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A qualitative factor analysis of renewable energy and Sustainable Energy for All (SE4ALL) in the Asia-Pacific

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HIGHLIGHTS

- This study develops 10 qualitative lessons responsible for successful renewable energy access programs.
- These concern appropriate technology, income generation, financing, leadership, and capacity building.
- They also involve flexibility, awareness, stakeholder engagement, community ownership, and technical standardization.

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ABSTRACT

This study assesses the factors responsible for the success and failure of renewable energy access programs in Bangladesh, China, Laos, Mongolia, Nepal, Sri Lanka, India, Indonesia, Malaysia, and Papua New Guinea. Based on 441 research interviews over the course of four years, site visits to 90 renewable energy facilities, and focus groups with almost 800 community members in 10 countries, this study develops a series of overarching qualitative factors that correlate with programs that met their targets, sometimes ahead of schedule, and produced measurable benefits exceeding costs. The inverse of these factors is associated with programs that did not meet their targets, were behind schedule, and/or produced measurable costs exceeding benefits. It concludes by offering 10 lessons for energy analysts and development practitioners concerning appropriate technology, income generation, financing, political leadership, capacity building, programmatic flexibility, marketing and awareness, stakeholder engagement, community ownership, and technical standardization.

1. Introduction

For roughly half of the global population, existence—and energy consumption—is remarkably distinct from the lifestyles most people in industrialized countries have become accustomed to. Imagine a daily ritual without consistently hot showers or baths, no indoor lighting at night, poorly cooked food, and debilitating health problems associated with indoor air pollution. Think about life with no steady pumping of water for drinking and irrigation, few televisions, mobile phones, or computers, and limited access to the fruits of modern civilization (Sovacool, 2012a, 2012b, 2012c).

The search for energy fuels and services is an arduous, consistent, exhausting battle. Women and children spend hours each day carrying fuel and water loads at times in excess of their weight, time they could otherwise utilize for productive work or education, with calamitous consequences on their health, their natural environment, and their community. Yet many if not most developing countries still lack the capacity and technology to shift to more sustainable and affordable supplies of energy. One survey of the 24 least developed countries in the world found that 22 of them each had less than 1% of their region's total energy resources (UNESCAP, 2008: 185).

However, small-scale renewable energy technologies—solar home systems, residential wind turbines, biogas digesters and gasifiers, microhydro dams, and improved cookstoves—offer households and communities the ability to tackle extreme poverty and raise standards of living (Sovacool and Drupady, 2012). Collaborations and programs involving governments as well as businesses, nonprofit organizations, banks, and community based cooperatives have blossomed in recent years to expand access to these technologies and the energy services they offer. As one such effort, in 2011 the Secretary General of the United Nations launched the initiative Sustainable Energy for All (SE4ALL) to create a coordinated global response to energy poverty and access problems. That initiative aims to ensure sustainable energy for all by 2030 through the achievement of three goals:

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Table 1
Number and share of population without access to modern energy services, 2009.

Region		Without access to electricity		Dependence on traditional solid fuels for cooking	
		Population (million)	Share of population (%)	Population (million)	Share of population (%)
Africa		**587**	**58**	**657**	**65**
	Nigeria	76	49	104	67
	Ethiopia	69	83	77	93
	Congo	59	89	62	94
	Tanzania	38	86	41	94
	Kenya	33	84	33	83
	Other Sub-Saharan Africa	310	68	335	74
	North Africa	2	1	4	3
Asia		**675**	**19**	**1921**	**54**
	India	289	25	836	72
	Bangladesh	96	59	143	88
	Indonesia	82	36	124	54
	Pakistan	64	38	122	72
	Myanmar	44	87	48	95
	Rest of developing Asia	102	6	648	36
Latin America		**31**	**7**	**85**	**19**
Middle East		**21**	**11**	**0**	**0**
Developing Countries		**1314**	**25**	**2662**	**51**
World		**1317**	**19**	**2662**	**39**

- Universal access to modern energy services;
- Double the global rate of improvement of energy efficiency; and
- Double the share of renewable energy in the global energy mix.

By the end of 2012, 14 countries in the Asia-Pacific had adhered to SE4ALL, with eight countries having completed the initial requisite rapid assessments and gap analyses necessary to determine their energy situation and needs.

To further help these countries reach their SE4ALL goals, this paper distills 10 lessons from 10 partnerships in Bangladesh, China, Laos, Mongolia, Nepal, Sri Lanka, India, Indonesia, Malaysia, and Papua New Guinea chosen from a sample of 1156 programs. In doing so, it isolates a common set of factors that energy planners and development practitioners can use when designing and implementing future renewable energy access projects.

The study focuses entirely on the Asia-Pacific, rather than Africa or other parts of the world, because energy poverty is primarily an Asian problem. According to the most recent data compiled by the International Energy Agency (2011), shown in Table 1, lack of access to electricity and dependence on traditional solid fuels for cooking is most acute in Asia. There, roughly one-fifth of the region's population lives without electricity, constituting 51% of those without access to electricity in the world; additionally, more than half of the region's population depends on solid fuels to meet their domestic energy needs (almost three-quarters of those in the world).

2. Case selection, data collection, and research methods

2.1. Case selection process

The author started by exploring the academic literature on energy access projects in Asia as well as reports and case studies on energy poverty published by a variety of institutions. This initial review produced a possible 1156 projects and programs in middle income and low income countries in the last two decades.

Since this was a voluminous amount of data, the author relied on a seven-phase selection process to reduce the number of cases to a manageable number. First, to be included in the study, a program had to involve the direct provision or supply of energy services through renewable energy to rural or poor communities and areas. This meant, in practice, that programs distributing other end-use devices, such as light bulbs, diesel generators, or mobile phones, were ineligible. This reduced the case study pool to 944.

Second, a case study had to be a fully implemented program in operation for at least four years. The intent here was to exclude pilot and demonstration projects, and also projects so short lived it would be difficult to draw general lessons from them. This reduced the pool to 332.

Third, the author excluded case studies that did not promote solar home systems, wind turbines, biogas, microhydro units, and cookstoves. This criterion meant that only small-scale technology, below 10 MW of installed capacity, was included. Excluded were renewable energy projects at the centralized, electric-utility scale. This lowered our pool to 290.

Fourth, the author wanted programs of a moderate size. So the author excluded case studies that had budgets of less than $50,000, which distributed energy services or technologies to less than 750 homes or customers, and/or those that installed less than 100 kW of total capacity. This dropped the number to 117.

Fifth, a case study had to be recent, either currently in operation or completed in the past 10 years (when our project commented in 2010). This meant the author excluded all projects ending before the calendar year 2000, lowering the pool to 55.

Sixth, sufficient data had to exist on the case study in question. This was admittedly subjective, but generally it meant the exclusion of cases with less than five published sources of credible information. This did create a bias in favor of cases from the World Bank, the Global Environment Facility, and the United Nations, as they are extensively documented. This reduced the pool to 24.

Seventh and the last, the case in question had to be a clear-cut example of either success or failure. By success, it accomplished its goals, at or below cost, and before or on schedule. By failure, it did not accomplish its goals, was above cost, and/or completely behind schedule. The literature on case study selection calls these "extreme" cases, for they refer to those at the outermost end of success or failure. This left the 10 case studies summarized in Table 2.

