. In Bangladesh, the Grameen Bank has been able to extend microfinance to some 2 million borrowers, 95 percent of whom are women. In India, the Chandrakanti project in Karimnagar and Khammam districts of Andhra Pradesh had succeeded in marketing 10,000 solar lanterns to self-help groups by March 2003 through micro-credit schemes. Similar institutions are running successful programs in more than 50 countries (IGES 2005).

5. Conclusions

The findings of the case study analysis strongly support the three starting hypotheses. These are discussed below.

Hypothesis 1: Policies that help to create a level playing field in energy markets for renewable energy to compete with fossil fuels will hasten the widespread adoption of renewable energy.

The findings confirm that transforming the policy and market conditions in the energy sector is a critical element in accelerating the adoption of renewable energy and thus in facilitating the transition to a post-fossil fuel era. The cases reviewed illustrate that policies creating a more level playing field for renewables to compete with conventional energy sources can be effective in enhancing the competitiveness of renewable energy technologies. Strategies to create such a level playing field in off-grid areas have included increasing the amount of government support to renewable energy. In grid-connected areas, policies have tended to focus on altering market conditions to makes renewable energy projects more viable, largely through subsidies, incentives, and mechanisms guaranteeing renewable energy a fair price and/or access to a market. The findings confirm that a renewable energy policy with clear targets help to induce prompt actions by energy users to mitigate environmental problems by adopting renewable energy.

Hypothesis 2: The creation of public and private institutions that provide increased financial and technical support will promote development and marketing of renewable energy and thus help to hasten its widespread adoption.

The findings confirm that a wide range of actors are involved in promoting and supporting alternative energy technologies. Civil society organizations have been important advocates in structuring the policy and political debate on finding alternatives to fossil fuels. Government institutions have taken the lead at the stage of policy formulation and implementation. Sub-national institutions have played a prominent role especially when new forms of energy have been introduced as part of rural electrification programs. Provincial and local governments have been key actors in policy implementation at sub-national level. The private sector and consumers have been important in the policy implementation phase, especially when renewable energy technologies have reached the stage of commercialisation. Thus, the promotion of renewable alternatives to fossil fuels involves a complex process of interaction among a variety of actors.

Hypothesis 3: In developing countries, the initial focus of policies should be on promoting renewable energy in non-grid-connected areas.

The study indicates that directly adopting renewable energy technologies, rather than first going through a stage of using conventional energy, is a prior issue possible in off-grid areas of developing countries, but subsidies might be needed for some time until economic development makes these energy sources locally affordable as well as capacity development for appropriate practices. In grid-connected areas, renewable energy faces an uphill struggle because of past state subsidies to support the establishment of the power grid and the sunk costs of existing technologies. In off-grid areas, renewable energy has an advantage in that it does not necessarily require a large grid infrastructure to be built based upon decentralized energy system. Even if the cost per unit of energy output were exactly the same for renewable and non-renewable energy technologies (output from renewables is currently more expensive) it would make sense for a national renewable energy policy to target off-grid areas first, in particular for rural electrification. In markets where renewables are uncompetitive and do not have special advantages, such as urban areas, policies should aim at leveling the playing field on which renewables compete with conventional energy over the medium term; it appears that developing institutions that can support renewable energy development—financing, technical, and marketing organizations—may be an appropriate priority in such areas. Over time, as economies of scale and technological developments bring down the unit costs of renewable energy, and the cost of conventional energy goes up, renewable energy will become more competitive in grid-connected areas and the costs to the state of maintaining a level playing field will go down, hopefully to the point where subsidies can be removed from both renewable and non-renewable energy, appropriately applying the related sunset provisions. However, there is a need to examine the likely consequences of promoting renewable energy in non-grid-connected areas for the economy as a whole and more attention and economic priority need to be given to grid area.

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