2.2. Data collection process

The author and his research team relied on what academics call an inductive, narrative case study approach based on data

Table 2
Overview of 10 renewable energy access case studies.

Type	Country	Case study	Primary partners	Primary beneficiaries	Technology	Dates	Cost ($)	Accomplishments
Success	Bangladesh	Grameen Shakti	Grameen Shakti, Grameen Technology Centers, World Bank, Infrastructure Development Corporation Limited, and Government of Bangladesh	Rural communities and women	Solar home systems, biogas, and improved cookstoves	1996–present	100 million (annual)	Installation of 500,000 solar home systems, 132,000 cookstoves, and 13,300 biogas plants among 3.1 million beneficiaries
Success	China	Renewable Energy Development Program	World Bank, GEF, National Development and Reform Commission, and local solar manufacturers	Manufacturers and nomadic herders	Solar home systems	2002–2007	316 million	Distributed more than 400,000 units in five years
Success	Laos	Rural Electrification Project	Electricité du Laos, Ministry of Energy and Mines, World Bank, GEF, and PESCOs	Rural communities and PESCOs	Small hydro and solar home systems	2006–2009	13.75 million	Electrified 65,000 previously off-grid homes and disbursed more than 17,000 solar home systems
Success	Mongolia	Rural Energy Access Project	World Bank, National Renewable Energy Center, Ministry of Fuel and Energy, Ministry of Finance, and Ministry of Environment and Resources	Nomadic herders, *soum* centers, and local solar companies	Solar home systems and wind turbines	2007–2011	23 million	Distributed 41,800 solar home systems, hundreds of wind turbines, facilitated the rehabilitation of 15 mini grids in soum centers, installed11 renewable-diesel hybrid systems
Success	Nepal	Rural Energy Development Program	World Bank, Government of Nepal, UNDP, Nepal Alternative Energy Promotion Center, District Development Communities, Village Development Communities, and Microhydro Functional Groups	Rural communities	Microhydro	2004–2011	5.5 million (original proposal)	Distributed 250 units benefitting 50,000 households in less than 10 years
Success	Sri Lanka	Energy Services Delivery Project	World Bank, GEF, Ceylon Electricity Board, and national banks	Rural communities, national banks, and local companies	Solar home systems and microhydro	1997–2002	55.3 million	Installed 21,000 solar home systems and 350 kW of installed village hydro-capacity in rural Sri Lanka, in addition to 31 MW of grid-connected mini-hydro-capacity
Failure	India	Village Energy Security Project	Ministry of New and Renewable Energy, World Bank, and Village Energy Committees	Rural communities	Biomass gasifiers, biogas systems, and improved cook stoves	2004–2011	8.6 million	Aimed to install 61 biogas projects, only 21 of 50 projects still functioning by 2009
Failure	Indonesia	Solar Home System project	World Bank, GEF, Ministry of Energy and Mineral Resources, Perusahaan Listrik Negara, and local banks	Rural communities	Solar home systems	1997–2003	118.1 million	Aimed to install 200,000 SHS across one million users; only 8054 SHS units ever installed reaching 35,000 villagers
Failure	Malaysia	Small Renewable Energy Power Program	Ministry of Energy, Green Technology, and Water, Tenaga Nasional Berhad, and Sabah Electricity Sendirian Berhad	Rural communities, manufacturers, and IPPs	Solar home systems, microhydro, biogas, and waste incineration	2001–2010	$220 million (unconfirmed)	Tried to install 500 MW of small-scale renewable energy technology by 2005, but ended up achieving only 12 MW; target altered to 350 MW by 2010, but only 61.7 MW were built by project close
Failure	Papua New Guinea	Teachers Solar Lighting Project	World Bank, GEF, Department of Education, Papua New Guinea Sustainable Energy Limited, and Teacher's Savings & Loan	Rural school teachers	Solar home systems	2003–2010	2.9 million	Attempted to install 2500 solar home systems and jumpstart a local market, ended up installing only one single unit

Table 3
Overview of research interviews.

Country	Case study	Number of interviews	Number of institutions	Dates visited
Bangladesh	Grameen Shakti	48	19	June 2009 –October 2010
China	Renewable Energy Development Program	30	17	May 2010–June 2010
Laos	Rural Electrification Project	16	11	March 2010
Mongolia	Rural Energy Access Project	22	10	June 2010
Nepal	Rural Energy Development Program	57	24	August 2010–November 2010
Sri Lanka	Energy Services Delivery Project	56	28	February 2011
India	Village Energy Security Project	51	17	September 2008–June 2009
Indonesia	Solar Home System project	36	22	June 2011
Malaysia	Small Renewable Energy Power Program	89	38	March 2010–February 2011
Papua New Guinea	Teachers Solar Lighting Project	36	14	February 2010–April 2010
Total		**441**	**200**	**September 2008–June 2011**

collected from research interviews and field research. In aggregate, the team conducted 441 of these research interviews with 200 institutions over the course of four years, research trips summarized are in Table 3. In each case we had simultaneous real-time translation into local languages and dialects. We relied on a purposive sampling strategy, meaning experts with extensive knowledge of each case were chosen to participate, and also a critical stakeholder analysis framework that required us to include respondents from government, civil society, business, academia, and local communities, as well as people in favor, and opposed to, each project. We made sure to include participants from:

- *Government agencies* such as the Nepal Ministry of Energy, Indonesian Ministry of Finance, Indian Ministry of New and Renewable Energy, Chinese Ministry of Science and Technology, and Sri Lanka Sustainable Energy Authority;
- *Intergovernmental organizations* such as the South Asian Association for Regional Cooperation, the Global Environment Facility, and the United Nations Development Programme;
- *International civil society organizations* or *think tanks,* including Conservation International, Friends of the Earth, Transparency International, and the Stockholm Environmental Institute;
- *Local civil society organizations* or *think tanks,* including Grameen Shakti, Yayasan Pelangi Indonesia, and Pragati Pratishthan;
- *Electricity suppliers* including the Nepal Electricity Authority, Tenaga Nasional Berhad in Malaysia, Ceylon Electricity Board in Sri Lanka, and Papua New Guinea Power Limited;
- *Manufacturers, industry groups,* and *commercial retailers* such as Alstrom Hydro, Barefoot Power Systems, Sime Darby, Siemens, and Sunlabob;
- *Financiers* and *bilateral development donors* including Deutsche Gesellschaft für Technische Zusammenarbeit, United States Agency for International Development, the Asian Development Bank, and the World Bank Group; and
- *Universities* and *research institutes* including the International Center for Integrated Mountain Development, University of Dhaka, University of Papua New Guinea, and the Chinese Academy of Sciences.

For each case study, we asked participants to (a) identify the benefits of the program at hand, (b) summarize some of the key barriers to implementation it had to confront, and (c) discuss general lessons that the case study offers energy policy and development practitioners. Due to Institutional Review Board guidelines, as well as the request of some participants, we present such data as anonymous, though information from the interviews was often recorded and always carefully coded.

To ensure a degree of triangulation and reliability, and to better understand our case studies, we augmented our research interviews with direct observation and site visits to 90 renewable energy facilities in our 10 countries over the course of March 2009–June 2011. These included a variety of sources, systems, sizes, and capacities, including some grid-connected facilities to gain a comparative perspective, as well as laboratories, testing centers, factories, and assembly lines. The site visits enabled us to discuss our cases with actual renewable energy operators, managers, and manufacturers. They also served as a useful vehicle to arrange additional research interviews. To receive input from energy-users, the research team conducted targeted focus groups and spoke with almost 800 community members, village leaders, and households in aggregate including local political representatives, research trips summarized in Sovacool and Drupady (2012). We lastly supplemented our interviews, site visits, and community consultations with a review of reports and peer-reviewed articles relating to energy policy in each country.

2.3. Factor analysis

To guide the interpretation of all of this data, the author relied on what is called a qualitative version of "factor analysis." Factor analysis is a method utilized primarily in economics and behavioral science to describe the variability among observed correlated variables, and to retain those factors whose meaning is most comprehensible to the researcher (Bartholomew et al., 2008; Bandalos and Boehm-Kaufman, 2009; Velicer and Jackson, 1990). This approach may sound a bit subjective and broad, but it has been used previously in the energy policy community. One study, for example, relied on factor analysis and noted that in India, failure to adopt or maintain microhydro units related strongly to variables such as unequal income distribution within villages, disputes over water or water shortages, and changes in management. Poorly trained operators, natural calamities like floods and landslides, misuse or inefficient monitoring, and little to no funds for maintenance also explained non-adoption (Ete and Prochaska, 2009). Another study conducted a factor analysis of the conditions explaining successful microhydro operation, and it noted the benefits of having a strong village leaders, the assistance of the local provincial council, a stream with strong flow and head to obtain consistent power output, an "easy" site for construction, and community agreement concerning cost sharing and electricity distribution (Deheragoda, 2009).

Understandably, looking at the factors responsible for a particular renewable energy project differs from those that might be responsible for a full-scale program. Thus, the qualitative factor analysis of the data drawn from the interviews, site visits, community focus groups, and program literature below assesses the factors attributed to successful (and unsuccessful) national programs rather than individual projects.

3. Results

This section argues that the following 10 factors, which some studies have called "design principles", "common ingredients" or "best features" (Barnes and Floor, 1996; Kammen, 1999; Martinot, 2001; Martinot et al., 2002; Magradze et al., 2007; Dijk, 2010; Bazilian et al., 2012; Chaurey et al., 2012; Sovacool and D'Agostino, 2012), correlate with successful national programs:

- Selecting appropriate technology through feasibility studies and surveys that, by asking local users what they want, are able to identify community needs and desirable energy services;
- Coupling renewable energy with income generating activities and partnering with livelihood groups such as farmers and crop processors, small businesses, restaurants, and community cooperatives;
- Providing access to financing and microcredit to overcome the first cost hurdle with purchasing systems;
- Having political leadership and a requisite alignment of national and local policies;
- Building capacity and investing in local institutions rather than merely providing technology;
- Being flexible in terms of deadlines and changing circumstances, including the avoidance of promoting technology selected only by donors;
- Conducting outreach and marketing campaigns and research to ensure that economic, social, and policy issues are addressed alongside traditional engineering and environmental aspects;
- Encouraging active participation (and feedback) from communities, essentially creating as much interaction among designers, producers, and users as possible;

- Avoiding giving away systems for free and instead requiring community contributions and cost-sharing;
- Enforcing technical standards and certifications so units, components, installation practices, and maintenance procedures are all sufficient to ensure reliable system operation.

These are listed in no particular order below though the evidence suggests that all are important.

3.1. Appropriate technology

Successful programs frequently start small with pilot programs or with feasibility studies before initiating full-scale projects and scaling up to greater production or distribution volumes. They almost always choose appropriate technologies matched in quality and scale to the energy service desired.

Feasibility studies and piloting are useful ways to identify market segments and determine if enough demand exists for renewable energy systems. The REDP in China, REP in Laos, REDP in Nepal, REAP in Mongolia, and ESD in Sri Lanka all relied on World Bank-sponsored feasibility assessments well before they were implemented, and GS conducted willingness to pay studies of consumers in Bangladesh to determine if they would pay more for solar energy than kerosene or dry cell batteries. For the REP in Laos, at least half the households in a given village had to express an interest in renewable energy before the scheme would extend to them. Correspondingly, in Nepal only communities expressing an interest and desire for energy could participate in microhydro schemes, and they had to know how to build, own, repair, and manage a microhydro unit before they were given one. GS started in Dhaka before expanding go the rest of Bangladesh, the ESD in two Sri Lankan provinces before expanding to eight, and the China REDP initially targeted six provinces in the Northwest before expanding to another three – demonstrating the utility of scaling up.

Successful programs also have an orientation towards energy services, matched in quality to end-uses, rather than technological deployment; they recognize technology not as an end itself, but a gateway to a particular energy service. For example, one respondent in Bangladesh informed us that GS:

> *Does not, like other groups, mistakenly think of 'energy services' as a single entity; there are really several types of demand for energy, as variegated as a patched quilt: heat energy comes from cooking with firewood, and its uses vary from boiling water to drying yarn and making bricks, SHS can do everything from lighting study areas and charging mobile phones to powering DVD players and televisions, biogas units provide cooking as well as fertilizer for farming. The key here is flexibility and a pairing of energy supply with energy quality and household needs.*

The REDP in Nepal and ESD in Sri Lanka relied on simple technologies matched in proper scale to the communities they were intended to serve. Rather than build new grids, communities were encouraged to construct simple microhydro units in the range of 10–100 kW to be owned and operated by communities themselves. Program managers empowered communities to adapt systems to meet their own needs. In Dhading, Nepal, where mustard does not grow, mechanical energy is used to husk rice. In Kavre, Nepal, more agriculturally oriented, grinding and mustard seed expelling are given priority. In Lukla, Nepal, a tourist destination home to hotels, tourist facilities consume most of the electricity.

Similarly, GS designed each of their programs in Bangladesh to meet distinct energy needs: improved cookstoves (ICS) for the "poorest," solar home systems (SHS) for slightly more affluent rural households, biogas systems for wealthy rural households or communities. In Mongolia and China, herders put SHSs to use separating milk and in Sri Lanka, charging mobile phones; SHS designs in Mongolia and China also favored quick assembly and disassembly so that they could be easily moved, accommodating nomadic lifestyles, including the system shown in Fig. 1.

Fig. 1. A portable solar home system near a Ger in Mongolia.

Failures tended to do the opposite: they restricted eligibility to a single technology or a predetermined size, with only one type of unit being promoted in Indonesia and Papua New Guinea, and the program in Malaysia actually excluding wind turbines. Furthermore, successful programs often possessed culturally sensitive dissemination efforts, opposed to those in Malaysia where indigenous communities felt alienated by the program and in Papua New Guinea where they felt threatened by it.

In other words, successful renewable energy projects considered the appropriateness of the technology diffused for the needs of the targeted communities but also anticipated how these needs will change and grow over time, and they facilitated the transition to larger wattages or different technologies. As Lovins (1976) presciently commented many decades ago, "people do not want electricity or oil, nor such economic abstractions as 'residential services', but rather comfortable rooms, light, vehicular motion, food, tables, and other real things."

3.2. Income generation

More effective programs couple and cultivate energy services with income generation and employment, they do not just "wait" for it to occur. They also sometimes offer scholarships and university training.

GS in Bangladesh offers a scholarship competition for the children of SHS owners. It also sponsors technical degrees in engineering and related fields for employees that commit to staying with the organization long-term. Also, GS has also done an excellent job linking its products and services to other local businesses, and integrating its technologies with other programs. As one example, it connects the use of biogas units in homes and shops with the livestock, poultry, agriculture, and fishery industries. Clients wishing to own their own biogas unit can also purchase livestock, and clients that do not wish to use the fertilizer created as a byproduct from biogas slurry can sell it to local farmers, aquaculturists, and poultry ranchers. Similar linkages have been made in the promotion of GS's solar panels, mobile telephones, compact fluorescent light bulbs, and light emitting diode devices.

In parallel, China's REDP offered nomadic herders tips on how they could use solar electricity not only for lighting but also to separate milk and cheese, charge mobile phones, and refrigerate yoghurt. In Laos, services put to use by solar panels have increased the business of restaurants, hotels, teahouses, and shops.

In Mongolia, improved access to cellular telephony from REAP has enabled herders to get better commodity prices for cashmere, meat, livestock, cheese, milk, yoghurt, and curd. In Nepal, the REDP has linked microhydro energy and the promotion of non-lighting uses of electricity including agro-processing, poultry farming, carpentry workshops, bakeries, ice making, lift irrigation, and water supply. In Sri Lanka, the ESD motivated many home-owners to begin new enterprises such as selling baked goods and vegetables, and it enabled shop owners to extend their operating hours after dusk. In fact, in the successor RERED project, income-generating activities were made a mandatory component.

The four "failed" case studies show the inverse. One of the objectives of the India VESP was to provide energy for productive purposes, yet since the value of biomass fuel was seen as free, and systems kept breaking down, few concrete opportunities for generating income materialized. In Indonesia, some SHSs were used to power cottage industries, agriculture, fisheries and other small enterprises. However, the overall program did not place any emphasis on income-generating activities. In Malaysia, although the overall SREP yielded dismal results, lack of institutional support seemed to have pushed some participants to develop their own income-generating activities in addition to selling electricity to the grid. For example, waste-to-energy projects received revenues from tipping fees, recycling, on-site manufacturing of plastic resin, fertilizer, and carbon credits, in addition to electricity sales. Unfortunately, there was no platform provided to share and improve on these innovations with other stakeholders. In Papua New Guinea, as only one sale was made, no income-generating opportunities occurred.

The key lesson here is that successful programs did not just supply energy or electricity, presuming people know how to use it; they instead teach them how to put that energy to productive use. In essence, these projects succeeded because they promote the types of economic activities that go hand-in-hand with modern energy, enabling communities to form strong livelihood groups, to process agricultural commodities and crops, and to sustain small businesses and enterprises such as bars and restaurants.

3.3. Financing

All successful case studies offered financial assistance to overcome the first cost hurdle related to renewable energy technology; in some cases this took the form of financing from microcredit, in other cases it took the form of an ESCO model. The emphasis, in other words, was on affordability rather than installed capacity.

GS's entire mission continues to revolve around providing microcredit to rural homes so they can purchase SHS, biogas digesters, and ICS. China's REDP investigated numerous mechanisms that would encourage consumer credit access for purchasing SHS, including consumer banks, rural credit cooperatives, and the PV companies themselves. The REAP in Mongolia gave low-interest loans, credits, and rebates to reduce the cost of SHS and small-scale wind turbines, and it also relied on bulk purchases of technology to keep costs low. Both the REDP in Nepal and the ESD in Sri Lanka overcame the first cost hurdle through grants and the availability of low-interest loans to consumers. The REP in Laos overcomes financing issues with its ESCO approach.

Our four failures, interestingly, show the opposite: that lack of effective financing can significantly impede programmatic progress. In India's VESP, disagreements and confusion over financing rates added to the expense, and therefore reduced the affordability, of community biogas projects. The credit component of the Indonesia SHS Project failed to adjust to the economic realities of the Asian Financial Crisis. With little domestic manufacturing and assembly, the program was entirely dependent on foreign components, which meant the regional crisis saw the devaluation of Indonesian currency and a threefold increase in the costs of SHS systems. In Malaysia, banks were unfamiliar with renewable energy projects and were therefore reluctant to lend to the sector. In Papua New Guinea, the financial institution that was chosen to provide credit to overcome the first cost barrier was one that customers were reluctant to patronize and did not have the necessary outlets in the targeted areas.

3.4. Political leadership

Effective programs received consistent political support, including a dedicated or experienced implementing agency, integration with other policies and regulations, and a clear project champion.

A key role for the government in any development project is to provide political leadership and facilitate an appropriate institutional and regulatory environment. During their initial phases, projects can benefit greatly from favorable legal intervention, the integration or harmonization of policies, the creation or alteration of some institutions, and the development of well-targeted incentives. GS benefitted from a national effort directed by IDCOL to distribute SHSs; the REDP in China benefitted from no less than six other renewable energy programs operating concurrently; the REP in Laos was preceded and proceeded by other "phases" of electrification. The REAP in Mongolia had benefitted from a national renewable portfolio standard and feed-in tariff, the REDP in Nepal saw ancillary support from related projects including bilateral programs operated by USAID, GTZ, and Danida in addition to a World Bank sponsored Nepal Power Development Project. The ESD in Sri Lanka was backed by public subsidies for electrification as well as a renewable portfolio standard and tax credits; its advocates also changed the Sri Lankan constitution so that off-grid and grid-connected developers had the legal right to distribute and sell electricity. At the same time, rapid political turnovers, such as 8 administrations in less than 10 years in Bangladesh, and ongoing civil wars in Nepal and Sri Lanka, meant that programs effectively *avoided* politicians as much as possible.

Conversely, our four failures did not see widespread political support, or saw it evolve in the wrong direction. In India, local political leaders often gave fuelwood away for free, mitigating the incentive to pay for a biogas system. In Indonesia, national subsidies for kerosene and grid extension plans functionally eroded the desirability of purchasing SHS units. In Malaysia, SREP lacked support from state and local policymakers and had to constantly swim upstream against subsidies for fossil fuels. In the case of Papua New Guinea, the TLSP was an extension of the failed Solar Lighting for Rural Schools (SLRS) program funded by a Japanese donor, without any genuine commitment from the Papua New Guinean government.

Designating a proper coordinating or regulatory agency with a strong mandate and well-defined responsibilities can also provide the oversight and coordination needed for a project to succeed. In fact, an autonomous, experienced, or strong implementing agency can be essential in ensuring that committed staff implement the project in a competent manner. As a nonprofit company, GS is entirely under the control of its managers. The REDP in China had a tough but fair PMO that oversaw its subcomponents, monitored progress, managed difficulties, and levied fines against participants that failed to meet standards. The REP in Laos, REAP in Mongolia, and ESD in Sri Lanka all had dedicated project management units or offices established by the World Bank and United Nations Development Program. The REDP in Nepal was implemented entirely under the direction of the Alternative Energy Promotion Center.

Indeed, it may be that a project's champions – those who advocate strongly for its cause – can influence success or failure. A champion can be a key leader in the community, a renowned political figure, an industry group, a grassroots organization, or even political pressure from a vulnerable community who publicly air their grievances or aspirations. In this regard, GS had the benefit of famous leaders including the Nobel Laureate Muhammad Yunus, the founder of the Grameen Bank, and a strong founding director Dipal C. Barua. The close personal connections between Yunus and President Bill Clinton played a role in USAID giving GS a $4 million grant in the late 1990s, so that the organization was able to raise funds and grow at critical moments of its existence.

In a similar vein, the ESD in Sri Lanka had a strong Administrative Unit (AU) behind it plus a collection of banks and trade and industry associations. These included the Solar Industries Association, Grid Connected Small Power Developers Association, Small Hydropower Developers Association, and Federation of Electricity Consumer Societies in addition to a dedicated NGO (Practical Action) and impassioned microfinance institution (SEEDS). DFCC Bank, the AU, was even willing to "initially sustain losses from operations for the first three years." As one respondent explained, "one of the reasons the ESD succeeded is because the government stayed out—the private sector just ran with it, guided by the AU." The REDP in Nepal was, likewise, supported by grassroots microhydro functional groups; the REP in Laos was supported by a collection of local and provincial organizations.

In contrast, our four failures suffered from lack of meaningful support. The VESP in India had little consistency between projects. The implementation of the Indonesia SHS Project suffered from a lack of coordination amongst the government agencies involved. Although BPPT had all the trappings of a proper implementing agency, in actual fact it was only interested in the technological development component of the project with no real desire to coordinate and oversee sales and maintenance. Relatedly, Malaysia's SREP found real opposition from TNB, the national utility, and neither SCORE nor the Malaysian Energy Commission had any real political power to go against it. The TSLP in Papua New Guinea was plagued by litigation in the courts, and an open disagreement between the World Bank and PNG Sustainable Energy regarding the direction the program should be taking.

3.5. Capacity building

Successful programs all undertook some degree of capacity building. Variants of this lesson include strengthening the technical or managerial capacity of domestic firms and institutions; outsourcing to international consultants when capacity is lacking; awarding research grants to manufacturers; improving the business practices of participating organizations; and emphasizing commercial viability.

Institution building can take a variety of forms. The REDP in China and REAP in Mongolia, for instance, focused on strengthening the ability for SHS equipment manufacturers to improve designs and performance through research grants; the ESD and REDP in Nepal did the same to microhydro designers and manufacturers. The REDP in China also established verification and claims tracking databases so inspectors could evaluate technical performance across the solar industry. The REDP in Nepal elected village leaders to learn how to manage microhydro dams and awarded grants for electricity connections to schools, hospitals and the replanting of trees used in microhydro construction. The REDP spent more on developing capacity and training than on technology. One study calculated that the total cost of installing microhydro systems under REDP was $14.3 million spread over 1996–2006, yet 56% was spent on capacity development and institutional strengthening, only 44% was spent on hardware such as electromechanical machinery, civil works, transportation, and turbines. In Laos, the REP enabled planners to develop a GIS database to coordinate electrification efforts, and it actually outsourced project components for SHS distribution off-grid to the French company, IED.

The REDP in China, ESD in Sri Lanka, REDP in Nepal, and REAP in Mongolia also directed funds to improve the logistics and management of participating institutions. These funds enabled companies and government ministries (when applicable) to build their own capacity in accounting, auditing, sales, and promotion, including tips on revenue collection and accountability as well as advertising campaigns and market analysis.

None of the four failed case studies, however, meaningfully built capacity. Only about half of the biogas systems installed under the VESP in India are still operational, even though the project ended in 2011. Out of the six SHS dealers approved in the Indonesia project, only one remains, and participating banks had little to no rural presence, with two of the four closed down during the Asian Financial Crisis and the other two barred by the Bank of Indonesia from giving credit until much later in the project. The Indonesian program spent 95% of its budget on technology and only 5% on capacity building. In Malaysia, the SREP allocated no funds for capacity building, and TNB viewed the development of the renewable energy market as detrimental to its profit margins and thus vigorously opposed projects. In Papua New Guinea, selecting SHS vendors based on a least cost approach resulted in approved bids being too low. One firm went bankrupt, whereas the other lacked strong networks in the rural areas and provinces it was supposed to serve.

3.6. Programmatic flexibility

All of our successes were diverse in the eligible technologies they included, customizing particular technologies to different sets of end-users. GS in Bangladesh did not presume what customers wanted, it asked them and then involved them in its programs. In a way each program targets those with different energy service needs, and eligible technologies vary by price. Those with livestock, straw, dung, corn, agricultural waste, and poultry can subscribe to biogas, those in need of light or television, a SHS, those using prodigious amounts of fuelwood, an ICS. Within each program, participants can select fiberglass or brick biogas units ranging from smaller household capacities to larger community-scale systems, SHS ranging from 10 Wp to 130 Wp (or even configured as micro-grids), and variously sized cookstoves. As one community leader told us:

> *Everyone in Bangladesh can benefit from at least one GS program, the ultra-poor with no land and cows can still afford an ICS, most poor households can afford a moderately sized SHS, the top 15 percent of the poor, the upper part, can go for biogas, in this way GS is very versatile, it's programs are matched seamlessly to end user needs, each at a different rung of the energy ladder.*

The REDP in China and REP in Laos featured SHSs of various sizes, the REAP in Mongolia did the same and also promoted variously sized wind turbines, the REDP in Nepal ranged widely in the types of microhydro units it supported, and the ESD in Sri Lanka distributed different types of SHS and microhydro dams.

In addition, being strategic about whether energy access will be provided by national electricity grids, micro-grids, or off-grid technologies featured in four of our cases. Nepal's REDP, Sri Lanka's ESD, and the REP I in Laos all met this criterion, with separate components tailoring grid, micro-grid, and off-grid solutions to local circumstances. The ESD went so far as to specifically target different beneficiaries: SHS for rural households, off-grid village hydropower projects for cooperatives and NGOs, grid-connected microhydro projects for tea estate management companies and Independent Power Providers. The REAP in Mongolia, similarly, pursued a two-pronged strategy of isolated units for some herders but micro-grids for *soum* centers.

By contrast, all of our failures exhibited a degree of rigidity in selecting technology: only technologies fueled by biomass were eligible under the VESP in India; only one type of SHS was eligible in both the Indonesian and Papua New Guinean cases; and the SREP excluded wind energy and promoted no solar energy systems because it was predisposed towards landfill gas capture and waste from the palm oil industry. In both the Indonesian and the Papua New Guinean cases, planners pushed solar energy because expert consultants told them to, not because communities had expressed an organic demand for the technology.

Some successful (and unsuccessful) cases adjusted targets and extended deadlines as well. The underlying element to this criterion is possessing adaptability to local events and unforeseen circumstances. China's REDP ended up canceling their finance component for SHS midway through because targets were being met without it, whereas Indonesia's SHS canceled theirs because of lack of interest. The REP in Laos revised their grid-connection targets midway through the program and the REP increased solar service rates to account for the climbing price of system components and of the kerosene lamps they were competing with. The REDP in Nepal extended its deadlines twice, the ESD extended its deadline once, to account for ongoing civil wars in each country. The ESD in Sri Lanka was also revised midterm to include microfinance firms as Participating Credit Institutions (PCIs) to overcome the difficulties facing its SHS component. The VESP in India was canceled early for not achieving its targets, the Indonesian SHS program revised its targets downward to account for a regional financial crisis and switched its subsidies to be per installed capacity rather than number of systems sold. The SREP in Malaysia and TSLP in Papua New Guinea extended their original deadlines as well, though this was because targets were *not* being met.

The implicit lesson here is that flexibility in program design and management can assist in expanding access and meeting goals.

3.7. Marketing and awareness

Successful partnerships do not take consumer awareness or information about renewable energy for granted. They have robust marketing, promotional, and demonstration activities, providing avenues for the public not only to understand the project better, but to also become better educated in renewable energy technology.

Marketing and promotion involve the publication and distribution of sales catalogs, informational brochures, product displays, websites, and advertisements (in print, radio, or on television). Indeed, almost all of our cases—including the failures—had some degree of promotion. Apart from GS in Bangladesh and the ESD in Sri Lanka described above, the REDP in China supported the production of TV and movie content to expand awareness about renewable energy, as well as initiated training capacity-building courses and conferences for PV companies; the REP in Laos, REAP in Mongolia, REDP in Nepal, VESP in India, SREP in Malaysia, and TSLP in Papua New Guinea had brochures and printed advertisements. The REAP in Mongolia also had a brainstorming workshop involving consultation with stakeholders, donors, banks, and suppliers; the ESD a Business Development Center which promoted public awareness through workshops and marketing campaigns.

Promotional efforts appear most successful when coupled with technology demonstration. In Bangladesh, GTCs conducted large demonstrations of solar and biogas devices and GS employees sometimes embarked on door-to-door visits to familiarize communities with the technology. GS engineers consistently worked with village leaders to distribute brochures, hold science fairs at local elementary schools, and host workshops for policymakers. The REDP in China, REAP in Mongolia, the REDP in Nepal, and the ESD in Sri Lanka did "road shows" where experts traveled around rural areas, frequently with systems strapped to the backs of motorcycle drivers, to display and demonstrate technologies to village leaders and household members.

Some of the new sales techniques developed and perfected with the Sri Lanka program were downright clever. One was displaying products to large groups of people rather than individuals; vendors and PCIs sent speakers with units to garment factories, schools, and hospitals, giving demonstrations and/or answering questions during lunch breaks or between shifts. Another was innovative displays, with rural salespeople fixing SHS in temples, churches, and community centers so people could literally see what they could do. Another was door to door visits for SHS done at night, so people could witness firsthand what rechargeable torches and electric lights can offer them. A fourth was dealers traveling by motorbike to loan sample systems for a single night so households could become familiar with solar electricity. A fifth was targeting women as beneficiaries since household surveys revealed that electricity access benefitted them the most—as it enabled labor saving appliances, reduced household chores, provided access to entertainment, and positively impacted family routines. A sixth was sending along bank officers with the technicians doing demonstrations so interested community members could sign up on the spot.

By contrast, in India, local plantation experts and many village households remained uninformed about the VESP. In Indonesia, outreach was negligible, with dealers unable to afford television and radio commercials and even brochures and catalogs. In Malaysia, demonstration was nonexistent if not counterproductive (all of the demonstration facilities we visited were no longer working despite being only a few years old), and in Papua New Guinea awareness raising activities were inappropriately located in bank offices far away from the teachers that needed actual solar systems.

3.8. Stakeholder engagement

Effective programs engage different institutional partners, involving a diversity of important stakeholders in each project, especially "non-state actors." This allows for the sharing of risks as well as organizational multiplicity which can create "checks and balances" on other actors involved in the project. Typically, these actors transcend multiple scales, making them "polycentric" (Ostrom, 2010; Sovacool, 2011).

Each successful case engaged stakeholders a variety of scales. Rather than run things from Dhaka, GS in Bangladesh now has a network of more than 1000 offices spread throughout the country. GS not only enrolls communities into renewable energy projects at the household and village level but also engages district and national policymakers along with international donors and lending firms. China's REDP involved actors at not only the global scale (World Bank and GEF) but the national scale (NDRC), provincial scale (governments), and corporate scale (solar and wind manufacturers). The REP in Laos divided tasks so that grid-expansion was carried out by EdL on a cross subsidization model but off-grid SHS were diffused according to an ESCO model involving Village Off-grid Promotion and Support (VOPS) offices, Provincial Electricity Supply Companies (PESCOs), village electricity managers

(VEMs), and policymakers at Provincial Departments of Energy and Mines. The REAP in Mongolia enrolled the World Bank and GEF along with the National Renewable Energy Center, Ministry of Fuel and Energy, Ministry of Finance, Ministry of Environment and Resources, and local *soum* centers.

The REDP in Nepal is especially diverse and polycentric, for it collaboratively works with various layers of community organizations, including governments, and social networks. The REDP partnered with and built on earlier work from the UNDP, Danida, USAID, and the ADB. In the REDP, District Development Committees and District Energy and Environment Sections share experiences institutionalizing bottom up participation in the project. National actors like the AEPC and Ministry of Environment, Science, and Technology, as well as global actors like the World Bank and UNDP, play significant roles as well.

The ESD in Sri Lanka, likewise, incorporated national and local banks, microcredit agencies, the Ceylon Electricity Board, national ministries, NGOs such as Practical Action, and industry trade groups. Polycentricity ensured that a "diversity of responses" facilitated the efficient performance and self-organization of a program in the face of "unanticipated conditions" (Nair, 2010).

In the case of India, a multilayered service delivery model was present in each project, whereby the Project Implementing Agency formed a Village Energy Committee consisting of representatives of villagers and the local government. However, consultation among all stakeholders, including the MNRE, state governments, VECs, and *panchayats* was poor, leading to delays and frequent disagreements.

In Indonesia, the BPPT did very little to adjust the project design to properly involve financial institutions, SHS vendors, and end-users in the project – mainly letting the Asian Financial Crisis take its toll. Similarly, in Malaysia, SREP was supposed to be managed by the Malaysian Energy Commission as the implementing agency. However, the Commission did not have the authority to enforce SREP, reconcile complaints, or expedite projects. With limited oversight, it was always at odds with utility companies and/or participants when trying to pursue the interests of the project. In Papua New Guinea, the TSLP suffered from a nonfunctioning chain of command and a lack of interaction, understanding, and trust between the key stakeholders.

3.9. Community ownership

Having local communities pay for renewable energy projects with their own funds means they express interest and responsibility in how they perform; they become not only passive consumers, but also active participants. As one respondent explained, "classically, energy planners have seen the access question as one involving 'givers' and 'takers:' the utility giving electricity or donors giving technology, and the consumers taking it. This completely places the energy services provider and consumer into a false dichotomy, one which successful programs break." Contributions do not have to be financial, either; communities and households can donate time (such as digging a canal), land (such as free property for the project site), or resources (such as wood for distribution poles).

For instance, in Bangladesh, GS established 45 Grameen Technology Centers to train members of the communities they operate in to maintain and repair their own systems, be it SHSs, ICSs, or biogas digesters. In fact, GTCs prioritize training programs for women which have contributed toward improving their social and economic standing. The Mongolian REAP and Chinese REDP established testing centers closer to communities so that they could be more involved in maintenance. The Laos REP involved villager leaders in the formulation of local electricity companies. Microhydro projects in Nepal and Sri Lanka were designed to accelerate community-level participation by asking for voluntary land donations for the construction of canals, penstocks, power houses and distribution lines. Villagers were also required to contribute labor and civil works. (One additional benefit of strong community participation in microhydro projects in Nepal is that the units were not prone to being targeted by Maoist insurgents during the civil war.)

Conversely, while some VESP test projects, especially those run by NGOs, emerged as vehicles to encourage greater community involvement, in many more, communities were only involved nominally and continued to expect or rely on government officials to operate and manage biogas systems. Additionally, 90% of project costs were provided through grants from the government and 10% provided by villagers either in-kind or in cash. In Indonesia, little effort was made to fully understand the true energy needs of the targeted population, and the national government expanded the grid to communities that had just purchased SHS units, flooding the secondary market and mitigating the desire for households to pay for systems. Malaysia employed a relatively top-down approach in terms of selecting eligible technologies, determining tariffs, and adjusting program targets. There is no evidence that local communities were consulted in any of these decisions. In Papua New Guinea, individual ownership of SHSs became a concept insulting to tribal communities, resulting in vandalism and theft of units and components.

This lesson about not giving technologies away has been confirmed by one wide-ranging survey of renewable energy markets in developing countries, noting that donations without cost recovery can actually destroy markets (Martinot et al., 2002). Many state-financed renewable energy projects following the "give technology away for free" model resulted in damaged technologies, since people tend not to take care of things they do not have to pay for. The study also found that such approaches can inhibit commercial markets as consumers come to expect more donor aid and will wait rather than pay market prices. It lastly found that subsidies are unlikely to lead to sustainable markets unless they explicitly create conditions whereby they are no longer needed, and that they can undermine private investments. As one consultant with experience implementing renewable energy projects in dozens of countries commented, "energy services must always be paid for, at a fair cost… Once you give something away for free, you better be prepared to give it away for free forever."

3.10. Technical standardization

Programs that work tend to promote or harmonize rigorous technical standards to ensure renewable energy technologies perform as expected. This underscores the reliability component of energy access, and it also serves as a meaningful form of consumer protection. As one of our interviewees argued:

> *People will pay for energy services, just not for unreliability or unpredictability; they won't pay for electricity that is on when they don't need it or off when they do need it. Nor will they pay for electricity that has such erratic voltage fluctuations it fries appliances – that's what they don't want to pay for. But reliable, efficient service – yes, they want that.*

Thus, successful cases strengthened technology—from design and installation to maintenance and replacement—in tandem with institutions and community awareness.

China's REDP, for example, focused on whole-cycle quality improvement for solar panels and SHS. It executed a "start-to-finish" quality process by establishing manufacturing standards and practices, facilitating access to product certification, and introducing a randomized testing regime which penalized companies at the production-line and retail stages for non-compliance with system performance requirements. It also culminated in the "Golden Sun" label to certify compliance with REDP's standards. REAP in Mongolia established technical standards and procedures for testing the quality of SHS and wind devices and mandated that only qualified systems could receive support under the program. SHS were even sent to China for testing to ensure compliance. In Sri Lanka, the ESD mandated that technologies meet national standards and technical compliance had to be verified by chartered engineers. Standardization and certification have been proven to facilitate more widespread manufacturing, reduced costs, and improved quality of systems in other studies (Barnes and Floor, 1996).

4. Limitations and further research

Though the 10 lessons above have been derived from a robust data collection process, four caveats must be advanced.

First and foremost, given the hundreds and perhaps thousands of renewable energy access programs around the world, the sample size of 10 cases is remarkably small, and can produce a biased result. Same with the fact that most of the cases involved large World Bank, United Nations Development Programme, or Global Environment Facility projects. Expanding the analysis beyond our case studies, within and outside of Asia, to confirm or disprove our factors would be expedient.

Second, a more formalized, empirical, quantitative assessment of the influence that each of our 10 lessons has on renewable energy access would be insightful. It would help complement the qualitative analysis provided here. Other research could explore which factors matter the most, which should be "weighted" more heavily, or are more salient, than others.

Third, research distinguishing project inputs—how projects ought to be designed and implemented, what goes in to them—from outputs—what those projects accomplished, what society got out of them—would be valuable, as well as the sequential or temporal nature of some factors. Some of the lessons, such as community involvement in design, are clearly inputs. Others, such as improved technology, are outputs. Some factors, such as political support, can be both an input (creates momentum to get a project started) and an output (a project that results in national legislation or leadership). In terms of timing, it could be that some of our factors, such as feasibility studies and technical standards, are prerequisites for others, such as capacity building and marketing, meaning that a certain sequence of factors is needed to achieve success. One Sri Lankan respondent argued that the ESD worked so well merely because "it came at the right window, it was all about timing." Analogously, some of the factors fall into the technical domain, such as standards, whereas others are economic, such as financing and income generation, and still others political (support and policy harmonization) and social (marketing and awareness). This study functionally mixes these inputs and outputs, and socio-technical dimensions together, as well as their timing, yet demarcating them would be helpful.

Fourth, it is conceivable that when undertaking the case studies, the author overlooked other drivers that strongly correlate to project successes and failures. For example, it may be possible that there is a correlation between the pace at which electricity demand increases and support for a particular renewable energy program. Geography and resource potential certainly play a strong role, with Nepal and Sri Lanka adopting microhydro units because they work well in the fast moving, mountainous rivers throughout each country; Indonesia and Papua New Guinea are well suited for solar energy because of their archipelagic nature. Population density, national population, and education exert strong influences: part of the reason Grameen Shakti has grown so quickly is because it has a captive market of more than 160 million potential customers in Bangladesh (the seventh largest population on the globe), China is the most populous country in the world, contrasting sharply with the relatively small number of people in Malaysia or Papua New Guinea (though this argument does not explain the tribulations of the VESP in India). Moreover, the high literacy rate of rural villagers in Sri Lanka contributed to the progress of the ESD while the lower literacy rates of those in Indonesia and Papua New Guinea inhibited dissemination. The global financial crisis and increasing consensus on the need for international action on climate change also influenced our case studies, whether by motivating political leaders to initiate projects (a plus) or negatively affecting the price of materials and commodities related to renewable energy systems as demand outpaced supply (a minus). Research exploring which internal or external factors were unnoticed in our analysis would be valuable.

5. Conclusions

Despite these caveats and suggestions for future research, the data from these 10 case studies strongly imply best practices for program design. Successful partnerships actively promote community participation and ownership. They couple energy services with income generation and employment, and they distribute responsibilities among different institutional partners, involving a diversity of important stakeholders. They choose appropriate technologies matched in quality and scale to the energy service

Table 4
Three paradigms of renewable energy development.

Attributes	Donor gift paradigm (1970s–1990s)	Market creation paradigm (1990s and 2000s)	New "sustainable program paradigm" (mid-2000s–present)
Actors	One, usually a government or just one development donor	Multiple government agencies and/or multilateral donors	Multiple public, private, and community stakeholders
Primary goal	Technology diffusion	Market and economic viability	Environmental and social sustainability
Focus	Equipment, often single systems	Multiple fuels (e.g. "electricity" or "fuelwood")	Energy services, income generation, institutional and social needs and solutions
Standardization	Little standardized between projects	Some standardization	Standardized with certificates, testing regimes, and national standards
Implementation	One time disbursement	Project evaluation at beginning and end	Continuous evaluation and monitoring
After-sales service and maintenance	Limited	Moderate	Extensive
Ownership	Given away	Sold to consumers	Cost-sharing and in-kind community contributions
Awareness raising	Technical demonstrations	Demonstrations of business models	Demonstrations of business, financing, institutional, and social models

desired, often with direct input from communities and users themselves. They do not "give away" renewable energy technologies or over-subsidize technology or research. Successful partnerships do not take consumer awareness about renewable energy for granted and, instead, direct resources at knowledge dissemination, marketing and promotion. Effective partnerships strongly emphasize after sales service and maintenance, ensuring that technologies are cared for by rural populations or technicians.

We know that the inclusion of multiple stakeholders in program design, implementation, and evaluation can enhance the efficacy of renewable energy deployment. The involvement of women's groups, multilateral donors, rural cooperatives, local government, manufacturers, nongovernmental organizations and other members of civil society, and even consumers, can increase both the performance and legitimacy of partnerships. They improve performance since input from multiple stakeholders can accelerate feedback; they improve legitimacy since programs with a broader base of support, and community involvement, are less likely to be opposed, protested, or even attacked physically during civil wars and internal conflicts.

We know that the most effective way to expand access to renewable energy through partnerships necessitates a shift in how most development practitioners conceive of energy technology and program structure. Effective partnerships emphasize markets and energy services for customers, rather than technologies. They go beyond merely equipment supply to assess income generation, applications, and user foci. They consider the economic viability of renewable energy technology as only one piece of the puzzle alongside policy formation, financing, institutional capacity, and social needs. They usually require national or local champions, either in the form of institutions or individuals. Successful programs share not only the rewards of building sustainable renewable energy markets, but also the risks. Practitioners, and those interested in energy development, could start by shifting how they conceive of energy technology and program structure to focus on the "Sustainable Program Paradigm" in Table 4.

Lastly, and perhaps most importantly, we know that investments in renewable energy bring benefits that far exceed their costs. In some cases these include improvements to household income and standards of living, in others productivity and community development. In others they bring technological reliability and quality, and reductions in cost. In still others they encompass significantly reduced greenhouse gas emissions and rates of deforestation. Investments in renewable energy technologies and programs represent one of those rare cases where not only households and small enterprises benefit, but also companies, regulators, and society at large. Particular experiences will always differ according to culture and context, yet when designed appropriately, renewable energy access programs can quickly and effectively accelerate the adoption of cleaner technologies in the areas of the world that most urgently need them.

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References

Bandalos, D.L., Boehm-Kaufman, M.R., 2009. Four common misconceptions in exploratory factor analysis. In: Lance, Charles E., Vandenberg, Robert J. (Eds.), Statistical and Methodological Myths and Urban Legends: Doctrine, Verity and Fable in the Organizational and Social Sciences. Routledge, New York, pp. 61–87.

Barnes, Douglas F., Floor, Willem M., 1996. Rural energy in developing countries: a challenge for economic development. Annual Review of Energy and Environment 21, 497–530.

Bartholomew, D.J., Steele, F., Galbraith, J., Moustaki, I., 2008. Analysis of Multivariate Social Science Data, 2nd ed. Chapman & Hall/Crc, New York.

Bazilian, M., Nussbaumer, P., Singer, C.E., Brew-Hammond, A., Modi, V., Sovacool, B. K., Ramana, V., Aqrawi, P.K., 2012. Improving access to modern energy services: insights from case studies. Electricity Journal 25 (1(January)), 93–114.

Chaurey, A, Krithika PR, Palit D, Rakesh S, and BK Sovacool. "New Partnerships and Business Models for Facilitating Energy Access," Energy Policy 47(1) (June, 2012), pp. 48-55. DOI: http://dx.doi.org/10.1016/j.enpol.2012.03.031.

Deheragoda, C.K.M. 2009. Renewable energy development in Sri Lanka: with special reference to small hydropower, Tech Monitor (November/December), pp. 49–55.

Dijk, Annemarije L., Jooijman-van, J.Clancy, 2010. Impacts of electricity access to rural enterprises in Bolivia, Tanzania, and Vietnam. Energy for Sustainable Development 14 (10 (March)), 14–21.

Ete, M., Prochaska, F. 2009. Determinants of success and failure of community based micro hydro projects. In: Proceedings of the Energy and Climate Change in Cold Regions of Asia Seminar, April 21–24, Ladakh, India, pp. 33–35.

International Energy Agency, 2011. Energy for All: Financing Access for the Poor. OECD/IEA, Paris, October.

Kammen, Daniel M., 1999. Bringing Power to the People: Promoting Appropriate Energy Technologies in the Developing World. Environment 41 (5 (June)), 10–15.

Lovins, A.B., 1976. Energy strategy: the road not taken. Foreign Affairs 55 (1), 65.

Magradze, N., Miller, A., Simpson, H., 2007. Selling Solar: Lessons from More Than a Decade of Experience. Global Environment Facility/International Finance Corporation, Washington, DC.

Martinot, E., 2001. Renewable energy investment by the World Bank. Energy Policy 29, 689–699.

Martinot, E., et al., 2002. Renewable energy markets in developing countries. Annual Review of Energy and the Environment 27, 309–348.

Nair, S. 2010. Evolution of Approaches towards Evaluation of Adaptive Responses, Presentation to the Evaluating Adaptive Responses to Climate Change Workshop of the South Asia Conference of Evaluators (The Evaluation Conclave), The Lalit Hotel, New Delhi, India, October 25.

Ostrom, E., 2010. Polycentric systems for coping with collective action and global environmental change. Global Environmental Change 20, 550–557.

Sovacool, B.K., 2011. An international comparison of four polycentric approaches to climate and energy governance. Energy Policy 39 (6), 3832–3844.

Sovacool, B.K., 2012a. Deploying off-grid technology to eradicate energy poverty. Science 338, 47–48. (October 5).

Sovacool, B.K., 2012b. The political economy of energy poverty: a review of key challenges. Energy for Sustainable Development 16 (3(September)), 272–282.

Sovacool, B.K., 2012c. Design principles for renewable energy programs in developing countries. Energy & Environmental Science 5 (11(November)), 9157–9162.

Sovacool, B.K., Drupady, I.M., 2012. Energy Access, Poverty, and Development: The Governance of Small-Scale Renewable Energy in Developing Asia. Ashgate, New York.

Sovacool, BK and AL D'Agostino. "A Comparative Analysis of Solar Home System Programmes in China, Laos, Mongolia and Papua New Guinea," Progress in Development Studies 12(4) (October, 2012), pp. 315-335. DOI: http://dx.doi.org/10.1177/146499341201200404.

United Nations Economic and Social Commission for Asia and the Pacific (UNESCAP). Energy Security and Sustainable Development in Asia and the Pacific. UNESCAP, Geneva, ST/ESCAP/2494, April 2008.

Velicer, W.F., Jackson, D.N., 1990. Component analysis versus common factor analysis: some issues in selecting an appropriate procedure. Multivariate Behavioral Research 25 (1), 1–28.